Strategies to Promote Mobility Management Incorporating Heterogeneity

Junghwa Kim**, Satoshi Fujii***, Backjin Lee****

1. Abstract

The objectives of this paper are to suggest strategies for Mobility Management (MM), which has attracted increased attention as sustainable transportation policy, through incorporating heterogeneity in trip maker. The heterogeneity was analyzed by latent class model using psychological variables and it was segmented by three latent classes: "Environmentalists with non-actively travel", "Environmentalists with actively travel", and "Non-environmentalists". In addition, it could be demonstrated the transitional process in travel behavior for reducing car use by structure equation model, consists of three steps (attitude change → behavioral intention → actual action.) and each step is influenced by psychological variables related to environmental awareness, attitudes toward public transportation and auto preferences. Finally to promote the MM effectively for sustainable transportation, some strategies were suggested with considering the characteristics of trip makers.

2. Introduction

To cope with the rapid rise in the number of automobiles, there is an urgent need to implement appropriate policies. Depending on circumstances, measures for reducing travel demand may involve a wide variety of actions, ranging from "push" to "pull" measures (Garling and Fujii, 2006). Mobility management (MM) has attracted increased attention since the end of the 1990s in European Union (EU) countries, Australia, and Japan as a "pull" measure designed to change car use behavior (Taniguchi et al, 2007) for sustainable transportation.

MM is an approach related to developing social consciousness with the aim of enhancing the effect of existing traffic policy, e.g., transportation demand management (TDM), and is intended to influence individual awareness and certain psychological factors to encourage voluntary behavior changes in car use. MM includes providing specific information on public transportation, developing travel campaigns, and providing travel education. A typical method involves participants' reporting their travel behavior or requesting necessary information for travel behavior change; they might also receive feedback that includes information about CO_2 emission from cars, advice on how to reduce car use, and individualized information on public transportation (Taniguchi and Fujii, 2007).

MM focuses on concretely grasping the transitional process of travel behavior based on socio-psychological aspect and employs a different application methodology for each behavioral change. For the analysis of the transitional process in MM, structural equation models (SEM) have been widely used to capture the relationship between psychological factors (e.g., perceptions, attitudes, and behavioral intentions) and actual behaviors. Although this specification is adequate for the analysis, the

---

* Key Words: Mobility Management, Heterogeneity, Latent class, Psychological variable, Strategy
**Ph.D Student, Department of Urban Management, Kyoto University, C1-2-432, Nishikyo-ku, Kyoto 615-8540, Japan, Tel: +81-075-383-3242; Fax: +81-075-383-3236; E-mail: junghwa.kim.trans@gmail.com
***Professor, Department of Urban Management, Kyoto University, C1-2-432, Nishikyo-ku, Kyoto 615-8540, Japan, Tel: +81-075-383-3238; Fax: +81-075-383-3236; E-mail: fujii@trans.kuciv.kyoto-u.ac.jp
****Associate Research Fellow, Korea Research Institute for Human Settlements,224 Simin-ro, Dongan-gu, Anyang-si, Gyeonggi-do, 431-712, Korea, Tel: +82-31-380-0373; Fax: +82-31-380-0484; E-mail: bjlee@krihs.re.kr

heterogeneity of the transitional processes of individuals is underexplored in the transportation field. Individuals, for instance, may have different levels of perceptions about "the protection and improvement of the environment" based on socioeconomic characteristics (e.g., income level). The relationship between behavioral intentions and actual actions for "the reduction in car use" may differ depending on public transport conditions, interactions among household members, and other factors. Additionally, models that explicitly consider heterogeneity are important for the implementation of MM. For instance, a traveler feedback program might be more effective for the person with a high perception of protecting the environment but a low behavioral intention of reducing car use, whereas a group discussion program involving household members might be more useful for the person who has a high behavioral intention of reducing car use but who is restricted in actually doing so.

In light of these considerations, the present paper aimed to develop a model incorporating the heterogeneity of transitional processes and to investigate the different impacts of psychological factors by classes. A latent class modeling framework was applied to effectively incorporate heterogeneity in the model, which, to the best of our knowledge, is the first time this approach has been used in the MM research field. After identifying latent classes and capturing characteristics of each latent class, structural equation models were developed for each latent class to analyze and compare transitional processes for suggesting strategic methodologies of MM.

3. Literature Review

Because the existing traffic policy focuses only on inducing travelers to shift from car use to other modes of transportation, it overlooks psychological factors such as perceptions about circumstances, the formation of individual social consciousness, and the final principal agent. In reality, there is still a lack of research using analytical methodology to examine travel behavior based on socio-psychological aspect in the transportation field.

Loukopoulos (2005) stated that individual environmental awareness has a greater influence than are socioeconomic factors (e.g., whether or not to own a car, household income, etc.) on reducing car use. Taniguchi and Satoshi (2007) suggested a model showing that the reduction in car use is influenced by behavioral intention, which in turn is influenced by psychological factors, including perceived behavioral control. This psychological relationship was applied in the present study. Toi (2008) suggested that the process of change in travel behavior is divided into two steps: environmental awareness and behavior evaluation. Toi also suggested a methodology for analyzing effects by dividing the first step into evaluations of environmental riskiness, social common good, and cognition of practicability and dividing the second step into evaluations of cost/benefit, social norms, and practicability. In general, the socioeconomic characteristics of individuals and households (e.g., gender, age, income, etc.) and the attributes of transportation modes (e.g., in-vehicle time and out-of-vehicle time) are considered factors having an effect on car and public transportation uses. However, besides these factors affecting mode choice, there is also the level of service (LOS) provided by the transportation mode and individual propensity with respect to travel preferences. Recent research by Johansson et al. (2006) revealed that interest in the environment, awareness of traffic safety, and individual propensity for convenience and comfort have large influences on the choice of travel mode and pattern.

Market segmentation theory is a latent class model that has been applied in various fields to explain the heterogeneity of data, but it has rarely been used in the transportation field. Previous studies in the transportation field have determined the air carrier choice of latent classes among the airline passenger group (Wen and Lai, 2010) and choice of long-distance travel by three road types, i.e., two lane, four lane without a median, and four lane with a median (Greene and Hensher, 2003). Moreover, the latent class model has been used to capture heterogeneity and duration of activities such as daily

shopping and in-home tasks. Specification of latent classes has proven beneficial for representing differences in individual and household response (Lee and Timmermans, 2007).

4. Data

A total of 1000 observations from lay people was randomly surveyed from three smaller neighboring cities in Korea, namely Suwon, Anyang, and Sungnam, located in the suburbs of Seoul, during 5 days after June 9, 2009. The survey was processed as individual interviews. The underlying reason that these suburb cities were selected for this study was that almost all travel occurring from them took place within Seoul because these cities lack self-sufficiency.

The survey questionnaire contained three sections and eight questions. All questions were related to psychological factors, providing a way to evaluate views about preference for car use, attitudes toward the public transportation system, and awareness of environmental problems using the three-point Likert scale with defined midpoints and endpoints where +1 indicated "no," and +2 and +3 represented "neutral" and "yes" answers, respectively.

The first section, which considered respondents' preferences for car use, included the following questions: "Do you like using a car?" and "Do you think that using a car is pleasant?" To measure attitudes toward public transportation, respondents were asked, "Do you prefer to use a subway or train?", "Do you prefer to use a bus?", and "Do you prefer to ride a bicycle?" Similarly, the questions, "Do you think that you should worry about the environment?", "Do you want people to worry about the environment?", and "Do you think that environmental problems become more important than anything else?" were used to evaluate awareness of environmental problems. As stated above, we included eight psychological questions to segment the population into latent classes. Four variables related to personal attributes were used to capture the effect of socioeconomics and travel habits on latent class membership. Table 1 presents scores for each question.

To estimate the proposed modeling framework, we also administered six questions related to the decision-making process for reduction in car use; these were classified into three sections: "attitude toward reduction in car use," "behavioral intention," and "actual action toward reduction in car use." Each section consisted of two questions: "Do you feel the necessity to reduce car use?" and "Do you feel obligated to reduce car use?" pertained to the section "attitude toward reduction in car use." "Do you make an effort to reduce car use?" and "Do you think of ways to reduce car use?" belonged to the section "behavioral intention." Finally, the section associated with actual action contained the questions: "How many times have you reduced car use?" and "Do you actually reduce car use?" These questions were also measured with the three-point Likert scale, as were the eight psychological questions.

Table 1. Lists of Queries.

Variable	Scores
Personal attributes	
(Gender)	+1 = Male, 0 = Female
(Age)	Age of individual in years
(Income per month)	+1 = less than 2 million, +2 = 2–3 million, +3 = 3–4 million, +4 = 4–5 million, +5 = more than 5 million

(Frequency of car use per week)	+1 = 1–3 times per week, +2 = 4–5 times per week, +3 = more than 6 times per week
Preference for car use	
(Do you like using a car?)	+1 = no, +2 = neutral, +3 = yes
(Do you think that using car is pleasant?)	+1 = no, +2 = neutral, +3 = yes
Attitude toward the public transportation system	
(Do you prefer to use train?)	+1 = no, +2 = neutral, +3 = yes
(Do you prefer to use bus?)	+1 = no, +2 = neutral, +3 = yes
(Do you prefer to ride a bicycle?)	+1 = no, +2 = neutral, +3 = yes
Awareness of environmental problems	
(Do you think that you should worry about the environment?)	+1 = no, +2 = neutral, +3 = yes
(Do you want people to worry about the environment?)	+1 = no, +2 = neutral, +3 = yes
(Do you think that environmental problems become more important than anything else?)	+1 = no, +2 = neutral, +3 = yes
Attitude toward reduction in car use	
(Do you feel the necessity to reduce car use?)	+1 = no, +2 = neutral, +3 = yes
(Do you feel obligated to reduce car use?)	+1 = no, +2 = neutral, +3 = yes
Behavioral Intention	
(Do you make an effort to reduce car use?)	+1 = no, +2 = neutral, +3 = yes
(Do you think of ways to reduce car use?)	+1 = no, +2 = neutral, +3 = yes
Actual Action toward reduction in car use	
(How many times have you reduced car use?)	+1 = unchanged, +2 = So-so, +3 = much
(Do you actually reduce car use?)	+1 = no, +2 = neutral, +3 = yes

5. Latent Class Analysis

As a first step, we initially estimated the latent class models without segmentation variables in the membership functions. To determine the proper number of latent classes using *M-plus* software and through BIC and AIC values, which were reported in Table 2, it was appropriate to check the optimal number of latent classes. The results showed that as the number of classes increases, both BIC and AIC decrease, except in the case of four classes, when the BIC value increased. A comparison of BIC and AIC values indicated that three latent classes could be identified for psychological characteristics, and this was the optimal number.

Table 2. BIC and AIC in Analyses with Various Numbers of Latent Classes.

Number of classes	No. of parameters (p)	Log-likelihood at convergence (L_c)	AIC	BIC	Decrement in BIC
1 class	18	-7497.586	15031.172	15119.512	-
2 classes	37	-7336.316	14746.631	14928.218	-191.294
3 classes	56	-7221.785	14555.571	14830.405	-97.813
4 classes	75	-7174.037	14498.073	14866.155	35.75

Each of the rows in Table 3 (Appendix) represents a different psychological question, and the columns show the probabilities of answering "no," "neutral," or "yes" to the question for each latent class. Thus, respondents belonging to latent class A had a 32.5% probability of saying "yes," a 57.7% probability of responding with "neutral," and a 9.8% probability of saying "no" to the question "Do you like using a car?" The probability of answering "yes" to each question is described in Table 3 for each type of travel behavior. The pattern of responses for all classes gives an overall capture of the characteristics of the responses for each class.

For latent class A, a remarkable characteristic was found in the section on "Awareness of environmental problems." They had high probabilities of saying "yes" to environmental questions: 86.1%, 75.8%, and 98.1%. These are outstanding percentages compared with those in the section about car preferences and attitudes toward public transportation (32.5% and 47.4% in "preference for using a car" and 11.6%, 39.7%, and 7.4% in "attitude toward the public transportation system"). This means that they were exceedingly consciousness of the environment and environmental pollution.

Latent class B also showed outstanding percentages of saying "yes" to environmental questions like latent class A (81.8%, 79.2%, and 84.3% in "awareness of environmental problems"). However they had different tendencies from latent class A that were high probabilities in all sections including "car use" and "attitude for public transport". In other words, they showed similar probability levels between mid-60% and low 80% in all sections, and replied positively to all psychological questions (77.2% and 63.7% in "preference for using a car" 75.9%, 77.6%, and 64.8% in "attitude toward the public transportation system," and 81.8%, 79.2%, and 84.3% in "awareness of environmental problems").

Latent class C showed a neutral attitude in all three sections, and it seems that members of this group had no distinguishing characteristics. They had 58.7% and 50.9% probabilities of responding "yes" to the two questions under "preference for car use" and 56.5%, 39.0%, and 43.2% probabilities of saying "yes" to the questions in the section "attitude toward the public transportation system." In the section related to environmental problems, their probabilities of answering "yes" to the three questions were 45.2%, 39.9%, and 58.1%. All of these probabilities were near the 50% level, meaning that constituents of latent class A did not have firm views with regard to the three sections of the survey.

When these tree latent classes were compared, it was possible to capture the characteristics of each class and could be identified as following. Once latent class A should be represented environmentalists who do not actively travel because they did not show preference in almost all alternative travel modes including auto (32.5%, 47.4%, lower than counterparts of class B and C), train (11.6%, lower than counterparts), transit (39.7%, slightly higher than class C but much lower than class B) and bicycle (7.4%, much lower than counterparts) as well. While latent class B should represent as environmentalists who actively travel because they show great preference not only to car but all kinds

of public transit and bicycle. In case of latent class C could be considered who do not perceive the environmental problems and who are not anxious about the environment pollution comparing with other two classes.

6. Model Estimation

As described above, three distinguished latent classes were identified with respect to travel behaviors. The modeling framework of structural equation models by each latent class were based on the theory of planned behavior, one of the most widely used behavioral theories (Conner and Armitage, 1998) with assumption that actual action to reduce car use is influenced by the behavior intention, and that behavior intention is influenced by attitude towards car use reduction. The estimation results of the models with personal attributes and psychological variables are shown in Table 4 (Appendix), along with parameter estimates and CR[1], *p*-value for the effects of personal attributes, and representation of the process of decision making about reduction in car use on latent class membership. In Table 4, certain variables with statistical significance are observed. Figure 1-3 also show the estimation results of the structural equation models by each latent class.

Considering the significant statistical values, it is obvious that there was a strong relationship in all models between "attitude toward reduction in car use" and "behavioral intention". Equally meaningful *p*-values were found for the path from "behavioral intention" to "actual action toward reduction in car use" in all models. "Awareness of environmental problems" was found to influence "attitude toward reduction in car use". "Attitude toward the public transportation system" had an effect on "behavioral intention," and "actual action toward reduction in car use" was directly affected by "preference for using a car". Although there was a slight difference in coefficients among the models, the above findings were observed to be basically consistent with the proposed hypothesis framework.

When the three models were compared, the coefficients among them differed. In the model for latent class A, the coefficient of the path from "preference for car use" to "actual action toward reduction in car use" was not strong compared with the other two models. It seems that the characteristic of latent class A, namely being environmentalists with tendency of non-actively travel, was reflected in the model. Furthermore, the relationship between "behavioral intention" and "actual action toward reduction in car use" was very strong (0.834) when compared with the models for latent classes B and C (class B: 0.499, class C: 0.581).

It should be noted that in men, the weekly frequency of auto use was lower compared to that in women, showing a high potential for a set attitude toward reduced car use. The older population appeared to more easily change their mode of travel from car use in latent classes A and B, and people belonging to latent classes B and C with lower incomes have a tendency to transfer their mode compared to those with higher incomes.

The overall goodness of fit of all the models appeared to be acceptable based on χ^2 value[2], GFI[3], and RMSEA[4], which can be found in Table 4 (Model latent class A: $\chi 2$ [df = 133] = 346.521, GFI

---

[1] CR (Critical Ratio): This is the estimate divided by its standard error. If we are dealing with random sample variables with standard normal distributions, then the absolute value of estimates with critical ratios more than 1.96 and 2.56 are significant at the 0.05 and 0.01 levels, respectively.

[2] χ^2 value: When degrees of freedom (df) are 133, $\chi^2 = 160.91$ ($p < 0.05$), $\chi^2 = 173.85$ ($p < 0.01$), $\chi^2 = 178.76$ ($p < 0.005$), $\chi^2 = 189.14$ ($p < 0.001$).

[3] Goodness-of-Fit-Index (GFI): GFI varies from 0 to 1, but theoretically can yield meaningless negative values. By convention, GFI should be near or greater than 0.9 for the model to be accepted. By this criterion, the present model is accepted.

[4] Root Mean Square Error of Approximation (RMSEA): There is adequate model fit if RMSEA is less than or equal to 0.08.

= 0.873, RMSEA = 0.079; Model latent class B: $\chi 2$ [df = 133] = 572.761, GFI = 0.884, RMSEA = 0.084; Model latent class C: $\chi 2$ [df = 133] = 339.122, GFI = 0.880, RMSEA = 0.076). These results are discussed in the following section.

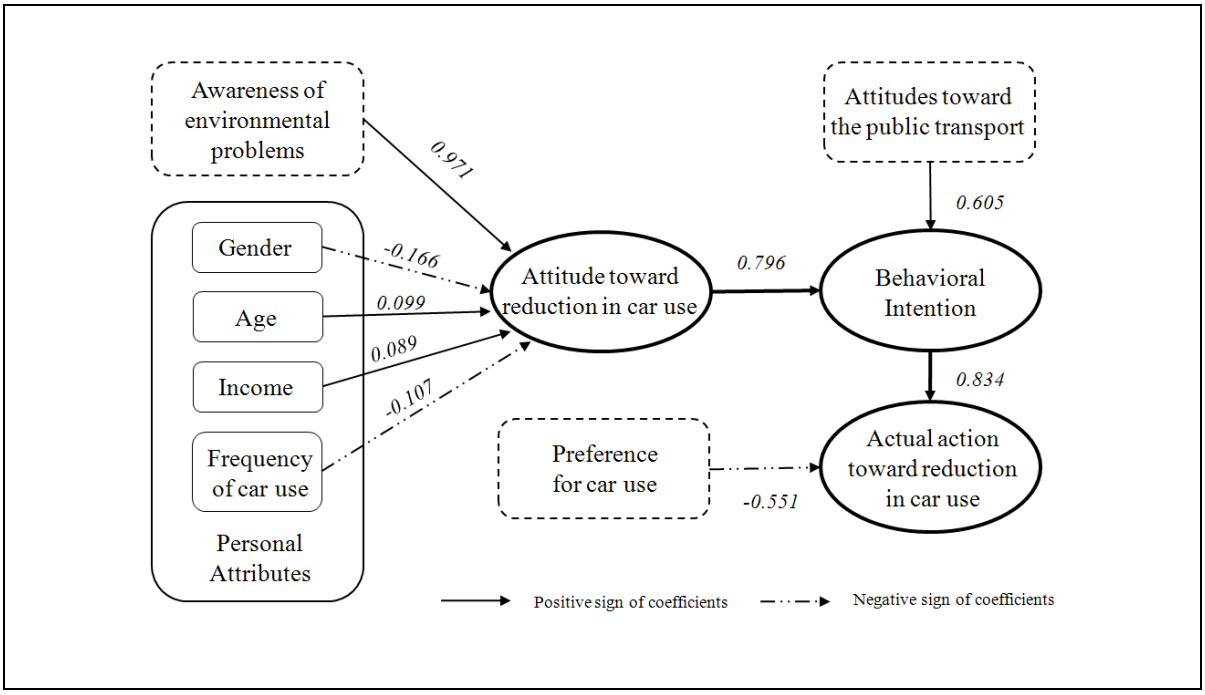

Figure 1. Estimated Model for Latent Class A.

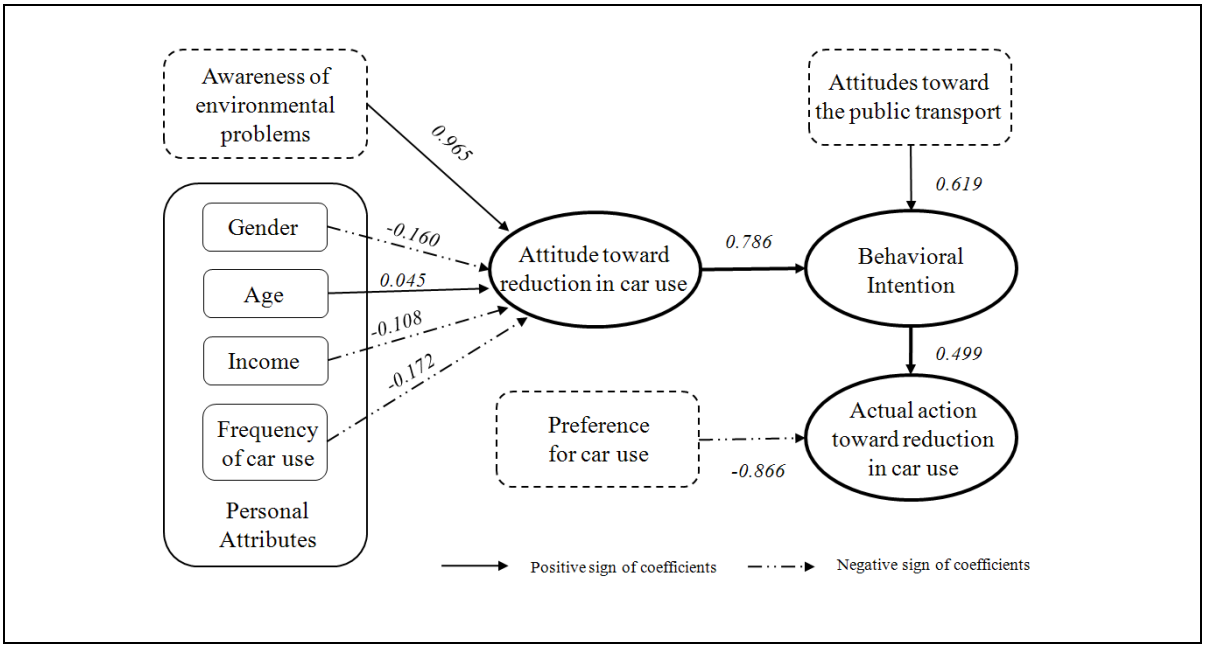

Figure 2. Estimated Model for Latent Class B.

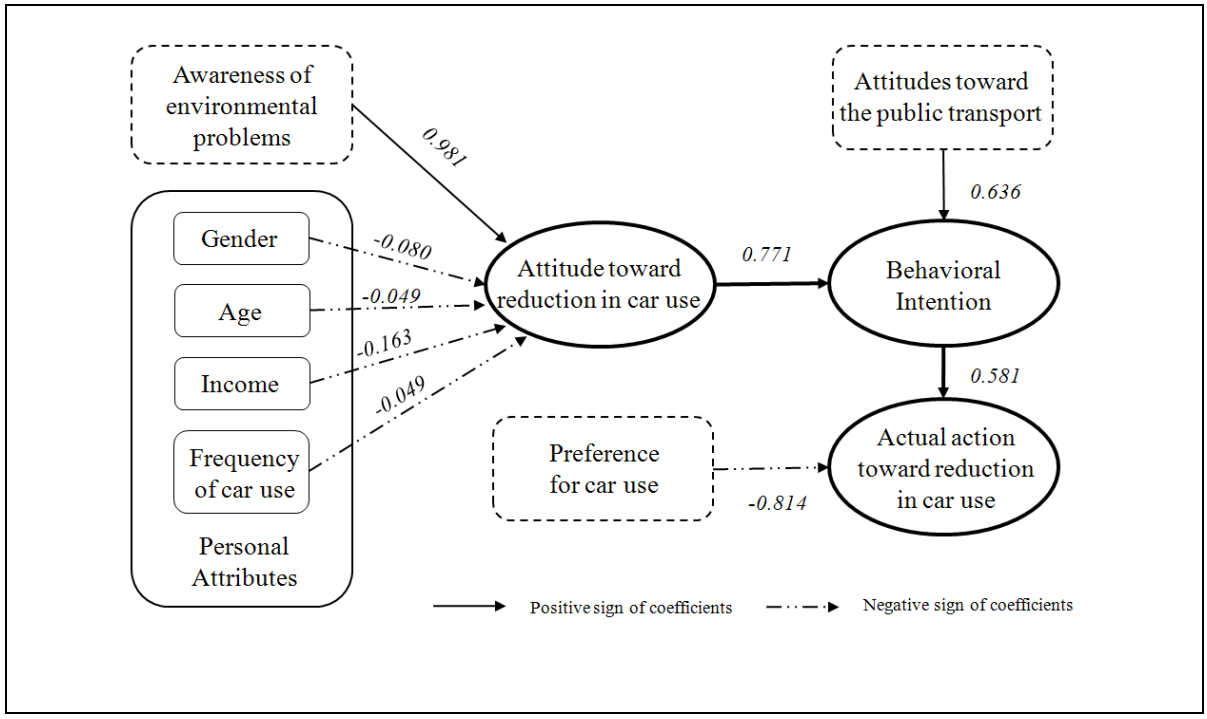

Figure 3. Estimated Model for Latent Class C.

7. Discussion and Conclusions

Heterogeneity by latent class analysis was segmented by the features of travelers into three classes: "Environmentalists with non-actively travel", "Environmentalists with actively travel", and "Non-environmentalists." Therefore, we could determine that there should be a differentiated policy for sustainable transportation that reflects the characteristics of latent classes in trip makers. It is apparent that the proposed models, which include heterogeneity, are strongly related to psychological variables and it was re-demonstrated that there are steps in the process of travel behavior modification as shown in some previous researches, namely attitude change → behavioral intention → actual action. Moreover, in this paper, a further study was performed about psychological variables that influence each step of processing. The latent psychological variable "awareness of environmental problems" influences the "attitude change" step, "behavioral intention" step is influenced by "attitude toward the public transportation system," and "actual action" step is affected by "preference for using a car." The positive sign associated with environmental awareness indicates that the more travelers recognize the importance of environmental problems, the greater the tendency is to change their travel mode from using an auto. Latent variables related to preference for public transportation also had positive signs. This means that travelers showing goodwill toward transit use have stronger behavioral intentions toward reducing car use. Because the negative sign for variables associated with preference for using an auto was estimated, it indicates that those who prefer to use autos have difficulty taking action toward reduction in car use. Besides, it was proved that personal attributes (e.g., gender, age, income, and frequency of using an auto per week) influenced the "attitude change" step.

As stated above, MM has attracted increased attention as new way to solve congestion problem through reducing car use and its measures have been proven to reduce car use in other countries, such as Japan, with the application of psychological latent variables related to car use. Therefore the results of this study can make a great contribution to suggest the strategies for effective promoting the MM for sustainable transportation, because it incorporated the heterogeneity to consider the characteristics of trip makers. In case of latent class A, policy should be focus on "behavioral intention" step with a

campaign about the positive effects of travel by public transportation to environment and provision of specific information to use transit easily. To attract them to actual action for reducing car use, it can be the strategy to concentrate on "behavioral intention" step since they already have strong correlation between "behavioral intention" step and "actual action" step. While the way that is providing information about negative effects of car use on the environment through educational program, might be good strategy to latent class B. Also, individualized feedback advice on how to reduce travel frequency can be effective method to handle them, because they are strongly influenced to have actual action from "preference for using a car" and they showed the actively travel tendency. For latent class C, it might be the best way to give educational feedback that includes information of environment, for instance about CO_2 emissions from car use, because the correlation between variable of "Awareness of environmental problems" and "attitude toward reduction in car use" step is high although they still do not recognize environmental problems.

The latent classes classified in this paper considered only three psychological latent variables: environmental awareness, attitude toward the public transportation, and preference for car use. However, factors related to the moral obligation to reduce car use and the image associated with cars may also be important latent variables for segmenting classes. Also, classifying the model that describes the process of voluntary change in travel behavior according to trip purpose may be a meaningful area of study. Therefore, we hope to elaborate on the above results in further studies for future publications.

8. References

1. Beimborn EA. Greenwald MJ. Jin X. 2002. Accessibility, connectivity, and captivity. Transportation Research Record 1835:9.
2. Bollen KA. Long SJ. 1993. Testing structural equation models. SAGE Focus Edition vol154: ISBN 0-8039-4507-8.
3. Choocharukul K. Van HT, Fujii S. 2008. Psychological effects of travel behavior on preference of residential location choice. Transportation Research A 42:116-124.
4. Conner M. Armitage CJ. 1998. Extending the theory of planned behavior: A review and avenues for further research. Journal of Applied Social Psychology 28:1429-1464.
5. Fujii S. 2007. Communication with non-drivers for promoting long-term pro-environmental travel behavior. Transportation Research D 12:99-102.
6. Fujii S. Taniguchi A. 2005. Reducing family car use by providing travel advice or requesting behavioral plans: an experimental analysis of travel feedback programs. Transportation Research D 105:385-393.
7. Fujii S. Gärling T. 2005. Temporary structural change: a strategy to break car-use habit and promote public transport. In G. Underwood (Ed.). Traffic and Transport Psychology pp. 585-592. Elsevier: Amsterdam.
8. Gärling T. Fujii S. 2006. Travel behavior modification: theory, methods, and programs. Resource Paper for the IATBR Conference. Kyoto. Japan. August 16-20.
9. Goodman LA. 1974. The analysis of systems of qualitative variables when some of the variables are unobservable, Part1: A modified latent structure approach. American Journal of Sociology 79:1179-1259.
10. Green WH. Hensher DA. 2003. A latent class model for discrete choice analysis: contrasts with mixed logit. Transportation Research Part B 37:681-698.
11. Haavelmo T. 1943. The statistical implications of a system of simultaneous equations. Econometrica
12. Jeroen K. Vermunt. 1997. Log-linear Models for Event Histories. Thousand Oakes, CA: Sage Publications.

13. Johansson MV. Heldt T. Johansson P. 2006. The effects of attitudes and personality traits on mode choice. Transportation Research Part A 40:507-525.
14. Lee B. Timmermans H. 2007. A latent class accelerated hazard model of activity episode durations. Transportation Research Part B 41:426-447.
15. Lee J. Cho M. 2009. A study on latent classes of social exclusion experience: analysis of difference in gender and education level. Social Welfare Policy 36:79-103.
16. Loukopoulos P. Jakobsson C. Gärling T. Schneider CM. Fujii S. 2005. Public attitudes towards policy measures for reducing private car use: evidence from a study in Sweden. Environmental Science & Policy 8:57-66.
17. Roeder K. Lynch KG. Nagin DS. 1999. Modeling uncertainly in latent class membership: a case study in criminology. Journal of the American Statistical Association 94:766-776.
18. Simon H. 1953. Causal ordering and identifiability. in Hood, WC; Koopmans TC. Studies in Econometric Method. New York: Wiley. pp. 49–74
19. Taniguchi A. Fujii S. 2007. Process model of voluntary behavior modification and effects of travel feedback programs. Transportation Research Record 2010:45-52.
20. Taniguchi A. Suzuki H. Fujii S. 2007. Mobility management in Japan: its development and meta-analysis of travel feedback programs. Transportation Research Record 2021:100-117.
21. Toi T. 2008. Current state and issues of mobility management from the aspect of public transport activity. Transportation & Economy Vol. 68(12):28-35. Transport for London. 2006. Transport 2025.
22. Wen C. Lai S. 2010. Latent class models of international air carrier choice. Transportation Research Part E 46:211-221.
23. Wright SS. 1921. Correlation and causation. Journal of Agricultural Research 20:557–85.
24. Yi C. Lee B. Kim J. 2009. An Introduction to Mobility Management: Voluntary Reduction of a Passenger Car Use for Environmentally Sustainable Transport. Korea Research Institute for Human Settlements (KRIHS).

9. Appendix

Table 3. Probabilities of Response to Psychological Question.

Psychological questions / Answer	Latent Class A			Latent Class B			Latent Class C		
	No	**Neutral**	**Yes**	**No**	**Neutral**	**Yes**	**No**	**Neutral**	**Yes**
Preference for car use	Neutral			High			Neutral		
(Do you like using a car?)	0.098	0.577	0.325	0.011	0.217	0.772	0.036	0.377	0.587
(Do you think that using car is pleasant?)	0.142	0.384	0.474	0.030	0.333	0.637	0.125	0.366	0.509
Attitude toward the public transportation system	Low			High			Neutral		
(Do you prefer to use train?)	0.273	0.610	0.116	0.010	0.231	0.759	0.108	0.327	0.565
(Do you prefer to use bus?)	0.177	0.426	0.397	0.069	0.155	0.776	0.149	0.461	0.390
(Do you prefer to ride a bicycle?)	0.339	0.587	0.074	0.018	0.335	0.648	0.171	0.397	0.432
Awareness of environmental problems	Remarkably high			Remarkably high			Neutral		
(Do you think that you should worry about the environment?)	0.027	0.113	0.861	0.006	0.176	0.818	0.127	0.421	0.452
(Do you want people to worry about the environment?)	0.008	0.234	0.758	0.003	0.205	0.792	0.171	0.430	0.399
(Do you think that environmental problems become more important than anything else?)	0.000	0.019	0.981	0.000	0.157	0.843	0.054	0.365	0.581

Table 4. Parameter Estimates of the Models by latent class.

Effects of explanatory variable on latent variable	Latent class A			Latent class B			Latent class C		
	Estimate	SE	CR	Estimate	SE	CR	Estimate	SE	CR
Personal attributes→Attitude toward reduction in car use	-	-	-	-	-	-	-	-	-
Gender →Attitude toward reduction in car use	-0.166*	0.055	-2.292	-0.160**	0.039	-2.712	-0.080	0.052	-1.069
Age →Attitude toward reduction in car use	0.099	0.002	1.404	0.045	0.001	0.796	-0.049	0.002	-0.666
Income →Attitude toward reduction in car use	0.089	0.016	1.264	-0.108	0.014	-1.870	-0.163*	0.019	-2.030
Number of times using auto →Attitude toward reduction in car use	-0.107	0.034	-1.508	-0.172**	0.026	-2.890	-0.049	0.035	-0.665
Awareness of environmental problems→Attitude toward reduction in car use	**0.971****	**1.056**	**2.900**	**0.965*****	**0.126**	**6.713**	**0.981***	**0.854**	**2.496**
Worry about environment	0.272*	0.697	2.396	0.532***	0.130	7.389	0.140	0.454	1.551
Need for social consciousness about environment	0.249*	0.673	2.301	0.486***	0.122	7.022	0.109	0.435	1.283
Importance of environmental problems	0.231	-	-	0.568	-	-	0.211	-	-
Attitude toward reduction in car use → Behavioral Intention	**0.796*****	**0.178**	**5.891**	**0.786*****	**0.139**	**5.612**	**0.771*****	**0.206**	**3.563**
Feeling the necessity to reduce car use	0.519	-	-	0.449	-	-	0.383	-	-
Obligation to reduce car use	0.584***	0.211	5.797	0.477***	0.173	6.358	0.753***	0.448	4.093
Attitudes toward the public transport → Behavioral Intention	**0.605*****	**0.098**	**5.696**	**0.619*****	**0.117**	**4.140**	**0.636***	**0.376**	**2.420**
Preference for using train	0.531***	0.142	5.763	0.442***	0.201	4.133	0.431*	0.761	2.515
Preference for using bus	0.687	-	-	0.522	-	-	0.269	-	-
Preference for riding bicycle	0.474***	0.139	5.382	0.298***	0.168	3.574	0.519*	0.800	2.541

**p < 0.05, ** p < 0.01, ***p < 0.001*

Table 4. (Continued)

Effects of explanatory variable on latent variable	Latent class A			Latent class B			Latent class C		
	Estimate	SE	CR	Estimate	SE	CR	Estimate	SE	CR
Behavioral Intention →Actual action toward reduction in car use	**0.834*** **	**0.132**	**8.437**	**0.499*** **	**0.173**	**5.359**	**0.581*** **	**0.300**	**4.086**
Effort to reduce car use	0.625	-	-	0.439	-	-	0.381	-	-
Thinking of ways to reduce car use	0.574***	0.104	7.303	0.377***	0.157	5.306	0.458***	0.284	4.072
Preference for Car Use →Actual action toward reduction in car use	**-0.551****	**0.435**	**-3.148**	**-0.866****	**1.307**	**-3.242**	**-0.814***	**1.597**	**-2.355**
In favor of using car	0.176	0.259	1.729	0.201*	0.375	2.467	0.238	0.570	1.916
Car use is pleasant	0.329	-	-	0.183			0.189	-	-
Actual action toward reduction in car use	-	-	-	-	-	-	-	-	-
Degree of car use reduction	0.855***	0.076	13.903	0.852***	0.128	8.906	0.799***	0.119	7.522
Actual action toward car use reduction	0.863	-	-	0.730	-	-	0.772	-	-
Class sizes [n]	259			474			267		
χ^2 [df = 133]	346.521***			572.761***			339.122***		
GFI	0.873			0.884			0.880		
RMSEA	0.079			0.084			0.076		

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$*