Factors Affecting Travel in the Bangkok Metropolitan Region

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Abstract

This study aims to explore the behavior of Bangkok Metropolitan Region residents when using transport and to examine the factors affecting their travel. The population comprise commuters residing in the Bangkok Metropolitan Region who use transportation in their daily lives. The data were collected through an online survey conducted between December 2021 and March 2022 from a sample of 618 commuters, selected by convenience sampling. The analysis is divided into three parts. In the first part, we explore commuters' transportation behaviors using descriptive statistics, and in the second and third parts, using a multivariate analysis of variance, we examine the factors that influence travel in the Bangkok Metropolitan Region in terms of private cars use and number of transfers required on public transportation. The findings show that only a small percentage of people used public transport only; most people used private vehicles or both public and private transport. Commuters spent 36.24% of their monthly living costs on transportation. Furthermore, type of residence, whether a commuter took the bus, and income were all significant factors that influenced travel behavior. The results suggest that, in order to increase the number of public transportation users, public transportation charges should be lower than parking fees and

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vehicle maintenance expenditures, and the operation and amenities of buses must be enhanced to meet the passengers' demands.

Keywords: private transport, public transport, traffic congestion, travel behavior

JEL Classification: L91, R40, R41

1. Introduction

The Bangkok Metropolitan Region of Thailand includes Bangkok, the capital of Thailand, and five neighbouring vicinities: (a) Nakhon Pathom, (b) Nonthaburi, (c) Pathum Thani, (d) Samut Prakan, and (e) Samut Sakhon. For several decades, this area has been troubled by traffic congestion; the situation has deteriorated year after year because of a variety of factors, such as a poor city layout, a lack of access to public transit, and an excessive number of private vehicles (Marks, 2019). The Bureau of Planning, Department of Highways (2021), projected that the average travel speed in the Bangkok Metropolitan Region might drop to just 13.64 km/hr in 2020, with access to the central business district taking up to 2 hours. According to the Office of Transport and Traffic Policy and Planning, the Ministry of Transport of Thailand (2018), in 2018, commuters in the Bangkok Metropolitan Region made a total of 10,949 million trips per year, including 8,989 million trips per year by private vehicles and 1,959 million trips per year by public transport. The proportion who used public transport in this area accounted for just 17.90%, far lower than the rate of private vehicle use. The widespread use of individual transportation in many countries indicates a decrease in the use of public transportation and a reduction in the importance of other modes of transportation, such as walking and cycling (Burian et al., 2018). At present, this severe traffic congestion has yet to be properly and sustainably alleviated. One of the best solutions may be the development of a mass transit system to boost the use of public transportation by urban commuters and reduce the number of personal automobiles travelling through the inner city, where traffic is typically extremely congested (Pita et al., 2017).

Numerous studies have indicated that, because of the large number of private automobile users in the Bangkok Metropolitan Region, having to make a transfer (i.e., from one bus to another) might be a strain because of the possible increase in overall journey time. Moreover, inconsistent service can lead to missed connections and extended wait times, both of which can have negative effects on the public transportation user's experience (Grisé & El-Geneidy, 2019). In reaction to

inconsistent service, a commuter may modify their departure time to leave earlier, and the extra time that must be allowed for delays has been demonstrated to dramatically reduce trip satisfaction (Loong & El-Geneidy, 2016; St-Louis et al., 2014). For travellers unfamiliar with a public transport system, poor information and/or signage at transfer points can lead to wandering, stress, and uncertainty, which can exacerbate the stress that some public transport users experience in comparison to other modes of transportation (Legrain et al., 2015). Passengers may experience anxiety if they are unable to find their route, and these perceptions of unfamiliar travel might influence their general opinions about public transportation services and their intention to use such services in the future (Schmitt et al., 2013; Schmitt et al., 2015).

Despite the fact that several studies have explored travel behavior in various countries or specific regions, the methods of conducting research vary, and the variables and findings fluctuate according to the characteristics of commuters in each region. As a result, the primary objective of this study was to examine the transportation behavior patterns of Bangkok Metropolitan Region residents in the hope of contributing to a better understanding of commuters' travel habits in this region and leading to improved management strategies to encourage public transportation use. In addition, although several studies have examined the factors that influence travel in various cities, only a few have focused specifically on the Bangkok Metropolitan Area. Thus, we also hoped our results would permit traffic congestion to be addressed in a sustainable manner.

2. Literature review

Understanding the frequency and characteristics of commuter mobility is critical for government and public sector urban and transportation planning. The term 'travel behavior' refers to the complex decision-making processes made by commuters regarding modes of transport, routes, departure times, and destinations; these are influenced by factors that include urban spatial structures, land use, and street networks (Qi et al., 2019). Liu and Xu (2018) explained how changes in people's lifestyles have led to substantial changes in travel behavior over the past 20 years, and these trends are expected to continue. Liu and Xu suggested that urban transportation systems must be altered to increase urban mobility and improve the environment, the economy, and society in general. In the present study, the use of private cars and the number of transfers represent travel behavior of commuters in the Bangkok Metropolitan Region.

Driving a car is necessary for a number of individuals because it confers prestige and provides a sense of independence. Because of the lack of public transportation in remote areas, owning a car is even more necessary because it is the only way to travel great distances. For older individuals who have greater difficulty walking (to the bus stop) and cycling, driving is frequently their sole independent mobility choice (European Commission, n.d.). Many factors affect people's choice to use private vehicles or public transportation. Numerous studies have shown that sociodemographic factors influence transportation mode choices. Age, for example, can affect an individual's willingness to travel, and health concerns can have a significant influence on travel choices (Zajickova et al., 2014). Li et al. (2018) discovered that gender and car ownership influenced transport mode choices in China. Other studies have indicated that a range of economic variables also play a part. To encourage greater use of public transport, it is essential to understand travel behavior in particular areas. Many studies have addressed choices in regard to public transportation modes. Quality, comfort, safety, and reliability, for example, encourage greater use of public transport.

Transfers play an important part in the everyday operations of public transportation services in terms of ridership, cost efficiency, and consumer perceptions of service quality. In response to the traditional understanding of the perceived inconvenience of transferring, public transport planning techniques have sought to limit or restrict transferring (Grisé & El-Geneidy, 2019). An integrated public transportation system is one of the best options that governments and public transport providers throughout the world use to increase the ease of transit and transfer because it allows operators to cater to varied origin–destination pairings by offering well-connected, straightforward routes (Chowdhury & Ceder, 2015). According to Bak et al. (2012), attracting potential customers requires excellent integration in the form of appealing interconnections among routes; consequently, transfers clearly are an essential component of integrated systems. The purpose of transfers is to expand consumers' destination options and minimise their travel time and expenses. Chowdhury and Ceder (2013) demonstrated that passengers on public transportation are more willing to choose routes with transfers if the connections are managed. 'Planned transfers' in an integrated public transportation system were defined in their study as connections that policymakers and network planners built on purpose during the planning phase of the system to make service more efficient and comfortable. Many users of public transportation may have a negative attitude regarding transfers (Chowdhury &

Ceder, 2015). When transfers are planned well and customer disruption is kept to a minimum through a good public transportation system design (e.g., well-coordinated schedules, frequent service, connections for pedestrians, and clear signage), transfers can be helpful because they give people more travel options than direct-service networks. Badia et al. (2017) examined a case study of a restructured bus network in Barcelona that shifted from a direct-service network to a transfer-based network, resulting in an increase in service demand. Their experiment showed that bus riders are less opposed to transfers than had previously been thought because demand had gone up.

3. Methodology

The population in this study was commuters residing in the Bangkok Metropolitan Region who usually take transportation in their daily lives. As shown in Table 1, our sample comprised 618 commuters, selected by convenience sampling from various regions of the Bangkok Metropolitan Region. The data were collected via an online survey between December 15th, 2021, and March 15th, 2022. The dependent variables were use of private cars and number of transfers used. The independent variables were divided into two groups: Group 1 (gender, age, education, occupation, and income) and Group 2 (types of residence, household size, taking buses, taking MRT, taking BTS, and income).

The analysis was divided into three parts. In the first part, we explored, using descriptive statistics, the residents' behavior in using transports on everyday journeys. In the second part, we examined, with a multivariate analysis of variance (MANOVA), Group 1 factors that influence travel in the Bangkok Metropolitan Region. In the third part, we explored, also using a MANOVA, Group 2 factors that influence travel in this region. Because the statistical tool permitted only five variables per run, we conducted the MANOVA twice.

Table1: Sample size classified by residence location

City	*n*
Bangkok Metropolis	268
Nakhon Pathom	70
Nonthaburi	70
Pathum Thani	70
Samut Prakan	70

Samut Sakhon	70
Total	618

4. Results

4.1. Commuter behavior in the Bangkok Metropolitan Region

We first focused on the behavior of commuters who travel often across Bangkok and its vicinity. The findings focus on the proportion of private and public transportation users, modes of transportation, number of transfers, frequency with which people travel, types of dwellings in which they reside, monthly transportation expenditures, and proportion of transportation expenses to household spending. According to Table 2, the majority of Bangkok Metropolitan Region commuters, 44.66%, used only private vehicles for their journeys, whereas only a few people, 14.08%, depended on public transport. The proportion of people who used both personal vehicles and public transport was 41.26%.

Table 2: Transportation uses of Bangkok Metropolitan Region commuters (December, 2021, to March, 2022)

Mode	*n*	%
Using personal transports only	276	44.66
Using public transports only	87	14.08
Using both transports	255	41.26
Total	618	100.00

Table 3 shows the proportion of Bangkok Metropolitan Region commuters who used each mode of transportation in their daily journeys. Those who used private vehicles, such as cars, motorbikes, and bicycles, accounted for the highest proportion, at 89.81%. The proportion of those who used private vehicle services was also somewhat high. The proportion of those who used taxis was the highest among this group, accounting for 64.24%, followed by those who used motorbike services, with a slightly lower proportion of 61.97%. Among all of those using public transport and mass transit services, those who used the BTS sky train, bus, underground train, and pickup truck taxi services showed the most similar proportions, amounting to 46.93%, 44.82%, 44.01%, and 44.01%, respectively, and the proportion of those who took ferries was lowest, accounting for 21.68%.

Table 3: Transportation modes used by Bangkok Metropolitan Region commuters (December, 2021, to March, 2022)

Mode	Use (samples)	Do not use (samples)
Personal		
Household vehicles (e.g., cars, motorbikes, and bicycles)	555 (89.81%)	63 (10.19%)
Private vehicle services		
Taxies	397 (64.24%)	221 (35.76%)
Motorbike taxies	383 (61.97%)	235 (38.03%)
Public transports and mass transit services		
BTS sky-trains	290 (46.93%)	328 (53.07%)
Buses	277 (44.82%)	341 (55.18%)
Pick-up truck taxies	272 (44.01%)	346 (55.99%)
Underground trains (MRT)	272 (44.01%)	346 (55.99%)
Ferries	134 (21.68%)	484 (78.32%)

Note: BTS = The BTS Skytrain, or Bangkok Mass Transit System, is an elevated rapid transit system in Bangkok, Thailand; MRT = The Metropolitan Rapid Transit, or MRT, is a mass rapid transit system in Thailand that serves the Bangkok Metropolitan Region.

Table 4 shows the number of transportation transfers taken by commuters in the Bangkok Metropolitan Region, thus indicating how often they need to change transportation from the original stop to other routes or other transportation modes until they reach their destination. The results show that more than half of commuters, 56.47%, were able to take just one trip to reach the destination without any transfers to other vehicles. For example, they were able to drive their cars from their accommodation to their workplace directly, or they were able to take only one bus route from the origin to the destination without transfers to different buses or other transportation modes, such as urban trains. Approximately one third of commuters had to change their vehicles once during a journey. This meant that they had to make two trips within a journey to reach their destination. For example, they might have needed to take a BTS sky train at the stop nearby their house and then change to another BTS sky train line to reach their office. The findings also show that a few commuters, 7.44%, needed to change their rides twice during a journey or take three trips to reach the destination, and 5.02% had to change their mode of transportation three times or take more than three trips within a journey.

Table 4: Number of transfers required during a journey from the origin to the destination (December, 2021, to March, 2022)

No. of transfers	n	%
None (1 trip)	349	56.47
1 (2 trips)	192	31.07
2 (3 trips)	46	7.44
More than 2 (>3 trips)	31	5.02
Total	618	100.00

The data in Table 5 illustrate commuters' daily travel frequency. According to the findings, more than half of commuters—58.9%—travel once a day, and roughly one-fourth of commuters, 26.2%, travel twice a day. Few people travel three or four times per day, accounting for 12.0% and 2.9% of the population, respectively.

Table 5: Travel frequency per day (December, 2021, to March, 2022)

Travelling frequency (times/day)	n	%
1	364	58.9
2	162	26.2
3	74	12.0
4	18	2.9
Total	618	100.00

Table 6 shows the different types of commuters' residences. Approximately 51.1% of them live in a house, with the remaining 14.7%, 14.4%, and 12.9% living in condominiums, town homes, and dormitories, respectively. Apartments house only 6.8% of the population.

Table 6: Commuters' types of residences (December, 2021, to March, 2022)

Types of residence	n	%
House	316	51.1
Townhome	89	14.4
Condominium	91	14.7
Apartment	42	6.8
Dormitory	80	12.9
Total	618	100.0

The proportions of average transportation expenditures spent by an individual per month are presented in Table 7. Almost half of the commuters, 49.51%, spent ฿1,501–4,600 monthly on transportation, and 35.76% spent ฿1–1,500 per month on their everyday journey. The proportion of people who spent more than ฿4,600 on their monthly transportation costs amounted to 14.73%.

Table 7: Monthly transportation costs per capita (in Thai Baht) of Bangkok Metropolitan Region commuters (December, 2021, to March, 2022)

Monthly Transportation Costs/Person (฿)	n	%
1-1,500	221	35.76
1,501-4,600	306	49.51
Over 4,600	91	14.73
Total	318	100.00

Table 8 shows commuters' average monthly household expenditures, average monthly transportation costs, and proportion of average monthly transportation costs and average monthly per capita household expenditures. The results indicate that the average monthly household expenditures equalled ฿10,845.40 per person, with ฿2,885.06 spent per person on transportation, which accounted for 26.60% of total monthly expenses.

Table 8: Proportion of average monthly transportation costs and average per capita monthly household expenditures per capita of Bangkok Metropolitan Region commuters (December, 2021, to March, 2022)

	Means (baht/person)	SD
Average monthly household expenditures	10,845.40	1,260.81
Average monthly transportation costs	2,885.06	315.56
(Transportation costs/Household expenditures) ×100	26.60%	

4.2. Factor affecting travelling in Bangkok Metropolitan Regions (Group 1 demographic factors)

We next examined, using a MANOVA, whether Group 1 factors (gender, age, education, occupation, and income) affected travel in the Bangkok Metropolitan Region (using private cars and the number of transfers).

A MANOVA requires that the dependent variables be correlated within a group in order to be used, so we examined the correlations between the dependent variables rather than examining each variable independently.

The data in Table 9 show that the dependent variables, use of private cars and number of transfers, were correlated at a significance level of .01; thus, MANOVA could be used for the data analysis because it is appropriate for analysis of within-group independent variables or nominal scales, and the two dependent variables were correlated.

Table 9: Correlations between dependent variables

Dependent variable		Using private cars	No. of transfers
Using private cars	Pearson Correlation	1	-0.794(**)
	p (2-tailed)		0.000
	N	618	618
The number of transfers	Pearson Correlation	-0.794(**)	1
	p (2-tailed)	0.000	
	N	618	618

**p < .01, two-tailed.

The data in Table 10 demonstrate the inequality of covariance between groups of demographic variables (gender, age, education, occupation, and income), with a Box's M value of 19.836 and an F value of 1.010, indicating a violation of the assumption. A larger sample size reduces the significance level of residual error; therefore, we used a sample size of 618 rather than the minimal sample size of 400 (D'Alonzo, 2004). Because the test is robust, Wilks's Lambda must be replaced with Pillai's trace, which is more robust when assumptions are violated. Test statistic values, on the other hand, are often comparable.

Table 10: Box's test of equality of covariance matrices

Box's M	19.836
F	1.010
$df1$	18
$df2$	2185.012
p	0.445

Note: The design was Intercept + Gender + Age + Education + Occupation + Income+ Gender × Age × Education × Occupation × Income.

The data in Table 11 show that gender, age, occupation, and income affected the dependent variables (use of private cars and number of transfers) at a significance level of .050, but education had no statistically significant effect.

Table 11: Multivariate tests of demographic factors

Effect		Value	F	Hypothesis df	Error df	p
Intercept	Pillai's Trace	0.081**	23.720[a]	2.000	535.000	0.000
	Wilks' Lambda	0.919**	23.720[a]	2.000	535.000	0.000
	Hotelling's Trace	0.089**	23.720[a]	2.000	535.000	0.000
	Roy's Largest Root	0.089**	23.720[a]	2.000	535.000	0.000
Gender	Pillai's Trace	0.046**		4.000	1072.000	0.000
	Wilks' Lambda	0.954**	6.290	4.000	1070.000	0.000
	Hotelling's Trace	0.048**	6.346[a]	4.000	1068.000	0.000
	Roy's Largest Root	0.047**	6.401	2.000	536.000	0.000
Age	Pillai's Trace	0.048**	12.498[b]	8.000	1072.000	0.001
	Wilks' Lambda	0.952**		8.000	1070.000	0.001
	Hotelling's Trace	0.051**	3.325	8.000	1068.000	0.001
	Roy's Largest Root	0.048**	3.352[a]	4.000	536.000	0.000
Education	Pillai's Trace	0.002	3.379	2.000	535.000	0.512
	Wilks' Lambda	0.998	6.415[b]	2.000	535.000	0.512
	Hotelling's Trace	0.003		2.000	535.000	0.512
	Roy's Largest Root	0.003	0.670[a]	2.000	535.000	0.512
Occupation	Pillai's Trace	0.047**	0.670[a]	8.000	1072.000	0.001
	Wilks' Lambda	0.953**	0.670[a]	8.000	1070.000	0.001
	Hotelling's Trace	0.049**	0.670[a]	8.000	1068.000	0.001

Income	Roy's Largest Root	0.048**		4.000	536.000	0.000
	Pillai's Trace	0.028**	3.199	2.000	535.000	0.000
	Wilks' Lambda	0.972**	3.229[a]	2.000	535.000	0.000
	Hotelling's Trace	0.029**	3.260	2.000	535.000	0.000
	Roy's Largest Root	0.029**	6.454[b]	2.000	535.000	0.000
Gender*Age* Education* Occupation* Income	Pillai's Trace	0.599**		134.000	1072.000	0.000
	Wilks' Lambda	0.490**	7.818[a]	134.000	1070.000	0.000
	Hotelling's Trace	0.860**	7.818[a]	134.000	1068.000	0.000
	Roy's Largest Root	0.491**	7.818[a]	67.000	536.000	0.000

Note: The design was: Intercept + Gender + Age + Education + Occupation + Income+ Gender × Age × Education × Occupation × Income.

[a]Exact statistic. [b]The statistic is an upper bound on *F* that yields a lower bound on the significance level.

The outcomes of Levene's test, shown in Table 12, suggest that the variances for use of private cars and number of transfers were not equal, $F(69,548) = 23.155$, $p = .000$, and $F(69,548) = 5.716$, $p = .000$, respectively. This indicates that there is a statistically significant effect at the 1% level ($p < .01$) for dependent variables, and therefore the null hypothesis of equal population variances is rejected. Even though these variables violate the homogeneity-of-variance assumption needed for a MANOVA, they only slightly affect the data reliability; hence, a MANOVA can be run on actual data, as seen in Table 13.

Table 12: Levene's test of equality of error variances for dependent variables

Dependent variable	*F*	*df1*	*df2*	*p*
Using private cars	23.155	69	548	0.000
The number of transfers	5.716	69	548	0.000

Note: The design was: Intercept + Gender + Age + Education + Occupation + Income + Gender × Age × Education × Occupation × Income.

Table 13 indicates that, at the 5% significant level, age, occupation, and income show statistical significance for both dependent variables, using private cars and the number of transfers. This implies that these factors have a two-pronged impact on travel in the Bangkok Metropolitan Region. Gender is significant for the number of transfers only, while education has no statistical significance at the 5% significant level. This model can explain about 36.3% variation of using private cars with the independent variable (adjusted R^2 = 0.363 = 36.3%). This indicates that there are around 63.7% variability of this dependent variable need to be explained. Besides, this model can explain about 31.4% variation of the number of transfers with the independent variable (adjusted r-squared = 0.314= 31.4%). This indicates that there are around 68.6% variability of this dependent variable need to be explained.

Since the computer programme used to run MANOVA limits the number of variables, significant variables of Group 1 demographic factors (age, occupation, and income) were run along with Group 2 demographic factors.

Table 13: Factors affecting travel in Bangkok Metropolitan Regions, tested by tests of between-subject effects

Source	Dependent variables	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	Using private cars	68.527[a]	81	0.846	5.348	0.000
	The number of transfers	163.883[b]	81	2.023	4.486	0.000
Intercept	Using private cars	0.999	1	0.999	6.317	0.012
	The number of transfers	17.032	1	17.032	37.768	0.000
Gender	Using private cars	0.505	2	0.252	1.595	0.204
	The number of transfers	8.588**	2	4.294	9.522	0.000
Age	Using private cars	3.186**	4	0.797	5.035	0.001
	The number of transfers	11.008**	4	2.752	6.103	0.000
Education	Using private cars	0.032	1	0.032	.200	0.655
	The number of transfers	0.064	1	0.064	.142	0.707
Occupation	Using private cars	4.064**	4	1.016	6.423	0.000
	The number of transfers	5.764**	4	1.441	3.195	0.013
Income	Using private cars	2.409**	1	2.409	15.230	0.000
	The number of transfers	5.071**	1	5.071	11.244	0.001

Note: [a]R^2 = 0.447 (adjusted R^2 = 0.363)

[b]R^2 = 0.404 (adjusted R^2 = .314)

**$p < .05$.

4.3 Factor affecting travel in Bangkok Metropolitan Regions (Group 2 demographic factors)

We next examined, using a MANOVA, whether Group 2 factors (types of residence, household size, taking buses, taking MRT, taking BTS, and income) influencing travel in the Bangkok Metropolitan Region (use of private cars and number of transfers).

The data in Table 14 demonstrate the inequality of covariance between groups of demographic variables (types of residence, household size, taking buses, taking MRT, taking BTS, and income), with a Box's M value of 178.972 and an *F* value of 4.609, indicating a violation of the assumption. A greater sample size reduces the significance level of residual error, so we used a sample size of 618 rather than the minimal sample size of 400 (D'Alonzo, 2004). Because the test must be robust, Wilks' Lambda must be replaced with Pillai's trace, which is more robust when assumptions are violated. Test statistic values, on the other hand, are often comparable.

Table 14: Box's test of equality of covariance matrices

Box's M	178.972
F	4.609
df1	33
df2	1939.735
p	0.000

Note: The design was: Intercept + Type of residence + Household size + Taking buses + Taking MRT + Taking BTS + Income + Type of Residence × Household size × Taking buses × Taking MRT × Taking BTS × Income.

The data in Table 15 show that type of residence, household size, taking buses, and income affected the dependent variables (use of private cars and number of transfers) at a significance level of .05, whereas taking MRT and taking BTS showed no statistical significance. One can see that only income, from the Group 1 variable, was still significant when it was run with the Group 2 demographic factors, whereas the other two variables (age and occupation) were no longer significant.

Table 15: Multivariate Tests of demographic factors

	Effect	Value	F	Hypothesis df	Error df	p
Intercept	Pillai's Trace	0.303	107.779[a]	2.000	497.000	0.000
	Wilks' Lambda	0.697	107.779[a]	2.000	497.000	0.000
	Hotelling's Trace	0.434	107.779[a]	2.000	497.000	0.000
	Roy's Largest Root	0.434	107.779[a]	2.000	497.000	0.000
Types of residence	Pillai's Trace	0.077		8.000	996.000	0.000
	Wilks' Lambda	0.924	4.993	8.000	994.000	0.000
	Hotelling's Trace	0.081	5.003[a]	8.000	992.000	0.000
	Roy's Largest Root	0.059	5.013	4.000	498.000	0.000
Household size	Pillai's Trace	0.053	7.320[b]	16.000	996.000	0.041
	Wilks' Lambda	0.947		16.000	994.000	0.041
	Hotelling's Trace	0.055	1.700	16.000	992.000	0.040
	Roy's Largest Root	0.041	1.703[a]	8.000	498.000	0.009
Taking buses	Pillai's Trace	0.101	1.705	2.000	497.000	0.000
	Wilks' Lambda	0.899	2.576[b]	2.000	497.000	0.000
	Hotelling's Trace	0.112		2.000	497.000	0.000
	Roy's Largest Root	0.112	27.942[a]	2.000	497.000	0.000
Taking MRT	Pillai's Trace	0.000	27.942[a]	2.000	497.000	0.931
	Wilks' Lambda	1.000	27.942[a]	2.000	497.000	0.931
	Hotelling's Trace	0.000	27.942[a]	2.000	497.000	0.931
	Roy's Largest Root	0.000		2.000	497.000	0.931
Taking BTS	Pillai's Trace	0.003	0.071[a]	2.000	497.000	0.497
	Wilks' Lambda	0.997	0.071[a]	2.000	497.000	0.497
	Hotelling's Trace	0.003	0.071[a]	2.000	497.000	0.497
	Roy's Largest Root	0.003	0.071[a]	2.000	497.000	0.497
Income	Pillai's Trace	0.961		206.000	996.000	0.000
	Wilks' Lambda	0.267	0.700[a]	206.000	994.000	0.000
	Hotelling's Trace	1.883	0.700[a]	206.000	992.000	0.000
	Roy's Largest Root	1.116	0.700[a]	103.000	498.000	0.000

Note: The design was: Design: Intercept + Type of residence + Household size + Taking buses + Taking MRT + Taking BTS + Income + Type of Residence × Household size × Taking buses × Taking MRT × Taking BTS × Income. BTS = xxxx; MRT = xxxx.

[a]Exact statistic. [b]The statistic is an upper bound on an *F* that yields a lower bound on the significance level.

The outcomes of Levene's test, presented in Table 16, showed that the variances for using private cars and the number of transfers were not equal, $F(103, 514) = 6.084$, $p = .000$, and $F(103, 514) = 5.418$, $p = .000$, respectively. This indicates that there is a significance at the 1% level ($p < .01$) for dependent variables, and therefore, the null hypothesis of equal population variances is rejected. Even though these variables violate the homogeneity-of-variance assumption needed for a MANOVA, they affect the data reliability only slightly; hence, a MANOVA can be run on actual data, as seen in Table 17.

Table 16: Levene's test of equality of error variances for dependent variables

Dependent variable	*F*	*df1*	*df2*	*p*
Using private cars	6.084	103	514	0.000
The number of transfers	5.418	103	514	0.000

Note: The design was: Intercept + Type of residence + Household size + Taking buses + Taking MRT + Taking BTS + Income + Type of Residence × Household size × Taking buses × Taking MRT × Taking BTS × Income. BTS = xxxx; MRT = xxxx.

The data in Table 17 indicate that, at $p < .05$, type of residence, taking the bus, and income showed statistical significance for both dependent variables. This implies that these factors have a two-pronged impact on travel in the Bangkok Metropolitan Region. Household size was significant for use of private cars only, and taking MRT and taking BTS had no statistically significant effects. This model can explain approximately 67.1% of the variation in use of private cars with the independent variable (adjusted $R^2 = .671$ [67.1%]). This indicates that around 32.9% of the variability in this dependent variable needs to be explained. In addition, this model can explain about 66.4% of the variation in the number of transfers with the independent variable (adjusted $R^2 = .664$ [66.4%]). This indicates that approximately 33.6% of the variability in this dependent variable needs to be explained.

Table 17: Factors affecting travel in Bangkok Metropolitan Regions, tested by tests of between-subject effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	p
Corrected Model	Using private cars	112.618[a]	119	0.946	11.579	0.000
	The number of transfers	295.578[b]	119	2.484	11.242	0.000
Intercept	Using private cars	1.240	1	1.240	15.171	0.000
	The number of transfers	13.490	1	13.490	61.059	0.000
Types of residence	Using private cars	1.741	4	0.435	5.326	0.000
	The number of transfers	2.430	4	0.607	2.749	0.028
Household size	Using private cars	1.556	8	0.195	2.380	0.016
	The number of transfers	1.959	8	0.245	1.108	0.356
Taking buses	Using private cars	2.657	1	2.657	32.503	0.000
	The number of transfers	12.182	1	12.182	55.136	0.000
Taking MRT	Using private cars	0.010	1	0.010	0.118	0.732
	The number of transfers	0.027	1	0.027	0.121	0.728
Taking BTS	Using private cars	0.049	1	0.049	0.601	0.439
	The number of transfers	0.004	1	0.004	0.019	0.891
Income	Using private cars	31.701	103	0.308	3.766	0.000
	The number of transfers	98.280	103	0.954	4.319	0.000

Note. [a]R^2 = .735 (adjusted R^2 = .671).

[b]R^2 = .729 (adjusted R^2 = .664).

5. Discussion

Our examination of Bangkok Metropolitan Region residents' behavior in using transportation showed that just a small percentage of people who used only public transportation. Most people used personal vehicles or personal vehicles together with public transport. These findings are in accordance with the report of the Office of Transport and Traffic Policy and Planning, Ministry of Transport of Thailand (2018), which stated that 82.1% of commuters in the Bangkok Metropolitan Region use household vehicles, such as cars and motorbikes, and 17.9% use public transport. Success in shifting modes from household vehicles to public transport primarily requires that the service quality satisfies regular and potential passengers given that door-to-door vehicles usually meet people's needs better than public transport because of their higher speed, ease, reliability, sense of freedom, and standard of living. High-quality public transport services are characterised by accessible public transport stops, service frequency, vehicle fleet modernisation,

on-time performance, and travel time (Burian et al., 2018). One of the primary reasons why many commuters prefer using a private vehicle to travel to work every day is the long travel time associated with public transportation. Waiting time, according to Doori (2017), has a significant influence on choosing modes of transport options. In that study, travellers were more willing to switch to public transportation if the waiting time was less than 10 minutes. Furthermore, the accessibility, convenience, and service environment of public transportation are all highly correlated with travel mode choice (Chen & Li, 2017; Gadzinski, 2016). Because Bangkok's mass transit services do not cover a wide region, many people cannot access the services, and commuters may be hesitant to use public transportation (Charoentrakulpeeti et al., 2006).

According to the findings presented in Table 8, the average monthly household expenditure of Bangkok Metropolitan Region residents was ฿10,845.40, and their monthly transport expenditure was ฿2,885.06. This indicates that 26.60%, or one third of Bangkok Metropolitan Region residents' monthly expenses, go to transportation. This proportion is considerably high when compared with the survey of the socioeconomic status of Bangkok households in the first half of 2019 by the National Statistical Office of Thailand (2019), which indicated that the monthly household expenditure of Bangkok residents was ฿31,753, and their monthly transport expenditure was ฿5,846, or 18.41% of their outgoings.

When exploring the factors that influence Bangkok Metropolitan Region commuters' travel habits, the results revealed that type of residence, taking the bus, and income were significant factors for both of the dependent variables: using private cars and the number of transfers. Type of residence may affect the ownership of private vehicles because of parking facilities. Guo (2013) revealed that the availability of residential parking can have a considerable impact on household automobile ownership decisions. Their effect surpasses household income and demographic variables, which are commonly thought to be the primary predictors of automobile ownership. People who usually take buses may refer to those who depend on public transport. According to Health and Social Care Information Centre (2015), people who rely on public transportation have a difficult time getting to vital activities such as those related to jobs, education, and health care in both rural and urban settings. Moreover, low-income households have a greater rate of nonvehicle ownership; in the United Kingdom, 40% of the people still do not have access to a car.

6. Conclusion and Recommendations

Our findings can be used to create guidelines to enhance the use of public transportation in Thailand, thus potentially decreasing transport expenses because the cost of public transport would be cheaper than the cost of personal vehicle usage. When more people use public transport, the number of private vehicles on the street declines. As a result, traffic congestion is relieved. Parking facilities and type of residences typically are associated; therefore, to increase the number of people who use public transportation, local administrative and government bodies must reduce public transportation fares so that they are less than parking fees and vehicle maintenance expenses. Taking the bus is a significant factor in travelling within the Bangkok Metropolitan Region. To retain the patronage of these travellers, bus operations and facilities must be enhanced to meet their expectations. For instance, all obsolete vehicles should be renovated or replaced to improve their appearance and use so that customers will be drawn to these services. In addition, bus operators must ensure the quality of their offerings, such as sufficient and reliable service. Another aspect that has an effect is income. Access to public transportation may not be an issue for residents with higher incomes, but it is for those with lower incomes. Therefore, operators must provide affordable service to this segment of clients in order to expand their accessibility.

This research has some limitations. We examined only samples from the Bangkok Metropolitan Region; future research should examine samples from additional Bangkok neighbourhoods. In addition, we used an online questionnaire that was self-administered. Future studies that incorporate interviews and other qualitative research methods may yield better information.

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