How Psychological Factors Influence Travelers' Satisfaction and Acceptability: The Structural Equation Modeling Approach

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Abstract

This research explored the influence of psychological factors, travel characteristics, and socioeconomic impacts on travelers' satisfaction, acceptability, and behavioral intention toward the introduction of Area Licensing Scheme or ALS in a Bangkok central business district. The relationship is found by means of Structural Equation Modeling (SEM). The results suggest that there are direct effects from traveler's satisfaction to travelers' acceptability and behavioral intention for private car users. To accept and intend to change their travel behavior, travelers elaborate hidden factors behind observable characteristics, social norm, perceived effectiveness and efficiency, awareness of revenue allocation, awareness of individual claim, and awareness of equity. The results could be used as a framework for providing appropriate promotion, education, and implementation plans for area licensing scheme that are compatible with travelers in local areas and other area having traffic problems similar to the study area.

1. Introduction

To have effective transportation system, transport planners and decision makers are required to deliver transportation measures and actions that balance the demand and supply of desired modes. In circumstances of existing urban travel problems such as traffic congestion and popularity of private vehicle usage, measures to impact travelers' behaviors, Travel Demand Management (TDM) are needed and proofed effective [1]. Nonetheless, the introduction of these measures in many cities has been ineffective due to several reasons. One of the reasons is that these implemented schemes did not create acceptable traveling environments to travelers, or in other words travelers were not satisfied, accepted, and they did not eventually adapt their behaviors. The facts confirm that the understanding of people attitudes and the relationship between intrinsic attitudes and behaviors are fundamentals to fabricate proper transportation measures and actions.

Referring to the theory of planned behavior (TPB) by Ajzen (1975), the variations of ones' actual behaviors are the consequences of the variations of his/her attitudes and intention [2]. Acceptability is the psychological attitude frequently emphasized as a motivator influencing people's intention to adjust their behaviors compatible with the conditions of any TDM strategies [3-4]. Nevertheless, the acceptability sometimes cannot explain the unpopularity of TDM implementation. Maslow [5] suggested the inclusion of satisfaction as another attitude toward an action. Satisfaction is the consequence of satisfying the sequential fundamental or expected desirables of human. Consequently, it is hypothesized that, when the basic or expected requirements of ones who participate with selected TDM measure are fulfilled, they will accept the measure and intend to automatically adjust their behaviors to meet the requirements of the measure.

Nonetheless, if ones are not satisfied, they may accept the measure but the actual behavior adjustment is not guaranteed.

Because of sophistication of human behaviors and variation of various factors influencing human attitudes, a tool that could draw desirable conclusion with greater explanatory powers is sought. Structural Equation Modeling (SEM) or Linear Structural Relationship (LISREL) Modeling is proposed as it could construct complicate relationships among all variables in the model simultaneously and could extract the hidden variables (i.e. psychological factors) effectively [6-8]. The model is widely used in fields of education, social science and psychology, where the human behavioral factors are examined. The model could also relax statistical constraints in the aspects of measurement error and correlation of residual, giving researchers more flexible and convenience in preparing the data before analyzing process [6-8]. With the advantages of this method, one eventually could explain travelers' attitudes and behaviors more obvious than the traditional methods--least square analysis and discrete choice analysis [6-7].

2. Methodology

2.1 The Selected TDM Measure

The Area licensing scheme (ALS) was used as an alternative travel condition. This scheme was one of the TDM measures, targeting at the changing of traveling decision on private car usage [1]. The ALS has been found an effective measure and implemented in many countries such as Singapore and London. In Bangkok, ALS was named as an accepted measure by people in Bangruk district [9]. This measure was thus under consideration for this research. The features of the measure were listed in Table 1 and used as prior information disseminating to respondents during the questionnaire (data collection).

2.2 Variables and Construction of Structural Equation Model (SEM)

Two groups of variables were identified in this research;

1. Exogenous variables (independent variable) were psychological factors, travel characteristics, and socioeconomic impact.

2. Endogenous variables (dependent variable) were attitudinal factors--travelers' satisfaction, acceptability, and behavioral intention.

The psychological factors, hidden factors, were the groups of variables that hypothetically influence attitudes of drivers. Each of psychological variables was assumed to affect directly on both driver's satisfaction and acceptability. Similarly, physical factors, travel characteristics and socioeconomic impact, were the individuals' factors that traditionally perform as (surrogate) psychological factors. For attitudinal factors, satisfaction was assumed as the dominant factor influencing on acceptability and behavioral intention. Likewise, acceptability was assumed to affect on behavioral intention, but did not have inverse effect on satisfaction.

Table 1 Detail of Area licensing scheme (TDM measure) introduced in this study

Programs' conditions	Details	Remarks
Operating days	Monday-Friday	-
Operating times	All operating time: 06:00 AM-08:00 PM	-
	Peak hours ▪ 06:00-09:00 AM (Morning peak hours) ▪ 04:00-08:00 PM (Evening peak hours)	
	Off peak hours ▪ 09:00 AM-04:00 PM	
Charging rates	▪ 40 Baht/day	Peak hours rate
	▪ 25 Baht/day	Off peak rate
Discount rate	30% of charging rate just for motorcyclist	-
Exceptions	▪ The register members of Bangruk district	-
	▪ Private cars with 4 passengers or more	-
	▪ Public transportation service	Bus and van service
	▪ Taxis and Tricycles with passengers	-
	▪ Public welfare transportation service	School bus, ambulance, emergency service

In this study, Structural Equation Modeling (SEM), the advanced statistical technique that is the combination of factor analysis, path analysis and regression analysis [6-8], was used as the tool of analysis. The causal structural models are presented in the form of matrix equation as shown below,

$$Y = \beta Y + \Gamma X + \zeta \qquad (1)$$

or

$$[Y] = [BE][Y] + [GA][X] + [z] \qquad (2)$$

Where;

Y = Endogenous variable matrix Y
X = Exogenous variable matrix X
β, BE = Causal relation matrix of Y variables
Γ, GA = Causal relation matrix between X and Y variables
ζ, z = Measurement residual matrix of Y variables

Table 2 Exogenous and Endogenous variables

Exogenous Variables	Physical Factors	Travel Characteristics (X1) Socioeconomic Impacts (X2)
	Psychological Factors	Important Aims to Reach (X3) Attitudes toward Limiting Car Use (X4) Social Norms (X5) Problem Perception (X6) Information and Knowledge (X7) Perceived Effectiveness and Efficiency (X8) Individual Claims (X9) Equity (X10) Revenue Allocation (X11) Perceived Behavioral Control (X12) The Meaning of Car Use (X13) Social Comparison (X14) The Expression of Self-Identify (X15) Safety (X16) The Emotional Function of The Car (X17)
Endogenous Variables		The Satisfaction toward ALS (Y1) The Acceptability toward ALS (Y2) Behavioral intention (Y3)

The lists of psychological factors in Table 2 followed the research work of Schade and Schlag (2003) [3] (variable X3 to X12) and Steg et al. (2001) [10] (variable X13 to X17) and were theoretically defined as hidden

factors influencing travelers' attitude. In this research, attitude was defined from one or combination of three attitudinal factors: satisfaction, acceptability, and behavioral intention. Satisfaction was defined as the important travelers' attitude affecting to acceptability and behavioral intention of travelers. Acceptability was assumed to influence travelers' behavioral intention but has no any feedback to satisfaction. Behavioral intention, from Ajzen's theory of planned behavior, was hidden motivation performed behind one's behavior or action [2].

The relationships among variables, the results of SEM analysis, were presented in three sets of effects; direct, indirect effect and total effect. Direct effect is the direct influence from an exogenous variable to any endogenous variables. Indirect effect is an impact from an exogenous variable imposed to any variable before transformed to destination variables. Total effect is the summation of the direct and indirect effect for each pair of consistent variables.

2.3 Data Collection and Analysis

Questionnaire survey was conducted on 397 private car drivers, randomly selected in Bangruk district, a commercial business district in Bangkok, Thailand. Attitudinal data were scaled and all data from questionnaire were transformed to numerical format. LISREL 8.53, a SEM parameter estimation program, originally developed by Joreskog and Sorbom (1973) [6-8], was used in model construction and parameter estimation. The results were presented in Table 3 and the significant relationships among variables were illustrated in Figure 1.

3. Results and Discussions

The model has favorable statistical indicators (goodness-of-fit index (GFI)>0.90, normed fit index (NFI)>0.90, root mean square residual (RMR)<0.10, and Chi-square/df ratio<3.00), and thus the statistical conclusions can confidently be drawn [8]. R^2 values indicate the sufficient ability of all variables in

the model to explain the variation of dependent variables (SAT, ACPT, and BEH). The highlighted parameters shown in Table 3 represent the significance at 95% level of confidence. In this paper, the discussion was emphasized on total effects of SEM results because the values represent all impacts between each pair of exogenous and endogenous variables.

Table 3 shows that some factors (not highlighted) are not statistically significant. These include physical factors (travel characteristics, socioeconomic characteristics, important aim to reach) and psychological factors (perceived behavioral control, social comparison, the expression of self-identity, safety, and the emotional function of the car). It is remarked that travel characteristics and socioeconomic impacts, the traditional factors for travel study, is unable to explain travelers' attitude. The psychological factors having no significant impact on attitudinal factors imply that they do not function as the actual motivators behind the attitudes of sampled drivers in this study.

The following section will examine factors that are statistically related to the attitudes:

Table 3 The results of Structural Equation Model (SEM) estimation

Relevant Variables	Endogenous Variables								
	Direct effect			Indirect effect			Total effect		
Passenger car users *N* = 397	SAT	ACPT	BEH	SAT	ACPT	BEH	SAT	ACPT	BEH
The Satisfaction toward ALS (SAT, Y1)	-	-	-	-	-	-	-	-	-
The Acceptability toward ALS (ACPT, Y2)	0.110* (2.754)	-	-	-	-	-	0.110* (2.754)	-	-
Behavioral intention (BEH, Y3)	0.388* (8.241)	0.081 (1.582)		0.009 (1.372)	-	-	0.397* (8.629)	0.081 (1.582)	-
Travel Characteristics (TRAV, X1)	-0.063 (-1.645)	-0.010 (-0.347)	-	-	-0.007 (-1.412)	-0.026 (-1.651)	-0.063 (-1.645)	-0.017 (-0.575)	-0.026 (-1.651)
Socioeconomic Impacts (SOC, X2)	-0.034 (-0.848)	0.039 (1.256)	-	-	-0.004 (-0.811)	-0.010 (-0.632)	-0.034 (-0.848)	0.035 (1.126)	-0.010 (-0.632)
Important Aims to Reach (IMP, X3)	0.005 (0.128)	0.030 (0.922)	-	-	0.001 (0.128)	0.005 (0.269)	0.005 (0.128)	0.030 (0.931)	0.005 (0.269)
Attitudes toward Limiting Car Use (ATTD, X4)	0.018 (0.415)	0.080* (2.422)	-	-	0.002 (0.410)	0.014 (0.768)	0.018 (0.415)	0.082* (2.457)	0.014 (0.768)
Social Norms (SOCN, X5)	0.130* (2.587)	0.302* (7.724)	-	-	0.014* (1.886)	0.076* (2.974)	0.130* (2.587)	0.316* (8.078)	0.076* (2.974)
Problem Perception PERC, (X6)	-0.073* (-1.812)	-0.037 (-1.184)	-	-	-0.008 (-1.514)	-0.032* (-1.929)	-0.073* (-1.812)	-0.045 (-1.431)	-0.032* (-1.929)
Information and Knowledge (INFO, X7)	-0.051 (-1.321)	0.063* (2.106)	-	-	-0.006 (-1.191)	-0.015 (-0.940)	-0.051 (-1.321)	0.057* (1.904)	-0.015 (-0.940)
Perceived Effectiveness and Efficiency (EFF, X8)	0.269* (4.979)	0.252* (5.848)	0.242* (4.731)	-	0.029* (2.410)	0.127* (4.672)	0.269* (4.979)	0.282* (6.674)	0.370* (7.658)
Individual Claims (INDC, X9)	0.273* (5.125)	0.003 (0.072)	0.167* (3.922)	-	0.026* (2.426)	0.093* (4.381)	0.273* (5.125)	0.028 (0.792)	0.259* (5.835)
Equity (EQUI, X10)	0.075 (1.500)	0.158* (4.083)	-	-	0.008 (1.317)	0.043* (1.960)	0.075 (1.500)	0.167* (4.265)	0.043* (1.960)
Revenue Allocation (REV, X11)	0.191* (4.307)	0.217* (6.148)	-	-	0.021* (2.320)	0.094* (4.229)	0.191* (4.307)	0.238* (6.838)	0.094* (4.229)
Perceived Behavioral Control (PERBC, X12)	0.034 (0.793)	-0.015 (-0.455)	-	-	0.004 (0.762)	0.012 (0.708)	0.034 (0.793)	-0.011 (-0.339)	0.012 (0.708)
The Meaning of Car Use (MEAN, X13)	-0.074 (-1.221)	-0.112* (-2.395)	-	-	-0.008 (-1.116)	-0.038 (-1.532)	-0.074 (-1.221)	-0.121* (-2.547)	-0.038 (-1.532)
Social Comparison (SOCIAL, X14)	0.086 (1.310)	0.073 (1.434)	-	-	0.009 (1.183)	0.040 (1.492)	0.086 (1.310)	0.082 (1.606)	0.040 (1.492)
The Expression of Self-Identify (EXP, X15)	0.056 (0.763)	-0.064 (-1.121)	-	-	0.006 (0.735)	0.017 (0.572)	0.056 (0.763)	-0.058 (-1.004)	0.017 (0.572)
Safety (SAFE, X16)	0.045 (1.006)	-0.005 (-0.154)	-	-	0.005 (0.945)	0.017 (0.963)	0.045 (1.006)	0.0001 (-0.012)	0.017 (0.963)
The Emotional Function of The Car (EMOT, X17)	-0.109 (-1.384)	-0.038 (-0.620)	-	-	-0.012 (-1.236)	-0.046 (-1.445)	-0.109 (-1.384)	-0.050 (-0.810)	-0.046 (-1.445)

Endogenous Variables	SAT	ACPT	BEH	* Accept at 95% degree of confidence					
R^2	0.468	0.681	0.531						
df	15			GFI			0.997		
Chi-Square	13.033			RMR			0.00845		
t-statistic at α = 0.05	1.753			NFI			0.997		

Remark: 1) N = Number of samples,   2) The number in parentheses are t-statistics

3.1 Attitudinal Factors

Satisfaction significantly influences acceptability and behavioral intention at 95% confidence level. Acceptability has no significant influence on behavioral intention. It is concluded that the satisfaction performs as the transformer that connects the influences between significant psychological variables and behavioral intention. The characteristics of satisfaction from the findings meet the expectation of research hypothesis and can imply that, when drivers are satisfied with the consequences of ALS implementation, they will accept the measure automatically and will intend to correct their travel behaviors to conform to the program.

3.2 Psychological Factors

All psychological factors, which their relationships with attitudinal factors are statistically significant, are summarized in Table 4. The numbers shown in the table are ranked according to magnitudes of impact, presented by coefficient value of each exogenous variable toward endogenous variables.
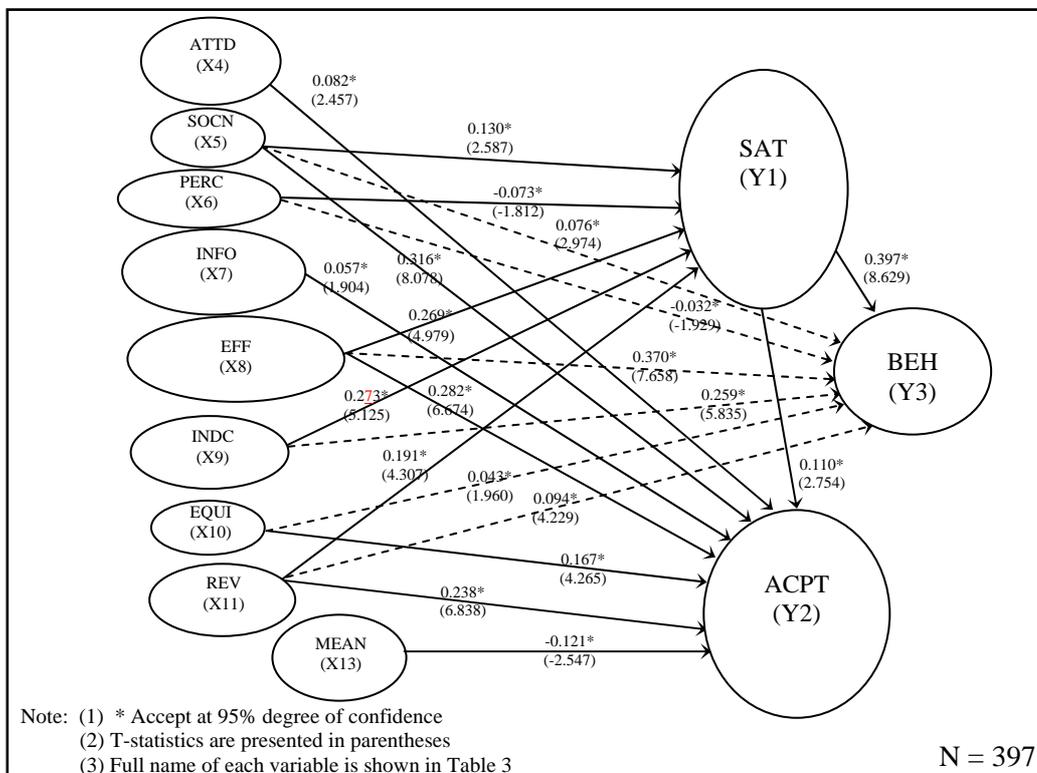

Figure 1 Illustration of Structural Equation Model (SEM)

Table 4 Significant psychological factors

Exogenous Variables	Endogenous Variables		
	Passenger car users		
	SAT	ACPT	BEH
Attitude toward limiting car use (X4)		6	
Social norms (X5)	4	1	4
Problem perception (X6)	5		6
Information and knowledge (X7)		7	
Perceived effectiveness and efficiency (X8)	2	2	1
Individual claims (X9)	1		2
Equity (X10)		4	5
Revenue allocation (X11)	3	3	3
The meaning of car use (X13)		5	

Perceived effectiveness and efficiency, awareness of revenue allocation, and social norm affect all satisfaction, acceptability, and intention. Problem perception and awareness of individual claims affect only satisfaction and behavioral intention. Surprisingly, the direction of impact from problem perception to satisfaction shows unreasonable mathematical sign (negative sign) and it is excluded from the list of satisfying factors. Attitude toward limiting car use, perceived information and

knowledge, and the meaning of car use affect only the acceptability, but not satisfaction and intention. Awareness of equity has a direct influence on the acceptance and intention.

Because of the significance of satisfaction as explained previously, as the medium to transfer the impacts of psychological factors to behavioral intention, the factors affecting satisfaction is further elaborated. The details of each factor in Table 5 come from the measurement model analysis of each psychological factor having components and the factors are ranked according to the degree of statistical ability to explain the variation of residuals. The discussion on each factor is presented below:

Table 5 Details on each psychological factor

Psychological variables	Details of factors	Rank
Awareness of individual claim	Degree of preferable on the consequences of ALS implementation compare to the present situation and all things considered if the measure have actual implemented	-
Perceived effectiveness and efficiency	Degree of perception of respondents toward ability of ALS in order to relieve traffic congestion problem in study area	-
Awareness of revenue allocation	Use revenue for traffic flow improvements (new road, signalization, etc.)	1
	Use revenue to improve the conditions for pedestrians and cyclists	2
	Use revenue for improving public transportation quality	3
	Use revenue for supporting state/municipal budget in general	4
	Use revenue to lower labor (income) taxes	5
	Use revenue for reducing public transport fares	6
	Use revenue for lowering fixed vehicle taxes	7
Social norm	Degree of favorable or unfavorable of the closest persons toward encouragement of respondents on ALS implementation	-
Awareness of equity	Expect that ALS will raise the equity on receiving less environmental problems	1
	Expect that ALS will raise the equity on having shorter travel time to the city center	2
	Expect that ALS will raise the equity on receiving a nicer city center	3
	Expect that ALS will raise the equity on more effort to plan trips	4

1. Awareness of individual claim

The more preference on the positive consequence of ALS implementation when compared to the present situation, the more satisfaction with the program. This factor is the most concerned (ranked 1) by drivers' psychology. The travelers value and compare travel situation before and after the implementation. This is an aggregate variable for a driver to judge the overall consequences of the measure. The findings suggest that this factor has influence on drivers' satisfaction, but not on acceptability. This implies that travelers do not consider individual claims as a parameter for determining acceptability.

2. Perceived effectiveness and efficiency

The more understanding about the performance of ALS measure, the more approval on the measure. The degree of worthiness of the measure influences both satisfaction and acceptability. It implies that drivers realize and expect the consequences (direct and indirect benefits associated with travel) from the measure.

3. Awareness of revenue allocation

Profits receiving from commuters for accessing into regulated area should be spent on appropriate matters in community according to the requirements of each stakeholder. The respondents expect that such revenue should be allocated to community for improving the conditions of traffic flow, developing the facilities for pedestrians and cyclists, improving public transportation quality, and supporting the budget of state or municipal in general respectively. Note that the first four orders of requirements are strongly emphasized on environment in the community. Additionally, the revenue should be spent for financial incentive; lower income taxes, reduction in public transport fares, and lower fixed vehicle taxes, respectively.

4. Social norm

Social norm indicates the degree of approval or disapproval by closest persons of any respondents on respondent's acceptability on the measure. The greatest significant of this factor implies that attitudes of the closest

persons with the respondent, such as their family, would affect the preference and acceptability of the respondent. Accordingly, if surrounding persons encourage the behavior adaptation toward ALS, he/she will yield greater intention to modify his/her travel behavior.

5. Awareness of equity

When ALS is introduced, the respondents expect that the impact on people in community should be born simultaneously and equally. The expectations include less environmental problem, shorter travel time to the city center, "nicer" city center, and more effort to plan trips. However, the findings suggest that although drivers will not be satisfied with above expectations, unless they sense the degree of consequences distributed to stakeholders in the community.

6. Other factors

Attitude toward limiting car use, perceived information and knowledge, and meaning of the car use influence only acceptability and have no impact on behavioral intention. These factors just make the respondents accept the conditions of ALS measure but do not impact motivation that leads to action. Note that the negative sign of meaning of car use variable is reasonable because this factor is the representation of respondents' desirable to drive their cars.

3.3 Direct Relationship between Psychological Factors and Behavioral Intention

Figure 1 illustrates the correlation between physical and psychological factors and behavioral intention (proxy to behavioral change) as dotted lines. The result of this alternate model construction implies the direct explanation of attitude without the assumption on emotional impulses. This relationship is explained by similar psychological factors, except equity which has direct influence on behavioral intention, but not on the satisfaction.

3.4 Discussions

Traditional travelers' variables may not indicate the attitude, and thus are not sufficient to address the intention to change their behaviors. This study demonstrates the advantage of psychological factors on assessing drivers' attitudes instead of the physical ones.

The research reveals that the acceptability and satisfaction mean differently to travelers, and have different implications to behavioral intention. The satisfaction influences acceptability and behavioral intention. This fact also reinforces the worthiness of satisfaction and its connection with human's attitude that subsequently reveals travelers' acceptability and intention to adjust their behaviors. To make area licensing scheme effective, it is necessary to make private car drivers satisfied with the scheme. The users need to determine their satisfaction from the fulfillment of psychological factors, although some of these factors may not be the trade-off for their own (direct) benefits, such as social norm, and revenue allocation.

For this reason, the satisfaction on individual claim, perceived effectiveness and efficiency, revenue allocation, social norm, and equity are vital for the success of implementation. Transportation planners should provide the strategies that make the conditions and standard of living of respondents in study area better than the existing environment and facilitate the information dealing with the advantages of the measure to community. Moreover, information about ALS should be provided to not only the travelers but also all stakeholders (especially closet persons) in community simultaneously.

It is noted that drivers' perception variable does not meet the hypothesis of the research (negative sign in Figure 1). Although logically unexplainable, this factor has high variation and relatively low statistical significant.

The findings can directly be applied in some policy implementations while the knowledge on traveler's behaviors can be used in better transportation demand modeling. The findings on the travelers' attitudes help

transportation planners to conduct the right course for proper promotion campaigns, education plan, technical implementation plan, and enforcement plan that yield the highest effectiveness. The psychological variables can be introduced in the data collection and variable selection for transportation demand modeling. These variables should be tested on their correlations with the corresponding demand for travel to ensure the accurateness of the demand estimation.

4. Conclusions

Psychological factors are proofed to affect private car drivers' attitude toward the behavior change measure. The correlation between psychological and attitudinal factors can be constructed by Structural equation modeling (SEM). Satisfaction performs as the important attitude toward acceptability and behavioral intention on the area licensing scheme (ALS). Although closely related with satisfaction, the acceptability does not imply the intention on behavioral change. Individual claims, perceived effectiveness and efficiency, and awareness of revenue allocation are the most concerned variables to travelers. It is implied that, to achieve behavior change and compliance to the measure, transportation planners should provide benefits or any necessary matters that respond and fulfill the basic requirements or expectations of travelers for making them feel satisfied with the implementation.

Additionally, SEM shows its ability in explaining complicate psychological relationships and can be an alternative analysis tool for transportation planners for analyzing sophisticate transportation and qualitative data, such as behavioral and psychological data to yield better decision. The outcomes from SEM would lead to a more understanding in social psychology and help develop pertinent transportation policies, strategies, and campaigns that are convincing and fulfill the fundamental requirements of people in communities, subsequently yielding more effective Travel Demand Management (TDM) implementation.

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