

FACTORS INFLUENCING MODE OF TRAVEL TO SCHOOL: A CASE STUDY OF NAKHON RATCHASIMA

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Abstract

Thailand is ranked as 1 of the world's most congested countries and Nakhon Ratchasima is an area in Thailand encountering that problem, especially in the areas to which a large number of students travel by private vehicles. Therefore, this study aims to investigate and analyze the factors influencing the students' mode of travel to school by public buses and develop a structural equation modeling of the students' public bus mode choice for trips to and from school. The sample group consisted of 680 parents whose children are studying at the secondary school level in Mueang Nakhon Ratchasima District. The data were collected by using a questionnaire and were analyzed by structural equation modeling according to the theory of planned behavior. From the model of factors influencing the motorcycle mode choice for school trips (a comparison between public buses and motorcycles), it was found that the behavioral intention to choose public buses to school has the most effect ($\beta = -0.944$), which is influenced by the attitudes, subjective norm, and perceived behavioral control in using public buses. In addition, the model of factors influencing the private car mode choice to school (a comparison between public buses and private cars) showed that the behavioral intention to choose public buses for school trips has the most effect ($\beta = -0.675$), which is influenced by the attitudes, subjective norm, and perceived behavioral control in using public buses. The results of this research can be used as guidelines for planning to promote students' public transport use for school trips.

Keywords: Public bus, theory of planned behavior, structural equation model, students

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Introduction

Thailand is ranked as one of the world's most congested countries. Referring to INRIX (2018), Thai people spent an average of 56 hours per year in traffic congestion in 2017, which is a problem caused by the increasing traffic volume. According to the statistics from the Department of Land Transport, under the Motor Vehicle Act, 1979 and Land Transport Act, 1979, at the end of 2018 Thailand had a total of 39,160,454 registered vehicles including 38,171,210 private cars and motorcycles. When compared to the vehicle numbers in 2015, the number of vehicles then registered under the Land Transport Act, 1979 and Motor Vehicle Act, 1979 totalled 35,546,514 including 34,616,257 private cars and motorcycles; the numbers increased by 9.23% from 2015, while the number of private cars and motorcycles registered increased by 9.31% (Department of Land Transport, 2019).

Nakhon Ratchasima is an area in Thailand where the use of private cars and motorcycles has increased. When considering the statistics from the Department of Land Transport, the number of new 1,336,960 vehicles registered under Land Transport Act, 1979 and Motor Vehicle Act, 1979 has increased by 8.36% when compared to of the figures for 2015. This causes traffic congestion during rush hours, particularly in urban areas which are the centers of prosperity, economic activities, education, trade, and services. Schools are one of the types of places with various activities and a lot of students travel to school for their education. For their choice of travel mode to school, the students in Nakhon Ratchasima have chosen to travel in private cars (54%), on motorcycles (14%), in school buses (15%), and on public buses (17%) (Napat, 2013).

The large use of private vehicles such as private cars and motorcycles in the school area increases the risk of road accidents (Albertsson and Falkmer, 2005) mental health problems, energy problems, and air and noise pollution. Therefore, public transportation management has been tasked to solve problems and create a sustainable transportation system (Qureshi and

Lu, 2007). The public bus is a form of public transportation which students use. A policy development for students to use public buses effectively needs to understand the decisions about the students' travel mode choice. Previous studies have focused on the psychological factors to choose the mode of transport depending on an individual's decision. From the study of McMillan (2005), it was found that parents' decisions have a direct influence on the students' travel mode choice.

Therefore, this study investigated the factors influencing the students' travel mode choice and the factors that affect the parents' decisions. Also, this study aims (1) to analyze the factors influencing the school travel mode of public buses and (2) to develop a structural equation model of the students' travel mode choice of public buses.

In the literature, there are numerous researches on theory planned behavior toward travel mode. Some examples of the researches which have focused on theory planned behavior toward travel mode are shown in Table 1.

Materials and Methods

Theory of Planned Behavior

The theory of planned behavior (TPB) is the study of the attitudes and the influence of attitudes on behavior change. The principles of planned behavior state that human behavior is greatly influenced by behavioral intention. The 3 factors (Ajzen, 1991) influencing behavior are attitudes, subjective norm, and perceived behavioral control.

Structural Equation Modeling

Structural equation modeling (SEM) is the model used to estimate the test of the relationship between different variables. This model is the result of the synthesis of 3 important data analysis methods, namely, factor analysis, path analysis, and parameter estimation in regression analysis; the structural

Tables 1. Summary of the relevant studies on the theory of planned behavior

Author(s) (year)	Mode of transport	Analysis method	Factors			
			Intention	Attitudes	Subjective norm	Perceived behavioral control
Morten <i>et al.</i> (2018)	Airplane	Hierarchical multiple regression analysis		✓	✓	✓
Liu <i>et al.</i> (2017)	Private car	SEM		✓	✓	✓
Kamarudin <i>et al.</i> (2016)	Public transport	Multiple regression analysis		✓		✓
Lo <i>et al.</i> (2016)	Private car, public transport, bicycle	SEM	✓	✓		✓
Donald <i>et al.</i> (2014)	Public transport, private car	SEM	✓	✓	✓	✓
Nordfjaern <i>et al.</i> (2014)	Public transport, private car	SEM		✓	✓	
Chen and Chao (2011)	Public transport, private car, motorcycle	SEM		✓	✓	
Chen and Lai (2011)	Public transport, private car, motorcycle	Regression analysis	✓	✓	✓	✓
Eriksson and Forward (2011)	Private car, bus, bicycle	Hierarchical regression analyses	✓		✓	✓
Long <i>et al.</i> (2011)	Sky train	SEM		✓	✓	✓

equation model accepts the measurement variances correlated (Hair, 2010) to the structural equation model which consists of 2 sub-models: the measurement model and the structural model.

Data Collection

This study collected data using self-administered questionnaires. The samples were drawn from parents of secondary school students studying in 21 schools in Mueang Nakhon Ratchasima District (The Office of Academic Promotion and Registration, 2019) using stratified random sampling classified by school type. According to the study of Golob (2003), the suggested number of samples in the structural equation modeling used for estimating the maximum likelihood is at least 15 times more than the suggested number of observable variables. In the study, the number of observable variables is 21. In total, there are 315 samples. However, for reserve samples, 680 samples were collected to prevent sample errors or damage, and these were considerably sufficient for SEM analysis.

Questionnaire

The researchers used the Likert scale to collect the data. It is divided into 5 levels: most

agreeable, agreeable, not sure, disagreeable, and strongly disagreeable (5 is the highest score and 1 is the lowest score). The components of the questionnaire are divided into 3 parts: part 1 is the socioeconomic status of the parent; part 2 is how the transportation mode to school is chosen; and part 3 is the planned behavior data toward the use of public buses. In addition, in the research, the researchers used the structural equation analysis. The variables can be summarized, as shown in Table 2.

Results and Discussion

Sample Characteristics

According to the survey of 680 parents, it was found that the personal information and socioeconomic status consisted of male students (48%), female students (52%), aged between 13 and 15 years (59%), aged between 16 and 18 years 41%, lower secondary school students (59%), and high school students and high school graduates (41%). The parents answering the questionnaires consisted of males (45%), females (55%), aged between 40 and 49 years (54%), and having 2-3 family members (62%). For the education level, the highest education level is a bachelor's degree

Table 2. Variable names and definitions of variables for factors affecting school travel mode choice

Variable name	Definition of variable	Description
MODE	The school travel mode which parents decide for their children	For model public bus and motorcycle 0 = choose public bus 1 = choose motorcycle
DIST_1	The distance between home and the public bus boarding point	For model public bus and private car 0 = choose public bus 1 = choose private car 1 = less than 0.5 km 2 = 0.5–1 km 3 = 1.1–1.5 km 4 = 1.6–2 km 5 = 2.1–2.5 km 6 = more than 2.5 km
WAIT	The duration of waiting time for public buses	1 = less than 10 min 2 = 10–20 min 3 = 21–30 min 4 = more than 30 min
POINT	Number of transfers in public buses to school	1 = 1 hop 2 = 2 hops 3 = more than 2 hops
COST	Daily expenditure for using public buses to go to and return from home and school	1 = less than 10 baht 2 = 10–20 baht 3 = 21–30 baht 4 = more than 30 baht
DIST_2	The distance between home and school	1 = less than 5 km 2 = 5–10 km 3 = 11–15 km 4 = 16–20 km 5 = 21–25 km 6 = 26–30 km 7 = 31–35 km 8 = more than 35 km
TIME	The travel time to and from home and school by public buses	1 = less than 10 min 2 = 10–20 min 3 = 21–30 min 4 = 31–40 min 5 = 41–50 min 6 = more than 50 min
Attitudes		
	Attitudes toward the use of public buses	
T1	Using public buses is convenient and comfortable	1 = Strongly disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly agree
T2	Using public buses is safe	
T3	Public buses yield satisfactory service	
T4	Using public buses helps save expenditure	
T5	Using public buses helps reduce pollution and environmental problems	
Subjective Norm		
	Subjective norm in using public buses	
T6	Your friend thinks that you should allow the students under your supervision to go to school by public buses	1 = Strongly disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly agree
T7	Your family thinks that you should have the students under your supervision go to school by public buses	
T8	Most of the people in your community have the students under their supervision go to school by public buses	
T9	Most people surrounding you have the students under their supervision go to school by public buses	
Perceived behavioral control		
	Perceived behavioral control in using public buses	
T10	The students under your supervision potentially use public bus service to go to school conveniently	1 = Strongly disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly agree
T11	Using public buses is easy for the students under your supervision	
T12	The students under your supervision potentially use public bus service to do other activities beyond going to school	
Intention		
	Intention to use public buses	
T13	The students under your supervision have the intention to use public buses to go to school on a regular basis/most frequently	1 = Strongly disagree 2 = Disagree 3 = Undecided 4 = Agree 5 = Strongly agree
T14	The students under your supervision are more likely to go to school by public buses	
T15	You attempt to have the students under your supervision to go to school by public buses next time/next semester	

Tables 3. Descriptive statistics

	Public buses and motorcycle				Public buses and private cars			
	M	S.D.	SK	KU	M	S.D.	SK	KU
DIST_1	2.20	0.94	0.70	-0.31	2.51	1.23	1.08	0.61
WAIT	2.06	0.44	0.28	2.10	1.90	0.56	0.22	1.21
POINT	1.27	0.45	1.02	-0.97	1.18	0.39	1.65	0.73
COST	2.61	0.85	0.84	-1.07	2.49	0.78	1.17	-0.35
DIST_2	3.32	1.63	1.48	1.90	2.51	1.39	1.51	3.02
TIME	2.95	1.01	0.97	0.59	2.47	1.19	1.10	1.36
T1	2.84	1.48	0.16	-1.36	3.58	1.16	-0.51	-0.53
T2	2.70	1.26	0.28	-0.76	3.29	1.12	-0.22	-0.50
T3	2.87	1.38	0.04	-1.19	3.26	1.03	-0.08	-0.29
T4	2.97	1.41	0.10	-1.21	3.75	1.23	-0.66	-0.57
T5	2.96	1.35	0.19	-1.22	3.78	1.29	-0.77	-0.55
T6	3.46	1.20	-0.69	-0.69	3.50	1.13	-0.56	-0.28
T7	3.74	1.00	-0.75	0.25	3.51	1.19	-0.37	-0.75
T8	3.49	0.86	-1.00	0.14	3.47	0.99	-0.54	-0.12
T9	3.73	1.10	-0.45	-0.51	3.58	1.15	-0.41	-0.62
T10	2.57	1.20	0.13	-1.06	3.30	1.11	-0.39	-0.48
T11	2.84	1.22	-0.03	-0.90	3.28	1.15	-0.12	-0.78
T12	2.75	1.30	0.33	-0.91	3.32	1.30	-0.24	-1.07
T13	3.04	1.18	0.06	-0.99	3.35	1.11	-0.44	-0.48
T14	2.90	1.00	-0.23	-0.97	3.27	0.98	-0.58	0.01
T15	2.61	1.58	0.45	-1.36	3.37	1.27	-0.20	-0.99

Notes. M, mean; SD, standard deviation; SK, skewness; KU, kurtosis

Table 4. Criterion of model fit indices

Model fit indices		Acceptable limits	References
Chi-square	χ^2	$\chi^2/df \leq 5$	(Deb & Ahmed, 2018)
Degrees of freedom	df		
Root mean square error of approximation	RMSEA	≤ 0.08	(Deb & Ahmed, 2018; Hu <i>et al.</i> , 2015)
Comparative fit index	CFI	> 0.9	(Deb & Ahmed, 2018; Hu <i>et al.</i> , 2015)
Tucker-Lewis index	TLI	> 0.8	(Hooper <i>et al.</i> , 2008)
Standardized root mean residual	SRMR	≤ 0.08	(Schreiber <i>et al.</i> , 2006)

(34%), having household income of 30,000-39,999 baht/month (29%), and spending most of their time on regular work (76%). For choice of travel mode to work, most possessed motorcycles (92%) and private cars (73%) and most had a motorcycle license (87%), followed by a private car license (70%). Most of the travel mode to work is by using private cars (55%). In addition, the most preferred travel mode choice to school is motorcycles (40%), followed by private cars (39%), and public buses (21%).

Descriptive Statistics

Table 3 shows the descriptive statistical data of the public transportation mode choice to school consisting of the mean, standard deviation, skewness (SK), and kurtosis (KU). It was found that the data have a normal

distribution because the SK value should be in the range -3.0 to +3.0 and KU values should be lower than 10.0 (Kline, 2011).

Confirmatory Factor Analysis

Mplus version 7 was used to assess the confirmatory factor analysis (CFA) of theory of planned behavior toward public buses. Table 5 illustrates the CFA model for the perceptions data with the following goodness-of-fit statistics: $\chi^2/df = 1.811$, $p < 0.001$, RMSEA = 0.044, SRMR = 0.022, CFI = 0.989, and TLI = 0.981. Table 6 illustrates the CFA model for the expectations data with the following goodness-of-fit statistics: $\chi^2/df = 2.733$, $p < 0.001$, RMSEA = 0.065, SRMR = 0.036, CFI = 0.958, and TLI = 0.939. When compared to the criteria shown in Table 4, the model contains the model fit indices that are in

Table 5. Confirmatory factor analysis of theory of planned behavior toward public buses (public buses and motorcycles)

	Indicators	Estimate ^a	SE	Est./S.E.	R ²
Intention					
T13	The students under your supervision have the intention to use public buses to go to school on a regular basis/most frequently	0.814	0.024	34.194	0.651
T15	You attempt to have the students under your supervision to go to school by public buses next time/next semester	0.752	0.027	28.379	0.505
Attitudes					
T1	Using public buses is convenient and comfortable	0.784	0.025	30.916	0.651
T2	Using public buses is safe	0.710	0.03	23.989	0.505
T4	Using public buses helps save expenditure	0.760	0.027	28.497	0.577
Subjective norm					
T7	Your family thinks that you should have the students under your supervision go to school by public buses	0.795	0.043	18.171	0.617
T9	Most people surrounding you have the students under their supervision go to school by public buses	0.712	0.043	16.643	0.507
Perceived behavioral control					
T10	The students under your supervision potentially use public bus service to go to school conveniently	0.795	0.029	27.773	0.633
T12	The students under your supervision potentially use public bus service to do other activities beyond going to school	0.698	0.032	21.946	0.566

a all indicators are significant at $\alpha \leq 0.001$

$\chi^2/df = 1.811$, root mean square error of approximation (RMSEA) = 0.044, standardised root mean residual (SRMR) = 0.022, comparative fit index (CFI) = 0.989, and Tucker-Lewis index (TLI) = 0.981

Table 6. Confirmatory factor analysis of theory of planned behavior toward public buses (public buses and private cars)

	Indicators	Estimate ^a	SE	Est./S.E.	R ²
Intention					
T13	The students under your supervision have the intention to use public buses to go to school on a regular basis/most frequently	0.741	0.03	25.091	0.549
T14	The students under your supervision are more likely to go to school by public buses	0.722	0.031	23.613	0.521
T15	You attempt to have the students under your supervision to go to school by public buses next time/next semester	0.713	0.031	23.057	0.509
Attitudes					
T1	Using public buses is convenient and comfortable	0.741	0.034	21.519	0.55
T2	Using public buses is safe	0.681	0.036	18.727	0.464
T4	Using public buses helps save expenditure	0.651	0.038	17.047	0.424
Subjective norm					
T7	Your family thinks that you should have the students under your supervision go to school by public buses	0.698	0.031	22.376	0.487
T8	Most of the people in your community have the students under their supervision go to school by public buses	0.653	0.035	18.901	0.426
T9	Most people surrounding you have the students under their supervision go to school by public buses	0.725	0.03	24.023	0.525
Perceived behavioral control					
T10	The students under your supervision potentially use public bus service to go to school conveniently	0.74	0.039	18.787	0.547
T12	The students under your supervision potentially use public bus service to do other activities beyond going to school	0.605	0.041	14.757	0.366

a all indicators are significant at $\alpha \leq 0.001$

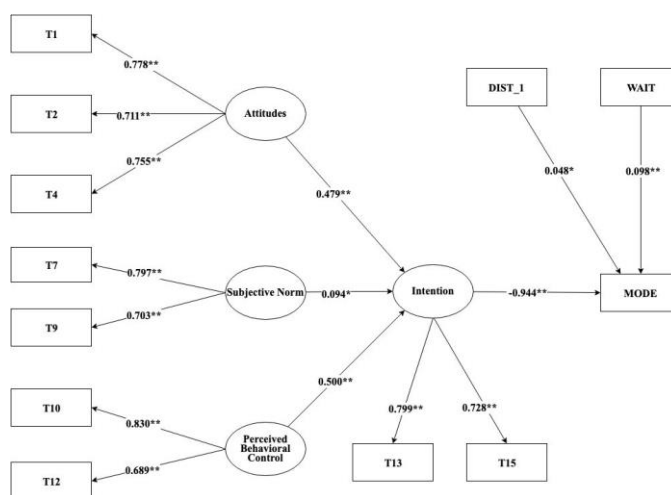
$\chi^2/df = 2.733$, RMSEA = 0.065, SRMR = 0.036, CFI = 0.958, and TLI = 0.939

accordance with the acceptable limits. The constructed latent variables are consistent with the question items, which are indicators, and relevant to the theory of planned behavior used as a reference frame as various variables can be used for structural equation modeling analysis.

Structural Equation Model and Factors Influencing School Travel Mode Choice of Public Buses and Motorcycles

Model Fit Indices

In Figure 1, the results of the consistency check of the fit model with the Mplus version 7 statistic program considering $\chi^2 / df = 1.519$,



$\chi^2/df = 1.519$, RMSEA = 0.035, SRMR = 0.024, CFI = 0.989, TLI = 0.983,
 * $p < 0.05$ and ** $p < 0.01$

Figure 1. Structural equation model and factors influencing school travel mode choice of public buses and motorcycles

are root mean square error of approximation (RMSEA) = 0.035, standardized root mean square residual (SRMR) = 0.024, comparative fit index (CFI) = 0.989, and the Tucker-Lewis index (TLI) = 0.983; when compared to the criteria shown in Table 4, it shows that the structural equation model is consistent with the empirical data at a good level.

Structural Path

In Figure 1, the intention in the public bus school travel mode choice is directly influenced by attitudes toward the use of public buses ($\beta = 0.479$) with a statistical significance level of 0.01, subjective norm in using public buses ($\beta = 0.094$) with a statistical significance level of 0.05, and perceived behavioral control in using public buses ($\beta = 0.500$) with a statistical significance level of 0.01. In other words, the contribution of the attitudes, subjective norm, and perceived behavioral control in public buses use will influence the parents to have the intention of public bus school travel mode.

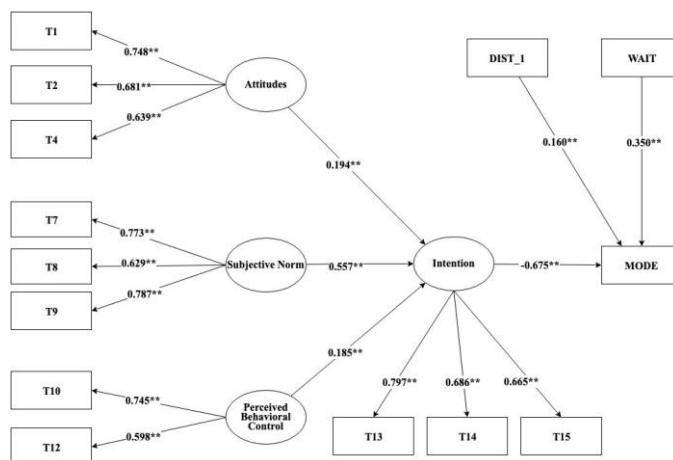
In Figure 1, factors influencing the motorcycle school travel mode choice (between public buses and motorcycle) revealed DIST_1 (the distance between the

home and public bus boarding point) ($\beta = 0.048$) with a statistical significance level of 0.05. In other words, the increase in distance between the house and boarding point will increase the motorcycle travel mode choice. That is, it will result in reducing the public bus school mode choice. WAIT (waiting times for public buses) ($\beta = 0.098$) has a statistical significance level of 0.01; that is to say, increasing the waiting time for public buses will result in more of the motorcycle mode choice for school trips. In other words, it will result in reducing the public bus mode choice. The intention to choose public buses for school trips ($\beta = -0.944$) is statistically significant at the level of 0.01. In other words, increasing the intention in choosing public buses for school trips will result in a lesser motorcycle mode choice for school trips or an increased public bus school travel mode choice.

Structural Equation Model and Factors Influencing School Travel Mode Choice of Public Buses and Private Cars

Model Fit Indices

In Figure 2, the results of the consistency check of the fit model with the Mplus version 7 statistic program considering $\chi^2/df = 2.938$,



$\chi^2/df = 2.938$, RMSEA = 0.069, SRMR = 0.063, CFI = 0.927, TLI = 0.901,
 * $p < 0.05$ and ** $p < 0.01$

Figure 2. Structural equation model and factors influencing school travel modechoice of public buses and private cars

are root mean square error of approximation (RMSEA) = 0.069, standardized root mean square residual (SRMR) = 0.063, comparative fit index (CFI) = 0.927, and the Tucker-Lewis index (TLI) = 0.901; when compared to the criteria shown in Table 4, it shows that the structural equation model is consistent with the empirical data at a good level.

Structural Path

In Figure 2, the intention of public bus school travel mode choice is directly influenced by attitudes toward the use of public buses ($\beta = 0.194$) with a statistical significance level of 0.01, subjective norm in using public buses ($\beta = 0.557$) with a statistical significance level of 0.01, and perceived behavioral control in using public buses ($\beta = 0.185$) with a statistical significance level of 0.01. In other words, contributing to the attitudes, subjective norm, and perceived behavior control in public buses use will influence the parents to have the intention of public bus school travel mode.

In Figure 2, factors influencing the private cars school travel mode choice (between public buses and private cars) revealed that DIST_1 (the distance between home and public bus boarding point) ($\beta =$

0.160) has a statistical significance level of 0.01. That is to say, the increase in distance between the house and boarding point will increase the private cars travel mode choice. In other words, it will result in reducing the public bus school mode choice. WAIT (waiting times for public buses) ($\beta = 0.350$) is statistically significant at the level of 0.01; that is to say, increasing the waiting time for public buses will result in more of the private cars mode choice for school trips. In other words, it will result in reducing the public bus mode choice. The intention to choose public buses for school trips ($\beta = -0.675$) is statistically significant at the level of 0.01. That is, increasing the intention of choosing public buses for school trips will result in fewer of the private cars mode choices for school trips or additional public bus school travel mode choices.

Conclusions

This study aims to investigate and analyze the factors that influence students' school travel mode by using structural equations based on the theory of planned behavior in Mueang Nakhon Ratchasima District by considering

the 2 groups of travel modes, namely, public buses and motorcycles and public buses and private cars. The considered factors consist of the distance between the house and the public bus boarding point, the waiting time for public buses, and the components of the theory of planned behavior consisting of attitudes, subjective norm, and perceived behavioral control and behavioral intention.

The results of the structural equation model analysis for public buses and motorcycles and public buses and private cars found that the distance between home and the public bus boarding points and the waiting time for public buses have a positive influence on the school travel mode choice of motorcycles and private cars at the statistical significance level of 0.01. In other words, if the distance from home to public bus boarding points and waiting time for public buses increases, it will result in a greater parents' school travel mode choice of motorcycles and private cars. That is to say, it will result in a decrease of the parents' choice of the public bus school travel mode. This is relevant to the findings of Napat (2013). In addition, the intention to choose the public bus travel mode for school trips has the most negative influence on the school travel mode choice of motorcycles and private cars at the statistical significance level of 0.01. It was said that the importance and the intention of public bus travel mode choice will make parents decide to increasingly choose public buses for their children's school trips (Chen and Lai, 2011; Eriksson and Forward, 2011; Lo *et al.*, 2016). The intention of public bus school travel mode is influenced by positive attitudes toward public bus use at a statistical significance level of 0.01. This is consistent with Kamarudin *et al.* (2016); Liu *et al.* (2017); Morten *et al.* (2018). The subjective norm of public buses has a positive influence on the intention of public bus school travel mode choice at a statistical significance level of 0.01. This is in line with the studies of Chen and Chao (2011) and Nordfjaern *et al.* (2014). In addition, the perceived behavioral control of public buses has an influence on the public school travel mode choice at a statistical significance level

of 0.01, which is consistent with the studies of Long *et al.* (2011) and Donald *et al.* (2014).

It can be concluded that the public bus school travel mode choice must focus on the intention of choosing public buses for school trips by promoting the attitudes toward using public buses in terms of convenience, safety, and cost-effectiveness of public bus use and supporting the subjective norm. In other words, the whole family, communities, and people around you should be encouraged to use public buses. For perceived behavioral control, public buses should be allocated with easy access for service and public bus routes to travel not only to schools but also to other places to encourage the parents' school travel mode choice of public buses for students.

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