Assessing Commuter Demands on New Public Transit Project: A Case Study of Campus Community
การประเมินความต้องการของผู้เดินทางสำหรับโครงการขนส่งมวลชนในอนาคต: กรณีศึกษาชุมชนมหาวิทยาลัย

Pawinee Iamtrakul[1] and Suthipun Thanesuen[2]
ภาวิณี เอี่ยมตระกูล[1] และสุทธิพันธ์ ธเนศวร[2]

[1] Faculty of Architecture and Planning, Thammasat University, Pathumthani 12121, Thailand
E-mail: apawinee@hotmail.com
คณะสถาปัตยกรรมศาสตร์และการผังเมือง มหาวิทยาลัยธรรมศาสตร์ จังหวัดปทุมธานี 12121

[2] PCBK International Company Limited 518/3 4th floor Maneeya Center North Bldg., Ploenchit Rd., Lumpini, Pathumwan, Bangok 10330, Thailand
บริษัท พีซีบีเค อินเตอร์เนชั่นแนล จำกัด 518/3 ชั้น 4 อาคารมณียา เซ็นเตอร์นอธ ถนนเพลินจิต แขวงลุมพินี เขตปทุมวัน กรุงเทพฯ 10330

Abstract

This paper presents the results of a qualitative study of stated choice designs to assess commuting and non-commuting demands. Base on this assessment, the exploration of the perceptions on public transport service in the presence of new public transport infrastructure could be performed. The case study of university community was selected in order to obtain a deeper understanding of travelers' attitudes towards transportation development. The key findings indicated that in order to increase public transport usage, the service should be planned in a way to accommodate travelers. Furthermore, the choices of transports are influenced by several factors, such as socioeconomic characteristics, travel behaviors and attitudes. Policies which aim to enhance the ridership of overhaul should be targeted on the consideration of effective supporting network along with an incorporating with land use planning to reduce frequency of car users.

บทคัดย่อ

งานวิจัยนี้ได้นำเสนอวิธีการศึกษาเชิงปริมาณในการคาดการณ์ความต้องการในการเดินทางของผู้โดยสาร ซึ่งได้ทำการประเมินจากความตระหนักของผู้โดยสารต่อความสำคัญของการให้บริการขนส่งมวลชนใหม่ที่จะเกิดขึ้นในอนาคต โดยการศึกษานี้ได้ใช้กรณีศึกษาของรถไฟชานเมืองบริเวณมหาวิทยาลัยเพื่อศึกษาถึงทัศนคติของผู้เดินทางต่อการให้บริการด้านการขนส่งดังกล่าว ซึ่งผลการศึกษาพบว่าในการส่งเสริมให้เกิดการเดินทางนั้น การให้บริการด้านการขนส่งควรถูกออกแบบเพื่อให้สามารถรองรับกับความต้องการของผู้โดยสาร นอกจากนี้ ทางเลือกของการเดินทางที่เกิดขึ้นนั้นยังเป็นผลจากหลากหลายปัจจัยที่เกี่ยวข้อง โดยควรที่จะนำมาพิจารณาในการวางแผนด้านการขนส่งเพื่อให้เกิดความสอดคล้องรองรับต่อการบริการ อันได้แก่ ลักษณะทางด้านเศรษฐกิจ สังคม พฤติกรรม และทัศนคติการเดินทาง

โดยจะเห็นได้ว่าในการส่งเสริมให้เกิดความต้องการการเดินทางที่สูงขึ้นนั้น นอกจากควรที่จะมุ่งเป้าพื่อให้เกิดโครงข่ายของการรองรับการเดินทางให้เกิดประสิทธิภาพแล้ว ยังจำเป็นที่จะต้องคำนึงถึงรูปแบบการใช้ประโยชน์ที่ดินซึ่งควรได้รับการวางแผนให้เกิดประสิทธิภาพ เพื่อส่งเสริมให้เกิดการลดความต้องการของการใช้เครื่องยนต์ในการเดินทาง

Keywords

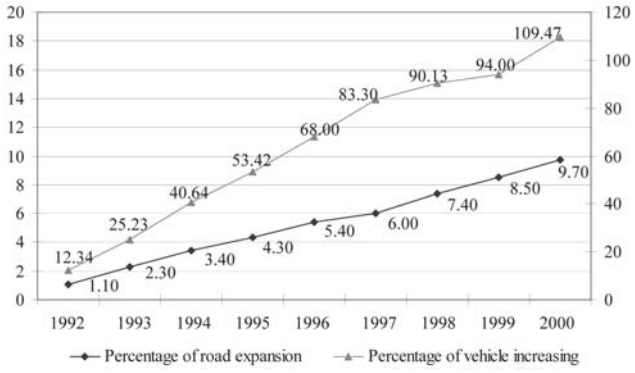
Transit-oriented Development (การพัฒนาพื้นที่บริเวณรอบสถานี)
Land Use (การใช้ประโยชน์ที่ดิน)
Urban Planning (การวางผังเมือง)

1. Introduction

Mass transit railway projects are often a top contender to solve the urban congestion problem, especially for many Asian cities (Tang & Lo, 2008). It is clearly seen that these projects in developed countries mainly aim to reduce the reliance on road vehicular traffic and hence relieve road congestion and environmental problems. Particularly, Thailand represents as one of the developing countries, on the other hand, the intensification of transit development aims to accommodate the rapidly increasing travel demands as well as to capitalize on their economic growth. Bangkok, the capital of Thailand represents as one of the mega cities with growing and expanding which traffic speeds tend to remain stable with moderate to high congestion in the central area. However, the congestion spreads outward geographically which has been influence by the expansion of Bangkok core area to its vicinities and also induces their longer distance of travel. The expansion of the metropolitan area to its proximity could be viewed in several aspects of consequences; e.g. population, density, number of household, no. of immigration and emigration (as depicted in Table 1). To sustain this continuing growth of population, BMA is required to manage land use and infrastructure development effectively as noticeably described in Table 1. Besides, Figure 1 also shows the evidence of the growth through time on all forms

Table 1. The growth of Bangkok and its vicinities in several aspects.

Population (Persons)	2000	2001	2002	2003	2004	2005	2006	2007	2008	Avg. % of Change/year
Bangkok	5,680,380	5,726,203	5,782,159	5,844,607	5,634,132	5,658,953	5,695,956	5,716,248	5,710,883	0.06
Samutprakarn	995,838	1,011,692	1,027,719	1,045,850	1,049,416	1,077,523	1,107,626	1,126,940	1,147,224	1.47
Pathumthani	654,701	679,417	708,909	739,404	769,998	815,402	861,338	896,843	929,250	3.28
Samuthsakorn	428,814	435,588	442,914	448,199	442,687	452,017	462,510	469,934	478,146	1.15
Nakornpathom	781,138	791,914	801,956	812,404	798,016	808,961	821,905	830,970	843,599	0.82
Nontaburi	859,607	884,077	905,197	924,890	942,292	972,280	999,057	1,024,191	1,052,592	2.04
Density (Person/sq.km.)	2,543	2,544	2,545	2,546	2,547	2,548	2,549	2,550	2,551	Avg. % of Change/year
Bangkok	3,623	3,652	3,688	3,727	3,593	3,609	3,633	3,646	3,642	0.06
Samutprakarn	992	1,008	1,024	1,042	1,045	1,073	1,103	1,122	1,143	1.47
Pathumthani	429	445	465	485	505	534	564	588	609	3.28
Samuthsakorn	492	500	508	514	508	518	530	539	548	1.15
Nakornpathom	360	365	370	375	368	373	379	383	389	0.82
Nontaburi	1,382	1,421	1,455	1,487	1,515	1,563	1,606	1,647	1,692	2.04
No. of Household	2543	2544	2545	2546	2547	2548	2549	2550	2551	Avg. % of Change/year
Bangkok	1,900,235	1,928,921	1,963,660	2,020,019	2,050,411	2,091,558	2,150,706	2,207,453	2,263,680	1.78
Samutprakarn	363,684	372,935	381,126	392,606	409,514	425,081	443,189	458,981	479,503	2.68
Pathumthani	282,275	291,862	305,693	324,932	346,950	370,867	387,509	411,022	427,051	3.77
Samuthsakorn	161,658	165,096	169,555	176,742	184,369	193,350	202,584	211,109	220,469	2.96
Nakornpathom	220,804	226,290	232,731	242,668	253,701	268,001	282,215	293,401	305,855	3.09
Nontaburi	363,786	369,061	377,222	388,552	404,431	421,554	449,200	468,769	491,795	2.89
Immigration (Persons)	2543	2544	2545	2546	2547	2548	2549	2550	2551	Avg. % of Change/year
Bangkok	443,017	451,609	461,139	479,693	504,043	453,405	436,973	420,946	413,331	-0.80
Samutprakarn	74,418	78,968	82,566	93,003	104,075	103,001	103,717	96,361	93,804	2.30
Pathumthani	46,253	59,408	64,734	77,938	99,716	98,980	98,537	94,180	90,085	5.41
Samuthsakorn	29,260	29,753	30,429	32,200	36,515	35,597	37,569	34,871	34,957	1.81
Nakornpathom	50,109	55,005	50,820	57,063	58,835	56,599	57,627	59,899	57,795	1.48
Nontaburi	71,614	73,200	75,311	83,868	96,027	99,390	93,874	91,102	95,522	2.78
Emigration (Persons)	2543	2544	2545	2546	2547	2548	2549	2550	2551	Avg. % of Change/year
Bangkok	473,758	482,878	476,019	498,454	578,319	472,759	449,255	438,945	440,415	-0.84
Samutprakarn	66,349	69,934	71,893	80,810	95,246	79,964	82,975	76,624	78,586	1.73
Pathumthani	31,244	35,847	38,279	43,878	70,015	58,960	60,251	62,311	62,348	5.54
Samuthsakorn	25,410	26,399	29,291	27,663	36,907	32,062	33,612	30,894	31,727	2.21
Nakornpathom	46,532	49,174	46,287	53,287	55,453	47,399	46,073	49,762	46,791	0.06
Nontaburi	55,250	55,678	54,820	65,403	89,387	74,266	72,187	68,017	70,306	2.38



Source: Office of Transport and Traffic Policy and Planning (OTP), 2004

Figure 1. The growing of road network and number of vehicle in Bangkok.

of road development and in terms of the yearly increasing in number of vehicles.

Despite the fact that the expansion of road network has been rapidly increasing, but the travel time and number of trips per person have both grown at similar rates. In 2003, Bangkok's in-use national motor vehicle fleet was about 2.9 million that was accounted for about 22% of the nation's registered motor vehicles including 57% of the private car fleet, 12% of national motorcycles and 42% of the combined truck and bus registrations. Pick-ups, almost all diesel engine powered, are widely used as a personal vehicles particularly in urban areas. Over the period from 1994 to 2003, Bangkok's motor vehicle fleet grew at an average rate of 3.3% per annum, thus increasing by a third over this period. The number of cars, vans and taxis grew at the relatively faster rate of 7.0% per annum over this period, while the number of motorcycles remained unchanged (World Bank, 2007). However, then existence of the outward expansion of the urban area may place some pressure for trip distances to rise, it is expected that this will be largely offset by changing land use that will enable people to undertake most of their activities in the region where they live. Increasing suburbanization and a possible slight decline in central area population density as shown in Figure 2 are expected to place increased reliance on motorized personal modes of transport.

Consequently, this study aims to observe the development of new transportation infrastructure in the urban transition area. With the consideration of the development plans at national, regional, sub-regional, provincial and municipality level, Pathumthani was selected as a study area for input

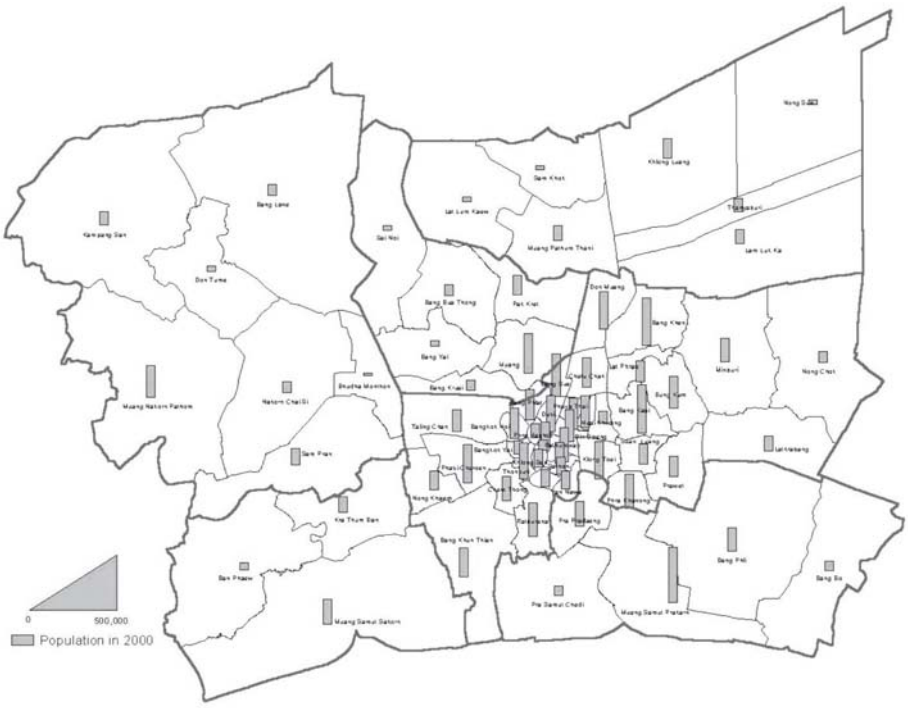


Figure 2. Population distribution in 2000 (URMAP, 2001).

to the further analysis since it could be also viewed as the prevalence of the satellite town of educational institution and industrial area. Meanwhile, the evolution of urbanization in the area should be studied to create a link between the growths of urban development leading to a conclusion on sustainable educational town. Furthermore, inconsistent with the transit network extension to cover the vicinity area of Bangkok, Pathumthani, the province that is situated of Thammasat University (Rangsit Campus) was selected as a study area to perform an assessment of the commuter demands on this new infrastructure, particularly for campus community case. Base on this exploratory, the discussion of the factors contributing to the efficient and effective transportation plan for new development could be accomplished in terms of several aspects such as users' needs, perception and attitude on the service. This is due to the reason that to reduce the demands on automobile while most people are now highly dependent on car travel is presented as new challenges to the planner, the operators, the public, and other stakeholders (Beirão and Cabral, 2007).

2. Urban and Transportation Planning in Bangkok

Several studies have recommended that Mass Rapid Transit (MRT) development has been as part of a suitable transportation system in Bangkok for many years. This idea is to integrate between land use planning and transportation planning for mitigation of traffic problem. Moreover, this is to control the phenomenon of urban sprawl due to the past urbanization pattern of Bangkok. The analysis of the Bangkok Environmental Improvement Plan (BEIP) revealed the following points:

1) Central areas of Bangkok have experienced declines of resident population,

2) Commercial and office centers have expanded along major corridor (ribbon development),

3) Suburban residential growth and development are major increasingly moving to the eastern and northern corridors.

To accommodate the increase in urbanization including population, commercial development and among others, it has been recognized that one of the most effective ways to facilitate urban restructuring is to move towards a polycentric system from the current mono-centric system in Bangkok (Figure 3). Furthermore, this approach can also drive to deliberately utilize the economic and other characteristics of urban rail transit systems. However, to support the transit development, Transit-Oriented Development (TOD) is an innovative strategy for planning the development of communities, cities, and regions. The general intent of TOD is to create land use patterns that support transit (TGM, 2003). Proximity site development areas should be well designed to provide maximum access and connectivity between the central core area and the surrounding

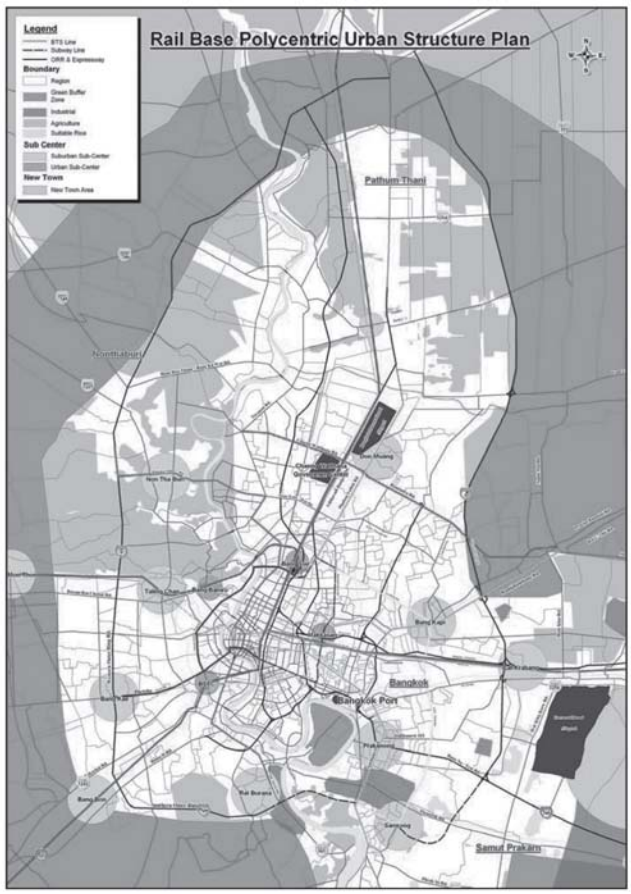


Figure 3. Rail base polycentric urban structure plan (IMAC, 2005).

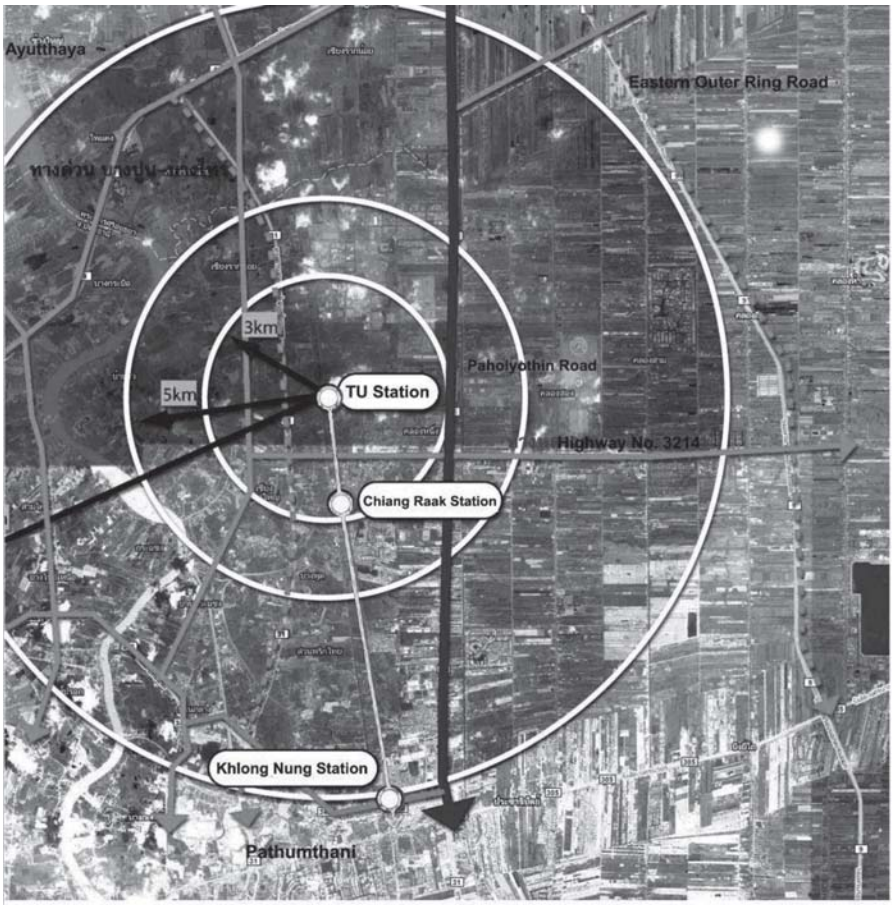


Figure 4. Study area.

area. This concept could make available easily accessible to major stations of the planned urban rail transit network will have newly increased land values, thereby enhancing economic potential for housing, light industrial, commercial and business development.

3. Methodology

TOD contains a variety of services required by residents, while also linking them to the rest of the region through the transit system. The context of the surrounding area proximity to the station is important on the consideration of future development for suitable pattern of TOD. This study selected the community type as a case study to verify the usefulness of the methodology. By utilizing the questionnaire survey was conducted inside the study area on November 2008, covering 10 km. radius as depicted in Figure 4. The surveyed locations consist of the following locations; Asian Institute of Technology (AIT), Thammasat University, Bangkok University, Communities, i.e. Ngam Chavee, Paad Rai, Navanakorn, and Klong Luang, Government Offices, Department Store, etc.

3.1 Sampling and Method

The sampling method was followed Taro Yamane's Population sampling table with the confidence level of 95% and ±3% error in order to cover the area sampling for the infinite number of population. The samples or respondents from this sampling method were totally 3,600 to cover the minimum size of sampling of 1,111 samples. The face-to-face interview was applied in the survey as well as self-answering by each respondent.

Base on the face to face interview technique to ask the respondents from the focused group,

it was found that the majority of respondents are stakeholders who would have both positive and negative impacts from project development. However, after screening process to obtain the final quality data to be input for further study, approximately 2,300 questionnaires (64%) were completed. This is more than the minimum sampling of the confidence level of 95% and ±3% error which was previously mentioned for the area of study more than 100,000 population. Even though the remaining questionnaires were not completed, some data can be used in the analysis. A preliminary question determined whether the commuter would appear as part of the stated choice experiment as selecting the transit as their main mode.

3.2 Characteristics of Land Use and Building Use

When considering the settlement of housing and transformation of land use in the study area, it was found that there is the major change along the highway (Phaholyothin Highway) as illustrated in Figure 5. This is due to the variety of infrastructure service provided to support job and housing development outside CBD community center under the geographic constrain of the area. Moreover, due to the expanding of the population of suburban communities, it is required the government in the surrounding area to use the scarce land resources effectively in support of the economic development and housing of the increasing population. The so-formulated land development strategies in turn have been a catalyst for the high population density sustaining over the years. On the one hand, thecontrolledsupply has put the prices of land and property on the fast rising track (Hensher & Rose, 2007).

To support transit development, the high-density residential estates built around railway stations would be recommended for further formed

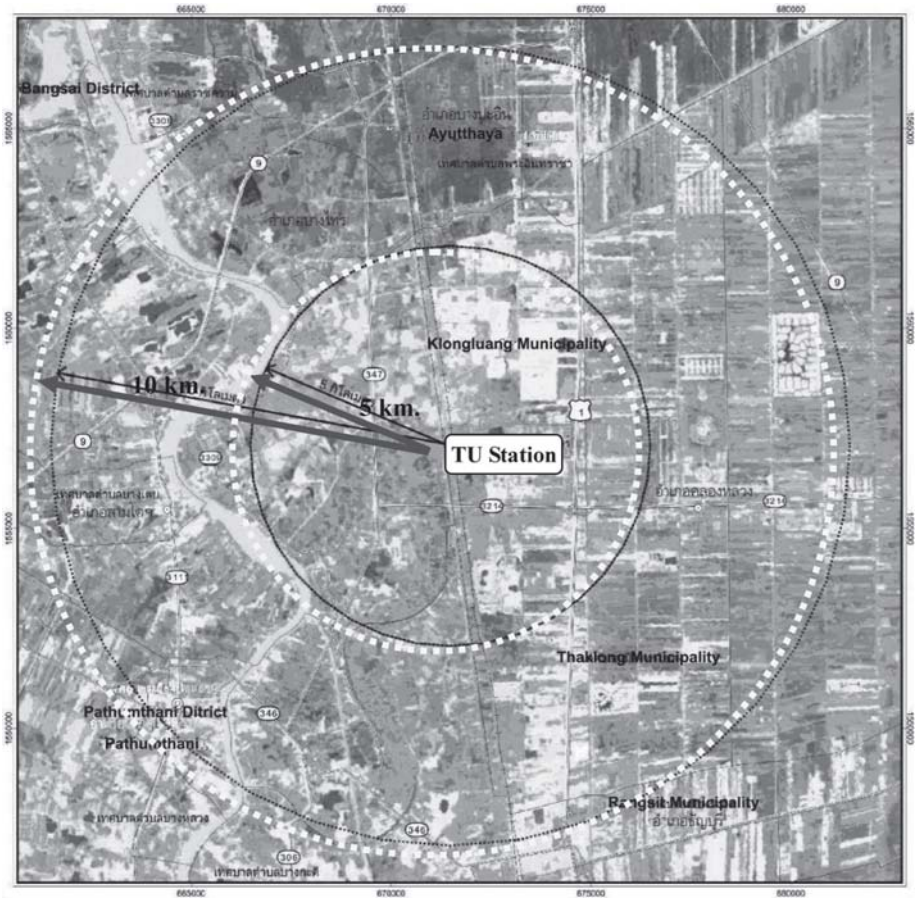


Figure 5. Urbanization of study area.

a large pool of potential passengers to support the operation of mass transit railways and the payback for the investment as there is large size of undeveloped area in the border of transit station.

When consider the type of building use on an influence on the ridership of transit patronage, it can be seen that most of the housing type in the study area is single housing that is about 96.9%. It is due to the capability of owner of single house would be able to afford for transit fare than the lower income level. Additionally, this is useful information to confirm that high potential on an enhancement of transit demands exists as there is shortest service of bus system in the study area to serve this housing development (feeder system). Moreover, it is obviously seen that the pattern of development along highway make corridor areas accommodate high demands of motorized vehicle (Figure 6). Thus, the future project of transit development would diminish the current problem while provide an effective link with existing service of transportation and land utilization promotion.

As previously mentioned about the majority building use, the presence of vast area of residential land use of 50.8% in the study area, followed by the industrial (31.5%) and academic institution (6.3%) as depicted in Figure 7. This combination of land use also confirms the high potential of generate transportation node. This is due to the fact that densities and levels of land-use mixture could encourage more transit riders. Mixed land-uses are thought to yield a number of transportation benefits, especially in suburban areas (Cervero, 1995). This is due to the availability for several mode choices to all for several type of activities of trip purposes (in mixed use area) with more convenient level of connectivity. Also, it is consistent to the characteristics of study area which is campus community with higher rate of non-motorized (e.g. walking, bicycling) modal splits.

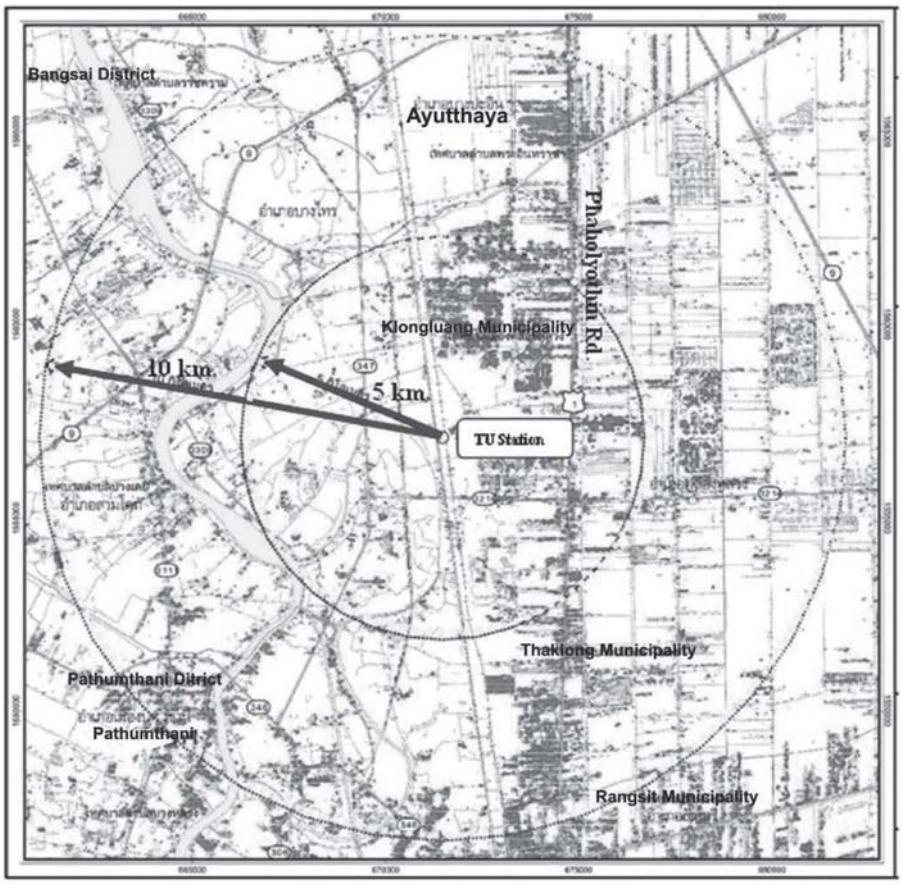


Figure 6. Ribbon development pattern in the study area.

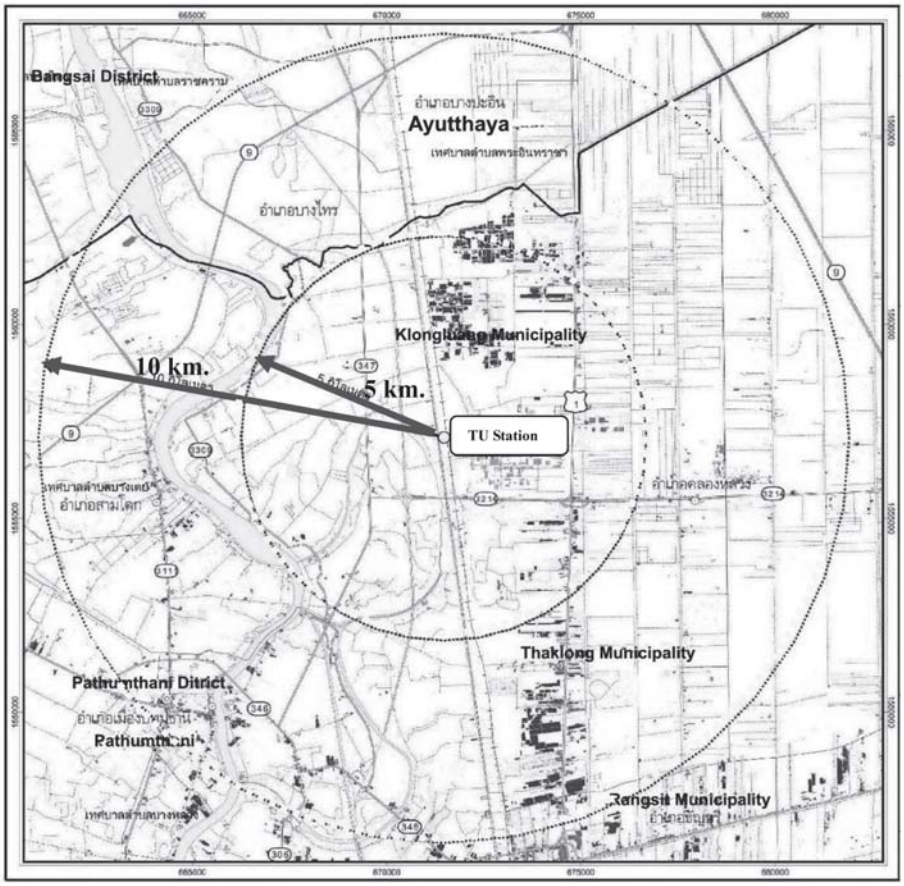


Figure 7. Land-use mixture in the study area.

4. Questionnaire Survey Analysis

Due to the reason that travel behavior is complex, a deep understanding of people's perceptions, attitudes and behavior are required. Qualitative methods are a powerful tool to explore those complexities, since they allow a grasp of the individual's own explanations of behavior and attitudes. Quantitative approaches have the advantage of measuring the reactions of many subjects to a limited set of questions allowing the comparison and statistical aggregation of the data. On the other hand, qualitative methods produce a wealth of detailed data on a small number of individuals (Beirão & Cabral, 2007). The analysis is classified into five parts according to the questionnaire that include; Personal Information, Opinions about Red Line Project, Travel Pattern, Development Pattern of Project, and Commuters' Attitude on Project.

4.1 Personal Information

From the analysis, most of the respondents are male, i.e. 62%. The age was well-distributed but the majority part was "below 20 years old" as the main locations of survey were Thammasat University and Bangkok University. Therefore, half of respondents were students with low income (< 6,000 baht per month). Only 14% of respondents had income more than 20,000 baht per month which can be classified to be a medium income group. Thus, the main transport mode was bus (35%), followed by car (27%) and van (15%). As the study has been conducted in Pathumthani province, most of the respondents were living in Pathumthani province. Figure 8 and Figure 9 show the personal information.

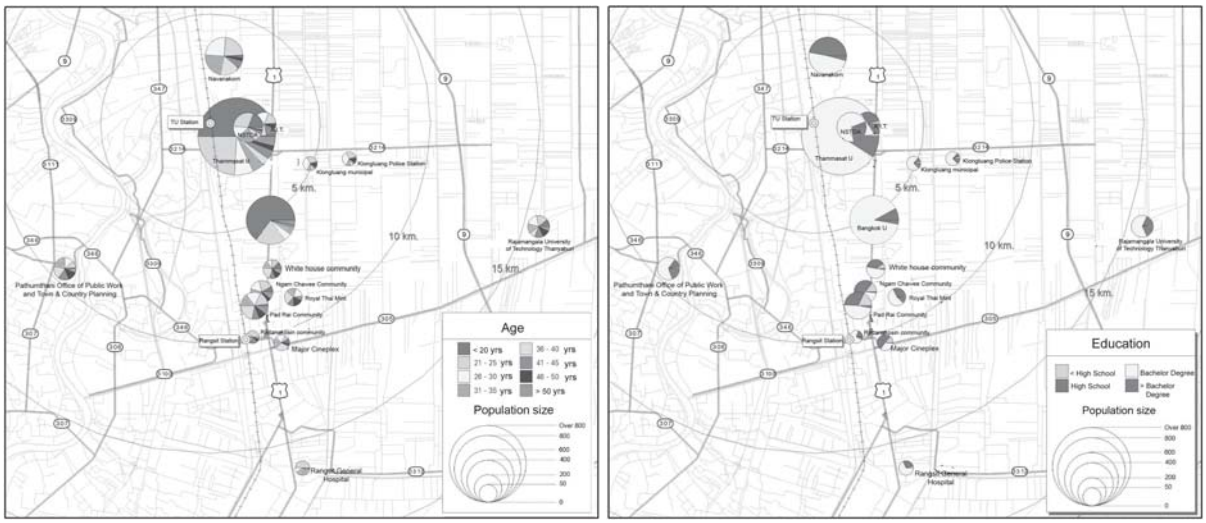


Figure 8. Distribution of age and education of respondents.

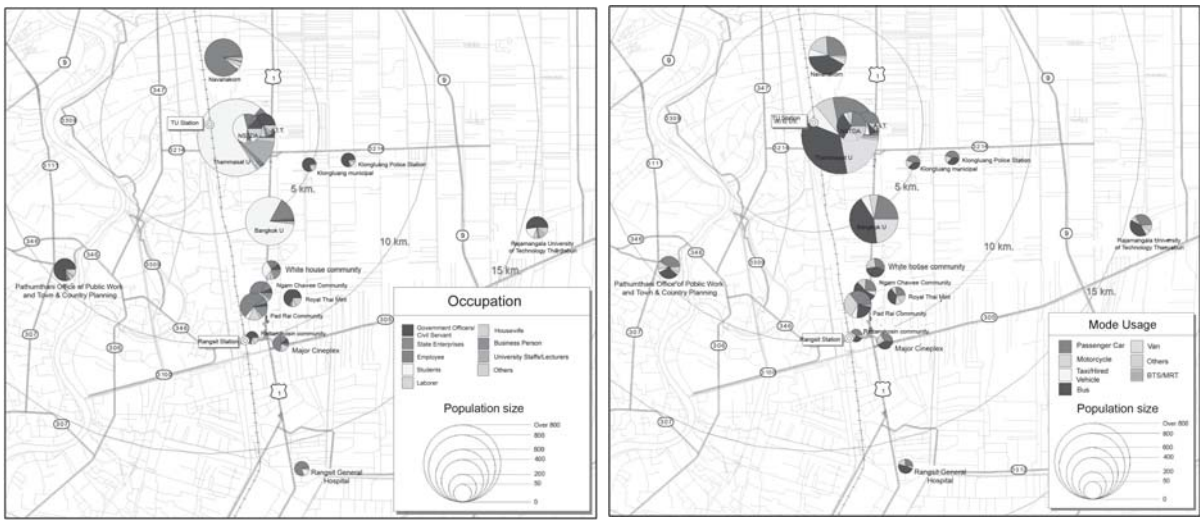


Figure 9. Distribution of occupation and mode selection of respondents.

4.2 Opinions about Red Line Project

This study also asks commuters' opinion about new development of the red line extension (Rangsit-Thammasat University) in the future. The results indicated that when the service is available, more than half of the respondents agreed to use this red line. In contrast, just 6% of respondents will not use it. The main reasons were that their school and university are in / near the route (40%) and their residential areas are in / near the route as shown in Table 2 and Figure 10.

For the travelling frequency, only 20% of respondents will use every day and 23% of respondents will use 3-4 times per week. It could be implied that the frequency of using the extension red line was relatively low. However, the decisions of respondents may be changed after the operation of the red line extension. Moreover, there is no red line project at the present time yet, thus the perception and the actual response from the respondent may be altered with their experience in the project, e.g. pattern, location of the station, accessibility, etc. Regarding the opportunity of using the red line extension, the analysis showed that most of the respondents will use the red line project for daily activities (to school and to workplace), followed by their destinations near the stations and traveling during the peak hour.

Table 2. Use of extension red line project.

Travel by the extension red line?		Frequency	Percentage
Definitely		2,031	56.42
Occasionally		1,361	37.81
Reason	their school and university are in / near the route	1,307	39.80
	their residential areas are in / near the route	600	18.27
	their workplaces are in/ near the route	615	18.73
	frequently travelling route	433	13.19
	Others	329	10.02
Not use		208	5.76
Reason	Off the route	176	63.77
	No opportunity	44	15.94
	Others	56	20.29
Total		**3,600**	**100.00**

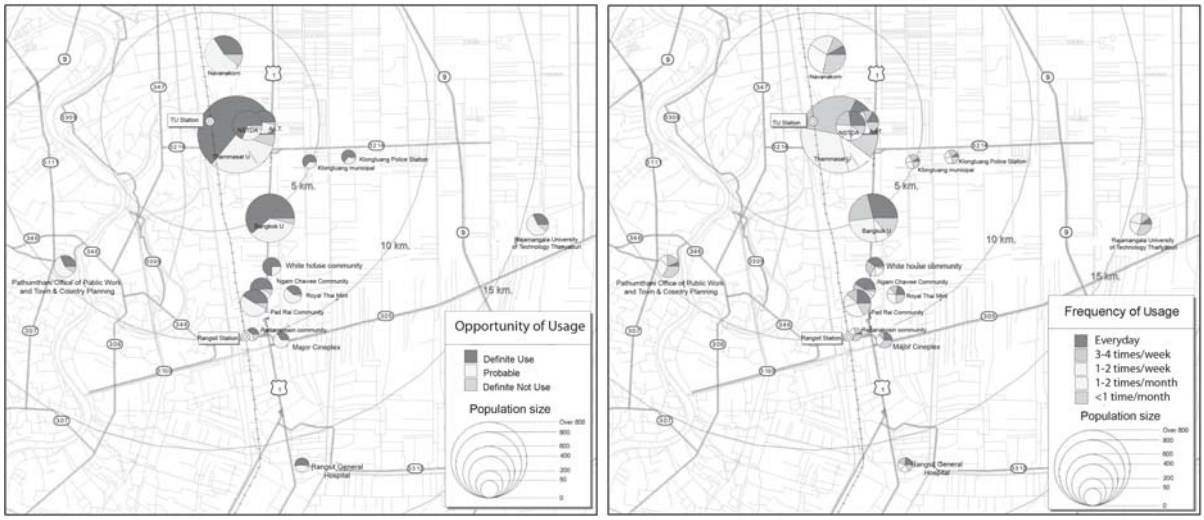


Figure 10. Distribution of opportunity for new mode usage and its frequency.

4.3 Travel Pattern

In this part, the respondents informed about their travel patterns, including origin, destination, transport mode, travel time, and expense. More than 50% of respondents are traveling more than two transport modes, mainly public transport (bus and van). Many respondents have to leave home very early in order to go to workplace or university on time. In the case that there is a red line extension in the future, about half of them will use it which corresponds to the results from the part 5.2. For the ones who will use it, they thought that they would save the travel time approximately 20 minutes. Moreover, they would save approximately 25 Baht. However, the travel expense of each respondents were not the same even though they travel from/to the same stations as there is no the fare structure for this extension project yet.

Moreover, many respondents will change the transport mode from own car to the red line extension which would save the travel time and travel expense. From the analysis, the regression

analysis was applied in order to obtain the relationship between travel time before and after operating the red line extension. The linear equation is shown below:

$$t_1 = 0.787t - 6.416 \quad (R^2 = 0.77) \qquad (1)$$

where t_1: travel time after operating the extension red line project

t: travel time at present

The result revealed that with the proposed project, although there are more connections to access new mode, people still prefer to travel by the proposed red line project as it is more convenient. For the change of travel expense, the regression analysis was also applied in order to obtain the relationship between travel expense before and after operating the red line extension. The linear equation is shown below:

$$c_1 = 0.704c - 5.414 \quad (R^2 = 0.64) \qquad (2)$$

where c_1: travel expense after operating the extension red line project

c: travel expense at present

4.4 Development Pattern of Project

1) Park & Ride

In this part, the first issue was about park & ride as it is one of the most important intermodal transfer facilities. Currently, the park & ride at BTS Mor-Chit station has been well-operated. The parking spaces are occupied all day as there are many passengers who travel from their homes and want to use the BTS system during the peak hour. Moreover, there is no parking fee, unlike the MRT system. MRT's park & ride are not for free but it is not too expensive.

One important factor for park & ride is the distance between park & ride and station. It is obvious that people do not want to walk so far to transfer the mode as almost 70% of respondents answered about 5 minutes or less. Moreover, only 20% answered about 10 minutes. The average walking time and median was 6.8 and 5.0 minutes, respectively.

2) Parking Fee

For the parking fee, daily and hourly parking fees were proposed in the questionnaire. Obviously, more than 80% of respondents preferred daily parking fee. Majority part answered 20 Baht/day (about US$0.6/day). However, the average daily parking fee was 26.68 Baht.

3) Fare

Fare structure is one of the important issues for the public transport. If it is too expensive, there is no passenger, and vice versa. There are two types of fares proposed in the questionnaire, i.e. flat fare and distance fare. Two third of respondents preferred a distance fare which is currently used in the current BTS and MRT systems in Bangkok. If the fare is set to be a flat fare, respondents preferred to pay 30 Baht (24%) and 20 Baht (23%) for this extension. After screening the data, the average flat fare was 24 Baht. In the case of distance fare, respondents preferred to pay 5 Baht (35%) and 10 Baht (32%) per station. The results are shown in the Figure 11.

4) Services

For the development of the extension red line project, the service is also important. From the analysis, it is apparent that infrastructure services were the most important (47%), followed by accessibility service (35%) and business service (18%). The infrastructure services are telephone, public toilet, post office, monthly ticket system, locker, common ticketing system, and one stop service. The most three important things were public toilet, telephone, and one stop service.

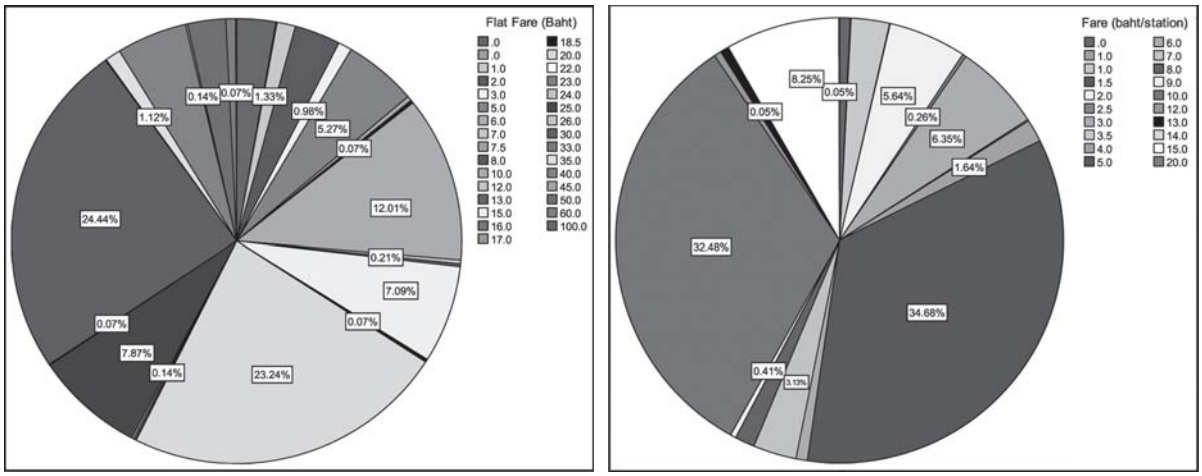


Figure 11. Flat fare and distance fare.

The accessibility services are connecting walkway, park & ride, personal assistance in the station, bicycle parking, and intermodal transfer facilities. From the result, the connecting walkway, intermodal transfer facilities, and park & ride were the most three important services. About the business services, it is obvious that most people want ATM to install in the station.

5) Intermodal Transport

The intermodal transport issue is become one of the most important issues for the public transport sector. From the consideration of intermodal transfer with other transport mode, convenience (43%) and safety (42%) were the most important issues for developing the intermodal transport system in the red line extension project while common ticketing system (15%) was the least important issue, as shown in Figure 12.

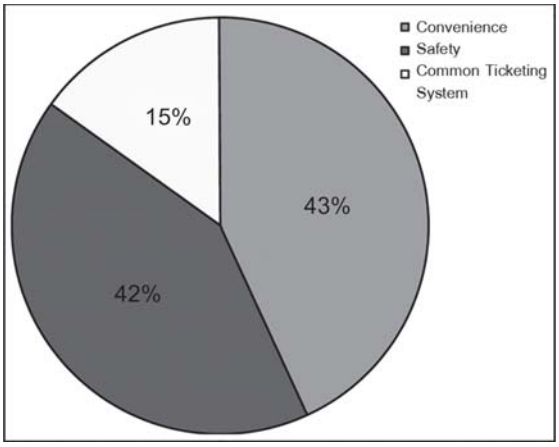


Figure 12. Important level of intermodal transport.

4.5 Commuters' Attitude on the Project

Regarding the travel attitude before and after the operation of the project, respondents had to compare between before and after the operation of the project in terms of 1) safety, 2) convenience, 3) effect to mental health and 4) effect to physical health. Unsurprisingly, most of the respondents agreed that every factor will be better after the operation of the project.

The question about the agreement for construction of the extension red line project has been queried. Even though this project will give the benefits to the people, only 56% agreed to construct the project. Therefore, some details regarding the benefit (especially social benefit) should be well-explained in the future study in order to let people understand the project.

4.6 Further Analysis

Further analysis was introduced regarding the use of extension red line project in order to understand the travel behaviors of the respondents. It is obvious that there are many factors that affect to the selection of the travel mode. The results are shown as follows:

- Most of the respondents who are willing to use the extension red line are the people who are traveling by bus (33%), followed by car (22.5%) and van (25.8%),
- Low income group will use the extension red line project more than the high income group,
- Respondents who are willing to use the extension red line are the ones who are living in Bangkok and its vicinities (88.3%). One of the reasons is that they are already familiar with the systems,
- Considering the occupation, student group is willing to use the extension red line most (52.6%),
- Respondents who are younger than 20 years old are willing to use the extension red line most (37.7%).

Moreover, One-way ANOVA was applied to test for differences among two or more independent groups, i.e. income and fare, as the study team thought that income would affect the selection of the fare level. From the results in the tables below, it is obvious seen that the different groups of income have different idea for selection of fare at significant level of 95%. Table 3 and Table 4 show the results from One-way ANOVA for flat fare and distance fare, respectively.

5. Conclusions

From the travel pattern, most of the respondents in the study traveled with more than two transportation modes per day. Therefore, the intermodal transfer facilities are very important in order to attract people to use the red line extension. Moreover, accessibility is also important. If the location of the station is far from the community, the number of passengers will be low multitude of origins and destinations. There are considerable risks that the anticipated demands and benefits will not be achieved. However, the provision of sustainable development is also risen to encourage the suitable development of suburban station type by consider the following point:

Table 3. One-way ANOVA test between flat fare and income level.

Flat Fare (Baht)					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	2055.742	5	411.148	2.832	.015
Within Groups	205881.376	1418	145.191		
Total	**207937.117**	**1423**			

Table 4. One-way ANOVA test between distance fare and income level.

Distance Fare (Baht/km)					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	158.994	5	31.799	2.265	.046
Within Groups	27315.505	1946	14.037		
Total	**27474.499**	**1951**			

- Maximize the level of potential accessibility for people in the proximity area of the service area of campus station. As a result, commuters could enjoy the service at a local level the quality of sidewalks and pedestrian facilities which are used by universal users,
- Enable passengers to transfer or change mode conveniently by making the new system be able to link with existing network (railway system, bus system, and other transport modes,
- Promote supportive services to facilitate users for their safety, convenient and comfortable while using transit such as business service (bank, grocery, bookstore, etc.), park and ride system, one stop service, etc.,
- Encourage denser, mixed-use development in the area of transit oriented where there are reasonable options for walking and bicycling to work, and where non-auto commuting is an explicit policy objective (such as for air quality attainment purposes) such as business and commercial activities taking advantage of the strategic location of inter modal stations,
- Infill development and reurbanization of traditional centers represent approach to creating viable mixed-use centers or encouraging new mixed-use suburban enclaves and edge cities, interlinked by efficient mass transit services (Cervero, 1995),
- The possible policy mechanisms should be pressure for bringing about such changes in the built environment are numerous, ranging from coordinated regional planning of transportation and land-uses to congestion pricing, etc.

Finally, it could be seen that there are many factors other than the land-use environment of transit oriented development which can also have a profound impact on future commuting behavior. Finding the right combination of land-use and non-land-use (e.g. pricing) initiatives for achieving various mobility and environmental objectives remains a significant public policy challenge. Moreover, an implication of this study could help a new transit system development in not only promoting ridership of public transport system while reducing the need for and use of private vehicles, but it also drives the policy for sustainable mass transit development.

6. Acknowledgement

The authors wish to express their sincere appreciation to Office of Transport and Traffic Policy and Planning (OTP) for their fully support on this research study. The authors also would like to convey the special thanks to the students of Faculty of Architecture and Planning, Thammasat University, Rangsit Campus, Thailand for conducting the questionnaire survey.

References

Asian Development Bank (ADB). (2005). *Performance evaluation report: Bangkok urban transport project* (Loan 1195-THA in Thailand). Retrieved November 2005, from www.adb.org

Beirão, G., & Cabral, J., S. (2007). Understanding attitudes towards public transport and private car: A qualitative study, *Transport Policy, 14,* 478-489.

Cervero, R. (1995). Mixed land-uses and commuting: Evidence from the American housing servey. *Transportation Research Part A, 30*(5), 361-377.

Givoni, M., & Rietveld, P. (2007). The access journey to the railway station and its role in passengers' satisfaction with rail trave. *Transport Policy, 14,* 357-365.

Hensher, D. A., & Rose, J. M. (2007). Development of commuter and non-commuter mode choice models for assessment of new public transport infrastructure project: A case study. *Transportation Research Part A, 41,* 428-443.

IMAC. (September, 2005). *The intermodal service integration for improvement of mobility, accessibility, sustainability and livelihood for Bangkok Metropolitan Region (BMR) and surrounding area.* Final Report Vol. II: Main Report, Report prepared for Office of Transport and Traffic Policy and Planning (OTP), Asian Engineering Consultants Corp., Ltd. Pacific Consultants International, TESCO Ltd. and Transconsult CO., Ltd.

Office of Transport and Traffic Policy and Planning (OTP). (2004). *The statistics of road network and number of vehicle in Bangkok.* Retrieved May 2009, from http://www.otp.go.th/

Tang, S., & Lo, H. K. (2008). The impact of public transport policy on the viability and sustainability of mass railway transit—The Hong Kong experience. *Transportation Research Part A, 42,* 563-576.

Transportation and Growth Management (TGM). (2003). *Connecting transportation & land use planning: Transit oriented development, University of Oregon.* Retrieved June 2009, from http://www.rrregion.org/pdf/publications/transportation/RRRC%20Transit%20Oriented%20Development%202006.pdf

URMAP. (2001). *Mass transit: Urban rail transportation master plan (BMA and surrounding areas),* December 2001. Bangkok, Thailand: Office of Transport and Traffic Policy and Planning (OTP).

World Bank. (2007). *Strategic urban transport policy directions for Bangkok, June 2007.* Bangkok, Thailand: World Bank.