Investigating Proenvironmental Behavior: The Case of Commuting Mode Choice

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Abstract. The central aim of this article is to investigate mode choice behavior among commuters in Ho Chi Minh City using disaggregate mode choice model and norm activation theory. A better understanding of commuters' choice of transport mode provide an opportunity to obtain valuable information on their travel behaviors which help to build a basic for proffering solutions stimulating commuters to switch to public transport, which in turn contribute to deal with traffic problems and environmental issues. Binary logistic regression was employed under disaggregate choice method. Key findings indicated that Demographic factors including Age (-0.308), Married (-9.089), Weather (-8.272); Trip factors including Travel cost (0.437), Travel distance (0.252), and Norm activation theory (Awareness of consequences: AC2 (-1.699), AC4 (2.951), AC6 (- 3.523), AC7 (- 2.092), AC9 (- 3.045), AC11 (+ 2.939), and Personal norms: PN2 (-2.695)) had strong impact on the commuters' mode choice. Although motorcycle was the major transport mode among commuters, they presented their willingness to switch to bus transport if it had less negative impacts on the environment and their daily living environment.

1. Introduction

It is true that many environmental problems nowadays are the consequences of people behaviors. Transportation is environmentally significant behavior that should be changed in an environmental friendly direction. In Ho Chi Minh City (HCMC), the largest motorcycle dependent city in Southeast Asia with the population of more than 7,955 millions (2014), the overflowing of commuters traveling by motorcycle causes the high pressures on urban environment and urban transportation. 78% of total means of transport in HCMC is motorcycle, and the number of motorcycle increases 10% per year with around 675 motorcycles per 1.000 people. Although the public transport system has been improved, it has not kept pace with the growth of population and private vehicles there. Traveling by motorcycle is obviously flexible and convenience but has substantial negative consequences in terms of environment like such as air pollution, noise, high consumption of nonrenewable energy, and transportation like motorcycle accident, and traffic jam. Recent researches have found that total loss (e.g. fuel consumption, accidents, waste of time due to traffic jams) caused by motorcycle in HCMC is around 1.07 billion USD/year which is even higher than its GDP annual growth rate around 10%. Furthermore, 70% of urban air pollution is derived from motorcycle's exhaust fumes which are placed on alert.

Can travel mode choice become a proenvironmental behavior? [1] stated that travel mode choice is "among the most environmentally significant decisions faced by individuals". In daily life, commuters with different demographic and trip characteristics repeatedly face the selection of travel modes where their decisions lead to positive outcomes for themselves and negative consequences for the environment,

or vice versa. To encourage proenvironmental behavior among commuters, a better understanding of psychological factor that influence their willingness to act in a proenvironmental manner is crucial.

Based on these facts expressed above, the main purpose of this article is to investigate model of the effects of demographic factor, trip factor and psychological factor on commuters' mode choice behavior in HCMC, Vietnam. In this study, the research model was derived from previous research, especially mode choice behavior was investigated by employing disaggregate model and psychological factor was originated in [2] norm activation theory (NAT).

2. Literature review

In reality, the exhaust from our automobiles is the number one cause of local air pollution and global climate change, so there could be environmental benefits if road users switch their transport modes, or simply traveled less [3]. In many cases, some types of journeys like leisure trip, educational travel might be reduced for some people, however commuting is one kind of travel that is more often than not unavoidable. Commuting mode choice have been examined in several studies [3] [4] [5] and in this work, it was also the main subject. In environmentally significant behavior research, [2] norm activation theory (NAT) was concerned as a type of classic psychological model [5] and it has been employed in several environemental behavior-related researches. Originally, NAT was developed to explain altruistic behavior, but it has been extended to proenvironmental behavior [6]. Both commuting mode choice behavior and NAT were the theoretical foundation of this work. This article attempted to investigate commuters' travel mode choice behavior by employing a disaggregate model containing variables from NAT. A brief description of choice model and NAT was presented below.

2.1. Disaggregate mode choice model

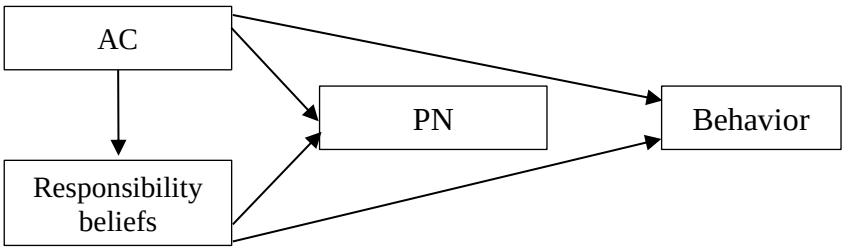
Disaggregate mode choice model is the subject in many transportation researches. In order to predict the preferences of travelers, a number of mode choice models have been developed; however, disaggregate mode choice model (or discrete choice model) based on utility is widely employed to predict an individual's choice [7]. The disaggregate mode choice model, whose benefits and shortcomings are studied and documented [8], are the second generation of modeling strategy [9] and it was capable of forecasting an individual's behavior in choosing a mode from various choice of available modes [10]. In fact, many researchers have applied disaggregate model to study the mode choice behavior [10] [11] [12]. Also, a wide range of variables impacting on mode choice behavior were considered from demographic factor (e.g. age, gender, education, occupation, family size, number of family workers, income level), trip characteristics (e.g. travel time, travel cost, travel distance) to personality traits (e.g. habit, attitudes, social norms, satisfaction, calm factor) [13] [14] [15] [16].

2.2. Schwartz's (1977) norm activation theory

Norm activation theory (NAT) developed by [2] explains altruistic and proenvironmental behavior. The theory holds that normative self-expectations experienced as feelings of obligation (personal norms, or PN) are the antecedent of altruistic acts and that personal norms are 'activated in individuals who believe that environmental conditions pose threats to other people, other species (awareness of consequences, or AC) and that actions they initiate could avert those consequences (ascription of responsibility to self, or AR)' [17]. AC and responsibility moderate PN's influence on behavior (Figure 1).

NAT has been applied to proenvironmental behavior with some successes [17] [18]. In the filed of transportation, NAT has also been employed and investigated thoroughly. In 1999, [19] added 'Personal norm' (PN) of NAT to the TPB model (Theory of planned behavior) to explain proenvironmental intentions for non-car travel modes. His regression analysis proved that R square increased after adding PN. In another research, NAT along with general environmental values were utilized to test a hierarchical model on general proenvironmental behavior. A Swedish sample of 1,400 individuals were used in a path analysis to test the model. The outcomes showed that 'the PN was derived from self-transcendent and ecocentric values; PN was activated by problem awareness and PN mediated the effects from general values, environmental values, and problem awareness on proenvironmental behavior'. For the purpose of examining the mode choice among students going to university, [5] also used German

students' data to compare NAT, theory of planned behavior (TPB), and theory of interpersonal behavior (TIB).



Note: AC = awareness of a behavior's consequences; PN = personal norm

Figure1. Norm activation theory [2]

3. Methods

[5] stated that the theories 'were developed in different research contexts and focus on different aspects of social behavior'. In this research, to examine commuters' travel mode choice behavior, research model included 'Demographic factor', 'Trip factor', and 'Psychological factor'. 'Demographic factor' and 'Trip factor' was derived from previous studies stated in literature review, and 'Psychological factor' was resulted from NAT. A mode choice model with 'Psychological factor' was tested based on NAT rather than using [2] exact formulation. NAT items which were adjusted to the current research context were relied on [2] definitions and previous environmentally significant behavior research [2] [5] (Appendix A).

We obtained the data for this study by Stated Preference (SP). Questionnaire was used for two modes of transports including motorcycle and public transport (bus transport). The survey was conducted in Ho Chi Minh City from Dec 2016 to Jan 2017. Both household survey and online survey were employed for data collection. Regarding household survey, we conducted the survey particularly in District 1, 3, 10, Phu Nhuan, Tan Binh and Binh Thanh which are the central urban areas of the city. The survey was piloted to make sure that the measuring instrument represented the goal of the study in terms of the information to be gathered [20]. Random samples of 20 observations attended the pilot test and the outcomes revealed that few questions needed to be modified. Hence, the questionnaire was amended based on the pilot test and was used for collecting the actual data for this study. A total of 407 respondents were interviewed in a period of three months. The number of valid samples for research was 345.

According to the central aim of this study, the binary logistic regression model under disaggregate choice methods was utilized for the purpose of determining the factors which would impact motorcycle riders to switch from traveling by motorcycle to selecting bus transportation. Generally, for the binary models, i and j are the two alternatives in the choice set of each individual:

$$U_{in} = V_{in} + \varepsilon_{in}$$
$$U_{jn} = V_{jn} + \varepsilon_{jn}$$

The probability that individual n chooses alternative i (P_{in}) is: $P_{in} = \frac{e^{V_{in}}}{e^{V_{in}} + e^{Vjn}}$, where V_{in} = the utility of alternative mode i to individual n.

In this model, the dependent variable was set to "1", if the commuters traveled by motorcycle and "0" for using bus transportation. The probability that an individual would choose the motorcycle could be written as:

$$P_{motorcycle} = \frac{e^{Vin}}{e^{Vin} + e^{Vjn}} = \frac{e^{\beta x_{motorcycle}}}{e^{\beta x_{motorcycle}} + e^{\beta x_{bustranspo\,rtation}}}$$

where:

$$V_{motorcycle} = \beta_0 + \beta_1 X_{Gender} + \beta_2 X_{Age} + \beta_3 X_{Married} + \beta_3 X_{Children} + \beta_4 X_{Education}$$
$$+ \beta_5 X_{Motor\_owner} + \beta_6 X_{Income} + \beta_7 X_{Travel\_time} + \beta_8 X_{Travel\_dis\,tan\,ce} + \beta_9 X_{Travel\_cos\,t} + \beta_{10} X_{AC} + \beta_{11} X_{PN}$$

The coefficients were approximated by fitting the data to the model (s). The maximum likelihood estimation technique was employed to optimize the probability produced by the observed individuals. Besides, Principal components analysis (PCA) was used to ensure that NAT's items were sufficiently correlated.

4. Results

4.1 Sample analysis

Motorcycle riders were significantly more likely to be young people, starting own family and having children. There was no significant motorcycle ownership difference between motorcycle rider (more than 92% of respondents having motorcycle), but there were differences in gender (62.5% female having a mean age of 29.3 years, and a mean family income of $315/month), and job type (58.7% of respondents were teacher/researcher, 34.9% were collar workers, and the remaining was blue worker). The number of commuter travelling by motorcycle accounted for 68.8%.

4.2 Reliability test

The assessment of scale reliability for NAT's variable was based on Cronbach's Alpha. Cronbach's alpha is a measure of internal consistency which indicates how closely related a set of items are as a group. Here, the result showed that the alpha coefficient for items (AC1, AC2, AC4, AC6, AC7, AC8, AC9, AC10, AC11, and PN1, PN2, PN3) were ≥0.6 and their correlated variables were >0.3, suggesting that the items had relatively high internal consistency. The item (AC3, AC5, and PN4) was rejected.

4.3 Principal component analysis

Next, to develop scales, NAT's items excluding AC3, AC5 and PN4 (Appendix A) were examined in a principal component analysis (PCA). The PCA is boot-strapped with 500 replications to construct bias-corrected confidence intervals for the eigenvalues [21] [22]. These value of confidence intervals will help to determine the number of factors. The principal factors analysis is utilized to identify items loading on a particular factor. If all items loading is above the value of 0.4 on a factor, they will be a part of the factor and will be included in scales constructed from that factor. In this article, we tested two variables from norm activation theory: 'Personal norms (PN)' and 'Awareness of consequences (AC)'. The result shows all item loadings is greater than 0.400.

4.4 Binary Logistic Regression Model

To investigate commuter mode choice, the binary logistic regression model was fitted to the data. The maximum likelihood estimates of binary logistic regression model are condensed in Table 2. Tested Model was estimated with 12 variables of NAT and 10 demographic variables. The coefficients for all the variables were estimated relative to the selected reference category (Table 1).

Table 1. Estimations from the binary logistic model

Model	B	S.E.	Sig.	Exp(B)	95% C.I.for EXP(B)	
					Lower	Upper
Gender (1)	-0.225	0.776	0.772	0.798	0.174	3.656
Age	-0.308	0.154	0.045	0.735	0.544	0.993
Job (1)	0.859	1.185	0.469	2.360	0.231	24.096

Job (2)	-0.293	1.185	0.804	0.746	0.073	7.601
Married (1)	-9.089	2.203	0.000	0.000	0.000	0.008
Income	-0.307	0.168	0.068	0.736	0.529	1.023
Weather (1)	-8.272	2.129	0.000	0.000	0.000	0.017
Travel time	0.015	0.018	0.389	1.015	0.981	1.052
Travel cost	0.437	0.102	0.000	1.548	1.268	1.890
Travel distance	0.252	0.089	0.005	1.287	1.081	1.532
Motorcycle ownership (1)	-1.497	0.863	0.083	0.224	0.041	1.214
AC1 (1)	-0.967	1.283	0.451	0.380	0.031	4.701
AC2 (1)	-1.699	0.799	0.034	0.183	0.038	0.876
AC4 (1)	2.951	1.111	0.008	19.122	2.165	168.874
AC6 (1)	-3.523	0.958	0.000	0.029	0.005	0.193
AC7 (1)	-2.092	0.843	0.013	0.123	0.024	0.644
AC8 (1)	0.131	1.561	0.933	1.140	0.053	24.298
AC9 (1)	-3.045	1.123	0.007	0.048	0.005	0.430
AC10 (1)	0.223	1.450	0.878	1.249	0.073	21.407
AC11 (1)	2.939	0.795	0.000	18.904	3.980	89.787
PN1 (1)	0.883	1.031	0.391	2.419	0.321	18.229
PN2 (1)	-2.695	0.868	0.002	0.068	0.012	0.370
PN3 (1)	1.914	1.401	0.172	6.783	0.436	105.566
Constant	8.776	4.239	0.038	6473.832		
-2 Log likelihood	73.094					
Model Chi-square	319.826, df 23, sig.=0.000					
Cox & Snell R^2	0.637					
Nagelkerke R^2	0.895					
N	317					

Reference category: bus transportation

$Ln = \frac{P}{1-P}$ = - 0.308 Age - 9.089 Married - 8.272 Weather + 0.437 Travel cost + 0.252 Travel distance -1.699 AC2 + 2.951 AC4 - 3.523 AC6 - 2.092 AC7 - 3.045 AC9 + 2.939 AC11 - 2.695 PN2

Chi-square omnibus tests of coefficients of the research model showing the value of 319.826, df 23, and sig.=0.000 confirmed that a test of the full model against a constant only model was statistically significant. The -2Log likelihood reflected the prediction deviation by the model. A smaller value indicated a better fit. With regard to model, the -2 Log Likelihood statistics was quite small (73.094). Cox and Snell's R^2 =0.637, and a Nagelkerke R^2 = 0.895, which explained 89.5% of the variation in the dependent variable. From the binary logistic regression model, the coefficient of variables had positive values meaning that motorcycle riders would not be likely to switch to bus transportation.

5. Discussion

5.1. Demographic variables significantly explained the mode choice behavior among commuters

The age had a significant contribution to explain commuter's mode choice behavior. The sign of the coefficient (-0.308) proved that old people tended to use their motorcycle than public transport. The Married coefficients for the motorcycle use was negative (-9.089), meaning that the couple was likely to use bus transport for their travelling rather than the single. Weather (-8272) affected the commuter's mode choice. If the weather condition was not good (e.g. flooding, heavy rain, storm), respondent was willing to switch to bus transportation.

With respect to cost, generally, cost is considered as one of the main factors affecting intercity mode choice (Manssour et al., 2014). Here in this article, travel cost (0.437) had strong impact on the travel decision of commuter. When travel cost increased and other variable was still unchanged, motorcycle riders did not choose bus service for their daily movement. Similarly, if travel distance (0.252) also increased, motorcycle riders would not willing to change to bus transport. The sign of both variables

(Travel cost, travel distance) was not as negative as expected. In Vietnam, despite the inexpensive of the travel cost of bus transportation (around 5000 - 10.000 VND/one ticket), the quality of bus service is quite low. Also, compared with motorcycle, bus transport does not have the advantages of the flexibility, the convenience, and it is mainly the means of transport for people who has low income and their travel distance less than 10 kilometers. It is these barriers that deter people who earn high income, considering time seriously from using bus service.

5.2. Norm activation theory provide useful insights into proenvironmental behaviors among commuters

5.2.1. Awareness of consequences

67% of respondents believed that 'flood water inner city is caused by motorcycle use' (AC2) and they expressed their willingness to change their transport mode (-1.699). In fact, flood is a major problems in HCMC in every rainny reasons and obviously, motorcycle is not a suitable means of transport for travelling when happening flood. Also, flood water inner city is the cause of many risks including motorcyle accident and traffic congestion. Hence, public transport seem to be much safer and convenient for commuting trips.

One of the solutions to tackle with traffic congestion and the growth of the number of motorcycles is building new roads or widening the old ones. In HCMC, the clearance of residential areas inner city faces various obstacles, therefore, many green space (e.g. green parks, ancient trees) has to yield to new big roads. Although, around 81% of respondents agreed that 'constructing new roads for the increasing number of motorcycle threatens the biosphere in my city' (AC4), however, respondents did not agreed to change their means of transport (2.951). In this research, it seemed to be dilemma for motorcycle riders whether to keep traveling by motorcycle or switch to bus service. Despite the degradation of biosphere due to the sacrifice of green space, widening roads would help to avoid many daily traffic problems, which was likely to encourage riders to use motorcycle.

Factors influencing motorcycle riders' quality of life directly affected their mode choice decisions. The findings showed that 'Motorcycle-related deteriorated biosphere reduces the quality of life in our cities (-3.523)', and 'Flood water inner city reduces the quality of life in our cities (-2.092)' were statistically significant with respect to commuter's choice of the public transport mode. Motorcycle is the main cause of polluted air in HCMC. The average emissions of motorcycle in rush hour or in traffic jam is too high compared with other vehicles making riders annoyed and also stimulating them to use bus transportation service.

In terms of the statement 'My transport choices can have an impact on the environment' (- 3.045), around 53% of respondents did not feel that their choices would be directly harmful to environment. They argued that their choices were just the intention and it only affected the environment when they decided to implement their decisions in reality. Consequence, they were not likely to switch to bus transportation. Then, over 80% of motorcycle riders confirmed that 'I contribute to pollution by commuting by motorcycle use' and expressing their positive attitudes towards switching to public transport use (2.939).

5.2.2. Personal norms

From their awareness about the impacts of motorcycle use on environment and the quality of their daily lives, commuters showed that they 'feel morally obliged to avoid using motorcycle to get to work place. The positive sign of the variable (- 2.695) implied that commuters were willing to use bus transportation as an expression of their moral responsibilities towards their own living environment.

6. Conclusion

The main purpose of this article is to investigate mode choice behavior among commuters in Ho Chi Minh City using disaggregate mode choice model and norm activation theory. The study showed that demographic factors (age, married), trip characteristics (weather, travel cost, travel distance) and NAT (awareness of consequences, personal norms) had strong impact on the commuters' mode choice.

Although bus service is crucial in urban transportation, since it affects all citizens and many social problems like reducing traffic jams, either improving energy efficiency or the environment, and

mitigating private vehicles in urban areas, motorcycle is still the highest priority among commuters. This can be explained by the noticeably-deteriorated bus service quality (e.g. rude staff, low-quality buses, less safety, careless bus drivers and ticket controllers), which have hugely affected the quality perceived by the road users, created user resentment and encouraged them to travel by motorcycle. It is possible to encourage more commuters, particularly who are married and old people, to use bus transport when bus service quality is improved. Determinants like travel cost encourage/discourage people to choose transport modes, therefore, attractive travel cost (e.g. discounted ticket) need to be provided. Recently, the bus service is improved with professional training for bus drivers and ticket controllers, the availability of seats, air-conditioners and wastebaskets on board, communication like bus route information, and schedule timetable. However, it should be noted that just an improvement of the bus service will not strongly impact on the commuters' mode choice decision. Improving bus transportation needs to be incorporated with the development of other public services including road infrastructure, urban planning and the development of alternatives such as bus rapid transit system and Metro lines in order to reduce travel distance and achieve sustainable transportation development as well.

The findings also revealed that NAT better explain commuter's mode choice behavior. Here in this research, commuters revealed their awareness on environment problems and their perception on the consequences of motorcycle uses to environment, their quality of lives in terms of deteriorated biosphere, flood water. Although motorcycle is the major means of transport in Vietnam, motorcycle rider expressed their willingness to switch to bus service or other alternatives provided that it would help to protect the environment and increase their quality of life.

Appendix

Appendix A. Variable Definitions

	Variable	Definition
Democraphic factor	Commute mode choice	Category variable, Motorcycle = 1, Public transport = 0
	Gender	Category variable, Female = 1, male = 0
	Age	Continuous variable, In years
	Married	Category variable, Married = 1, single = 0
	Children	Category variable, Having children = 1, Not having children = 0
	Job	Category variable, 1=Teacher/researcher, 2=Collar worker, 3=Blue worker
	Motorcycle ownership	Category variable, Having Motorcycle = 1, Not having motorcycle = 0
	Income	Continuous variable, millions VND/month
Trip factor	Travel time	Continuous variable, minutes
	Travel distance	Category variable, kilometers
	Travel cost	Category variable, thousands VND/one way
NAT	AC	AC1 - I believe that climate change is caused by motorcycle use. Agree/Disagree
		AC2 - I believe that flood water inner city is caused by motorcycle use. Agree/Disagree
		AC3 - I believe that dust pollution is caused by motorcycle use. Agree/Disagree
		AC4 - I believe that constructing new roads for the increasing number of motorcycle threatens the biosphere in my city. Agree/Disagree
		AC5 - Dust pollution reduces the quality of life in our cities. Agree/Disagree

	Variable	Definition
		AC6 - Motorcycle-related deteriorated biosphere reduces the quality of life in our cities. Agree/Disagree
		AC7 - Flood inner city reduces the quality of life in our cities. Agree/Disagree
		AC8 - Avoiding motorcycle use will help to solve wider environmental problems. Agree/Disagree
		AC9 - My transport choices can have an impact on the environment. Agree/Disagree
		AC10 - I can help to solve my town/city's transport problems by avoiding motorcycle use. Agree/Disagree
		AC11- I contribute to environmental pollution by commuting by motorcycle use. Agree/Disagree
	PN	PN1 - I feel personal responsibility for helping to solve my city's transport problems. Agree/Disagree
		PN2 - I feel morally obliged to avoid using motorcycle to get to work place. Agree/Disagree
		PN3 - I don't feel any personal responsibility for causing my city's traffic and environmental problems
		PN4 - People like me should feel morally obliged to avoid using motorcycle to get to work place

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