Integrated approach to mode choice including environmental concern and acceptability of bus service priority: A comparative study between Japan and Indonesia

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Abstract

Travel mode choice of commuters between private vehicle and public transit represents a conflict known as a social dilemma. While TDM strategies to cope with social dilemmas assume to affect people's travel decision, the acceptance of TDM measures is influenced by the psychological factor of environmental concern and awareness. The paper focuses on the acceptability of bus priority measures and presents an integrated choice and latent variable model. We conducted case studies in two local cities of Niigata, Japan and Yogyakarta, Indonesia to compare the importance of psychological factors affecting mode choice between private car and bus.

In Niigata, Japan, the study focused employees working in the central area and commuting by car from the suburban areas. A path diagram of the structural equation model (SEM) shows that fundamental environmental concern influences on the direct factors of 'expectation of modal shift' and 'justice and endurance of bus priority', and the direct factors contribute to the 'acceptance of bus priority'. Promotion of fundamental environmental concern as well as reflection on the impact of automobile dependency is required to accept bus priority measures. The integrated choice and latent variable model reveals that attitudinal and awareness promotion of bus priority contributes to modal shift into bus.

In Yogyakarta, Indonesia, the study also focused on employees and students living in the suburbs and commuting to the central area by car. Its SEM reveals that fundamental environmental concern influences neither on the expectation of modal shift, nor on the justice and endurance of bus priority measures. Car-commuters are asking to provide better level of service such as a comfortable air-conditioned vehicle to change into bus use, but psychological factors such as environmental concern and acceptance of bus priority measures do not influence on modal choice.

1. Introduction

Traffic congestion and environmental problems due to car use have been increasing and are serious to people's welfare in the urban area. Urban transport policy should shift from car dependence to TDM (travel demand management) strategies and the promotion of public transit. One of the policies is the execution of the bus priority measures such as bus exclusive lane and public subsidy providing to a bus company. However, car-driving commuters oppose the policy since they receive the disadvantage of bus priority measures, and its introduction cannot be smoothly advanced.

The choice between car and public transport can be seen as a social dilemma, and researchers have distinguished between two types of solutions to social dilemmas. The first is a psychological solution, which focuses on changing the individual attitudes and beliefs that influence the choice between cooperation and defection. The other is a structural solution, which focuses on changing the structure of transport systems and society to eliminate the dilemma. In our context the introduction of bus priority measures is a structural solution, then this generates the second-order dilemma to accept bus priority measures or not. It is necessary to take a

psychological strategy to make car users understand the effects and social fairness of measures, and as a result to promote the public acceptability of measures.

Particularly in Niigata, we have had an exact and practical reason why we should conduct this research. Using the new expressway Nittodo (Japan Sea Tohoku Expressway) opened in 2002, the introduction of TDM measures was proposed for commuters driving from the suburban cities of Shibata and Toyosaka to the central area of Niigata, and the Prefecture and City governments of Niigata executed a social demonstration project of Park & Bus Ride (P &BR) for two weeks in November 2003. In order to introduce such a P&BR scheme in full scale, it is thought that structural measures such as government subsidy to a bus company and bus exclusive lanes and their severe compliance management are necessary. At the moment, however, bus exclusive lane control executed on other streets in Niigata cannot be fully obeyed by commuting drivers. Citizens as a whole are not likely to support the introduction of a structural measure such as P&BR.

We define "bus priority measures" as the two measures of bus exclusive lanes and public subsidy providing to a bus company. Then, the research aims to construct a mode choice model taking account of the psychological factors which determine the acceptability of bus priority measures. These psychological factors must be clarified by a causal analysis of attitude structure which controls and promotes people's acceptability of bus priority. We conducted case studies in two local cities in Niigata, Japan and Yogyakarta, Indonesia to compare the importance of psychological factors which affect the mode choice between private car and bus.

2. Hypotheses of the study

This study hypothesizes that the acceptability of bus priority measures influences on the mode choice decision of an individual. Not only structural factors such as travel time and travel cost, but also psychological factors could contribute to the social dilemma situation of mode choice between car and public transit. There are quite a lot of early researches on social dilemmas of mode choice. As an example of their typical researches, Van Vugt, Van Lange & Meertens (1996) revealed that preference for public transport in a commuting situation is enhanced not only by average travel time and its reliability, but also by a pro-social concern (i.e. the belief regarding the impact of cars on the level of environmental pollution). Garvill (1999) revealed by using quantitative methods that intensions of fundamental factors like value orientation and environmental concern influence specific factors, and these specific factors have direct effects on behavioral intentions. The most important factors for instrumental cooperation (i.e. support for the introduction of regulations to constrain car use) are perceived needs to reduce the environmental problems immediately, and perceived collective moral obligation to cooperate. One of the most important factors for elementary cooperation (i.e. a willingness to reduce car use for daily trips) is expectation of others' cooperation.

Rietveld & Verhoef (1998) presented a conceptual model of the causal relation of factors which lead to the public acceptance of transport policy measures. This acceptance depends on the perception of the seriousness of transport problems (an individual and a social component), the perceived effectiveness of the measures, and features and current mobility pattern of an individual. Jakobsson, Fujii & Garling (2000) investigated private car users' acceptance of road pricing and showed that acceptance of road pricing is negatively affected by perceived infringement on freedom and perceived unfairness. Based on the study above, Fujii, Garling & Jakobsson (2001) clarified that environmental concern influences perceived fairness positively and perceived infringement on freedom negatively.

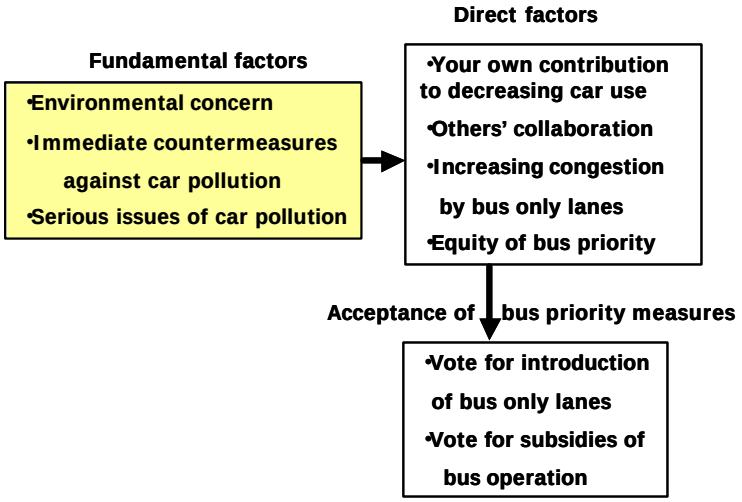

Figure 1. Hypothesized framework of accepting bus priority measures.

Based on the early researches above as a reference, the research hypothesizes the following causal relations of the public acceptability of bus priority, shown in Figure 1. The relations depict a fundamental factor and a direct factor. The fundamental factors of Q.1-Q.4 indicate the level of recognition to general environmental problems as well as public pollution due to car traffic.

Q.1. Environmental concern. What extent do you think that air pollution, noise, and energy consumption and global warming are a serious threat to our health and well-being?

Q.2. Environmental pollution by traffic. What extent do you think that private car traffic in the city contributes to air pollution, noise, energy consumption, and global warming?

Q.3. Immediate measures against traffic pollution. What extent do you believe that air pollution, noise, energy consumption, and global warming caused by commuting car traffic in the city should be reduced immediately?

Q.4. Pollution mitigation than convenience. Do you believe that a moral obligation to commuters to reduce the environmental problems and energy consumption is more important than a personal benefit of reducing commuting times and improving flexibility and comfort?

The direct factors are ones which influence the acceptability of bus priority measures directly, and their first group of Q.5 and Q.8 is willingness to use public transit.

Q.5. Conformity to others' cooperative behavior. If many other commuters have become to use public transit, then you are also willing to reduce your own use of automobile and change into public transit. What percentages of other commuters become to use public transit, when you are also willing to use public transit?

Q.8. Reduce car use and shift to transit. Are you willing to reduce your own use of automobile and change to public transit, with the aim of reducing traffic congestion, the environmental problems, energy consumption, and global warming?

"Conformity to others' cooperative behavior (Q.5)" is a causal relationship that is generally called as conformity, social pressure, or a bandwagon effect. It is hypothesized that other people's behavior influences on one's norm of behavior, and it becomes easier to tune to other's action of using transit for one who considers car pollution as a more serious problem. "How much you want to reduce car use for commuting to prevent car pollution (Q.8)" shows the willingness level of one's voluntary cooperation. We hypothesize that the more one considers car pollution as a serious and urgent problem, the more one voluntarily reduce car use.

The second group of Q.6 and Q.7 is hypothesized to be a responsive awareness when the bus priority measures are introduced.

Q.6. Endure congestion caused by bus lanes. Do you believe that car using commuters should be patient with heavier congestion caused by the installation of bus exclusive lanes, if the bus lanes were utilized efficiently with many buses being in operation on the lanes?

Q.7. Justice and equity of bus priority measures. Do you believe that it is a social justice and equality to increase bus passengers by means of providing subsidies for bus companies or installing bus exclusive lanes in the city?

Fujii et al. (2001) set up and tested a hypothesis that the acceptability of road pricing is decided by both factors of perceived fairness and infringement of freedom toward road pricing, and the higher perception of environmental problems brings about the higher perceived fairness and the lower infringement of freedom. When bus exclusive lanes are introduced under strict control of compliance, it can be predicted that car commuters might dissatisfied more strongly with severe traffic congestion on a general lane and feel higher infringement of freedom. The level of endurance how much one could endure increasing traffic congestion on a general lane is a key for commuters' attitude, and the higher level of endurance would bring about the higher acceptance of bus priority measures. Similarly it is hypothesized that acceptance of bus priority increases if perceived fairness improves.

Finally, the acceptability of bus priority measures is specified by approval or disapproval of the measures.

Q.9. Vote for bus subsidy. Are you willing to vote for the expense of governments' subsidies with the aim of improving bus services?

Q.10. Vote for bus lanes and strict control. Are you willing to vote for the introduction of bus exclusive lanes and their strict regulation, with the aim of achieving smoother driving of buses on four-lane streets in the city?

To search for the causal relation of acceptability of bus priority measures, the structural equation model (SEM) is applied using the software AMOS, and the discrete choice model (disaggregate logit model) is applied to the problem of mode choice. The integration of SEM and the choice model has been developed; for example, Morikawa & Sasaki (1993) tested that subjective factors or causal relation of awareness influence on behavior of mode choice. Ben-Akiva, Walker, Bernardino, Gopinath, Morikawa, & Polydoropoulou (2002) presented a general methodology of an integrated model where the latent variable model (the structural equation model) of attitude and perception was put into the choice model. Sequential and simultaneous estimation methods were proposed to estimate parameters of the discrete choice model. But, this research used a simpler one: a sequential numerical approach.

3. Overview of questionnaire surveys

Questionnaire surveys were conducted for commuters (employees and students) living in Niigata, Japan and Yogyakarta, Indonesia. The surveys conducted for the two cities are summarized in Table 1. Niigata is a prefecture capital city located on the Japan Sea side, about 300 kilometers from Tokyo, with population of 501,000 in 2000, area 205.9 km^2, and population density 2,433 persons/ km^2. The city has 240,000 passenger cars (1.23 passenger cars /household), 77,300 trucks & heavy vehicles, and 1,100 buses.

Yogyakarta is a capital city of Yogyakarta Special Province with population 494,000 in 2000, area 32.5 km^2, and very dense population density 15,200 persons/km^2. Its main Industries are tourism, education and small Industries. The city has 29,800 passenger cars, 11,000 heavy vehicles, 600 buses, and 159,000 motorcycles. Some private companies operate city buses using medium buses (27-30 seats in capacity) and minibuses (10-15 seats in capacity) without air conditioning.

Peoples' travel behavior and attitude for the two cities might be characterized not only by the economic and social difference of country as a whole, but also by the difference of city itself. Both cities are quite different in historical, social and economic environment, but can be typical local cities of the same size. Yogyakarta is a more densely inhabited city and has more serious problems of air pollution due to traffic congestion of cars and motorcycles than Niigata. But, this would not mean that people are much more concerned about the environmental problems than Niigata. This study aims not only to measure the level of environmental concern for both cities, but also to identify and compare the causal relations from environmental concern to mode choice for the two cities.

In Niigata, park and bus ride (P & BR) systems are assumed to introduce to employees commuting from the suburban area to the central part of Niigata. A questionnaire survey was carried out in 2002 targeting at employees working in the central district of Niigata. A total of 230 questionnaires were distributed, and among them 159 were returned by mail, and 128 were effective samples. Respondents are commuting to the central area of Niigata by car or train with distance of 10-30 km.

In Yogyakarta, Godean district in Sleman Regency, 10 kilometers west from the city center, was selected as a survey area since bus exclusive lanes might be technically feasible to introduce. Student surveyors interviewed employees and students commuting from Godean to the city center by car or motorcycle to answer the questionnaire. A total of 300 questionnaires were collected, and among them 196 were effective samples.

Table 1. Overview of questionnaire surveys.

	Niigata, Japan	Yogyakarta, Indonesia
City	Population 501,000 Area 205.9 km^2 Pop. density 2,433 persons /km^2 0.48 passenger cars/capita	Population 494,000 Area 32.5 km^2 Pop. density 15,200 persons /km^2 0.060 passenger cars/capita 0.32 motorcycles / capita
Respondents	Emplyoee of 30 companies, located in the center of Niigata, commuting from the suburbs.	Employees and students commuting to the center of Yogyakarta, living in Godean (10 km west of the center).
Year	October - November, 2002	2002
Method	Deliveried in office and Mailed back.	Interviewed at home.
Collected samples	Collected 159 samples, effective 128 samples (77 car users).	Effective 196 samples (52 car users, and 144 motorcycle users).
Used data for modeling	77 car users	52 car users

Survey items of the questionnaire include individual characteristic attributes, present commuting situation, attitude and awareness survey about environmental and urban traffic problems, and the SP (stated preference) data survey for mode choice. The attitude survey consists of 11 questions, following the hypothesis on the acceptability of bus priority measures presented in chapter 2. Question 6 was answered in percentage of every 10%, and the rest questions are in 7 staged points with 1: complete disapproval, 4: neutral, and 7: complete approval. For the mode choice analysis, the SP method was used to collect data, since some profiles of bus or P & BR operation must include discounting scenarios of parking fee and bus fare. Respondents were asked to answer six or eight questions, choosing between car and bus (P&BR), or between car and motorcycle by a pairwise comparison method. Presented profiles in the SP questionnaire were different between car users and motorcycle users in Yogyakarta, so we could not pool the data of both users. In Niigata, travel cost per month was specified separately by gasoline price, parking fee and bus fare in the questionnaire, and net commuting cost

was presented by subtracting commuting allowance from the total travel cost.

4. Analysis of attitude survey data

In Niigata, among respondents of the survey (128 samples), males are 69%, and 48% are over 40 years of age. Their commuting mode share is: car use 60.0% (77 samples), public transit 34.5% (44 samples), and others 5.5%. Respondents of 70% take more than 40 minutes for commuting. The official Person Trip Survey conducted by Niigata prefecture in 2002 revealed that 53.3% use car and 27.5% public transit among commuters whose destinations were located in the center of Niigata. Modal share of the respondents of our survey are similar to those of the Person Trip Survey.

In Yogyakarta, among respondents of the survey (197 samples), car users are 52, motorcycle users 144. The proportion of sex is almost the same for both users (77% for car, 67% for motorcycle), but age, occupation, and income distributions are quite different. Among the motorcycle users, 77% are less than 30 years of age, 47% students, and 77% have monthly income of less than 1.5 million Rupia. So we have decided to use the data of car users only to compare behavior and attitude between Niigata and Yogyakarta. Among the car users (52 samples), 69% are less than 30 years of age, 12% students, and 23% have monthly income of less than 1.5 million Rupia. Their share of 42% take more than 40 minutes for commuting, which shows their trip length is shorter than those in Niigata.

As mentioned above, the study compares behavior and attitude between Niigata and Yogyakarta by using the samples of car users only. Figure 2 shows the 7 points distribution of the attitude survey, for the 9 questions except for Q. 5. In Niigata, more than 80% of respondents approve for Q.1 to Q.3 of the fundamental factors, showing very high level of environmental concern. But, share percentages of approval decrease to 50% for both of Q.4 (pollution mitigation rather than convenience) and Q.8 (one's own expectation of car use reduction). Respondents of 70% approve for Q.6 (endure congestion caused by bus lanes) and Q.7 (justice and equality of bus priority), and more than 60% approve for Q.9 (vote for bus subsidy) and Q.10 (vote for bus exclusive lanes and their strict control). Respondents as a whole have very high level of environmental concern and approve the introduction of bus priority measures. But, when it comes to individual issues the survey indicates psychological situation such that car-commuters cannot give up convenience of using car.

The attitude survey in Yogyakarta presents almost the same distribution as Niigata. In detail, higher percentage of commuters than Niigata approve for Q.1-Q.4, but lower percentage (30%) than Niigata approve for Q.6-Q.7, and at the same time a little higher percentage (50%) than Niigata approve for Q.9-Q.10. In Yogyakarta, car-commuters are less likely to reduce their car use, and would not stand for being more congested such as bus exclusive lanes are introduced, supposedly since city bus is not a comfortable and feasible mode to choose for some car-commuters.

Figure 3 shows the result of Q.5, i.e. the cumulative percentage of one's own use of public transit use in Niigata and Yogyakarta. In Niigata, the cumulative curve indicates a typical shape, crossing with the 45-degree line at the two equilibrium points of 70% and 10%. The 70% point (although possibly 50% to 70%) is named as "a critical mass". If 70% of car-commuters use public transit at an initial stage, car users conform to others' behavior of transit use and shift to transit use, in a chain finally leading to transit use (cooperation) by all people.

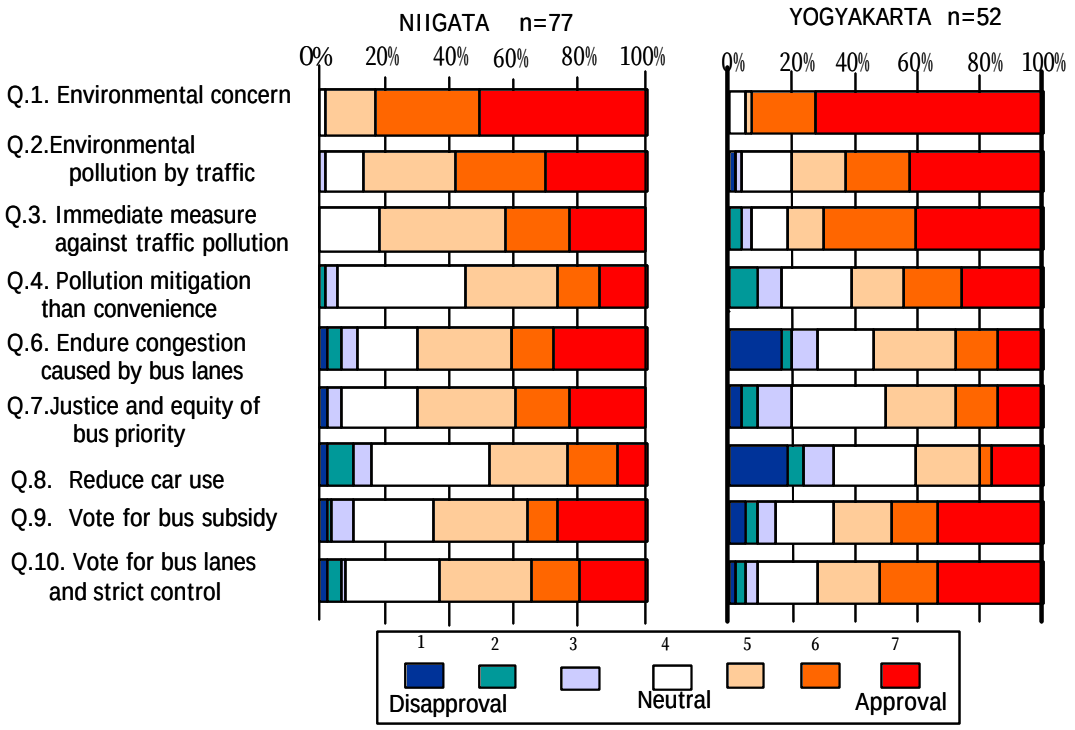

Figure 2. Distribution of attitude survey data (Niigata and Yogyakarta).

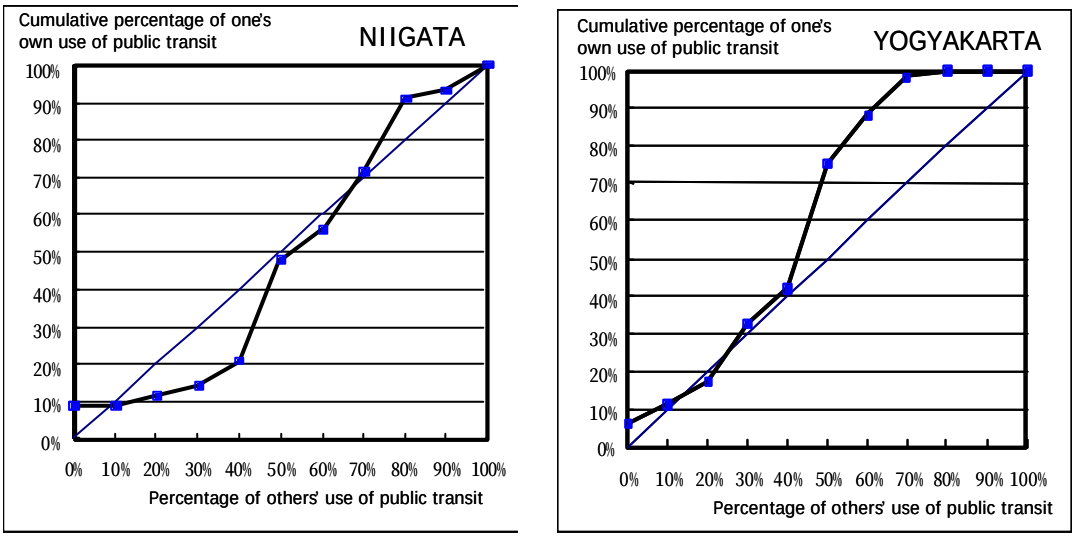

Figure 3. Cumulative percentage of one's own use of public transit, Niigata and Yogyakarata.

But, if less than 70% of car-commuters, even a little bit less, use public transit at an initial stage, share of transit use falls down to 10% finally. Since actual percentage share of transit use is far less than the critical mass of 70%, increasing share of transit use could not be expected by conformity to others' cooperative behavior. If the enforcement of push and pull measures decreases the critical mass down to the lower percentage than the present share of transit use, transit use or cooperation would be able to increase substantially. In Yogyakarta, its upper equilibrium point (a critical mass) is as low as 35% for car-commuters. But, this low percentage of the critical mass seems to be contradictory to the rather higher percentage of disapproval for Q.8 (reduce car use).

5. Integrated choice and latent variable model for Niigata

First, the structural equation model (SEM) is applied to searching for the causal relation of acceptability of bus priority measures using the software AMOS. The SEM is estimated and updated such that new paths are able to exist between the combination of latent variables and its goodness of fit can reach the highest value. Next, the modal choice model is estimated using the SP data, and the integration of choice and latent variable model will be studied.

The right-hand side of Figure 4 shows the cause and effect structure for the acceptability of bus priority measures in Niigata. The signs of parameter estimates satisfy a required condition and their t-values are significant at 1% level. GFI, Goodness of fit indicator, is 0.911 and AGFI, adjusted GFI, is 0.825. These statistics indicate reasonable estimates of the SEM. A path parameter estimate for Q.5 is –13.26, where its absolute value is very big since Q.5 has a percentage unit. Its minus sign satisfies the required condition such that reduction of car use must correspond to decreasing percentage of others' transit use when one is likely to change into transit use.

The cause and effect structure in Niigata can be interpreted as in the followings. "Environmental concern", rising recognition of environmental problems and intentions to improve problems of traffic pollution, strengthens "expectation of modal shift", intentions to reduce car use and increase transit use conforming to others' use of public transit. Here, the introduction of bus priority measures is assumed, a new latent variable can be named as "Justice and endurance" such that car-commuters must endure more severe traffic congestion on the general lane and identify bus priority as a more equitable measure. "Expectation of modal shift" improves "Justice and endurance", which then improves "acceptance of bus priority", approval of bus priority measures. At the same time, "expectation of modal shift" directly strengthens "acceptance of bus priority". The final effect of "acceptance of bus priority" can be promoted by both of voluntary "expectation of modal shift" and "justice and endurance" of introducing bus priority measures. As a whole, the estimated SEM supports the hypothesis proposed in chapter 2.

Next, the three latent variables of "expectation of modal shift", "Justice and endurance" and "acceptance of bus priority" were calculated for each sample by using the pass coefficients of the SEM, and then the disaggregate logit model was applied to estimate mode choice model by using the SP data and the latent variables. The Estimated results of mode choice model are shown in Table 2. There are two kinds of model: "with" and "without" latent attributes of the SEM. The model without latent attributes reveals satisfactory statistics. The utility of car in the model "without" has significant individual factors such as "type of car", "number of drop-in trips", and "present travel time for commuting". Then, we could estimate the model with latent attributes with higher value of the adjusted log-likelihood ratio (ρ^2) adding the two latent variables of "expectation of modal shift" and "acceptance of bus priority measures".

The whole Figure 4 shows the integrated model of mode choice and latent attributes. The left-hand factors show changes driven by the introduction of structural measures such as bus exclusive lanes, government subsidy and P & BR scheme. The right-hand factors show changes driven by the introduction of psychological measures such as environmental education and campaign of more friendly life to the environment. As already discussed, the two latent variables of "expectation of modal shift" and "acceptance of bus priority" will be strengthened when fundamental environmental concern improves.

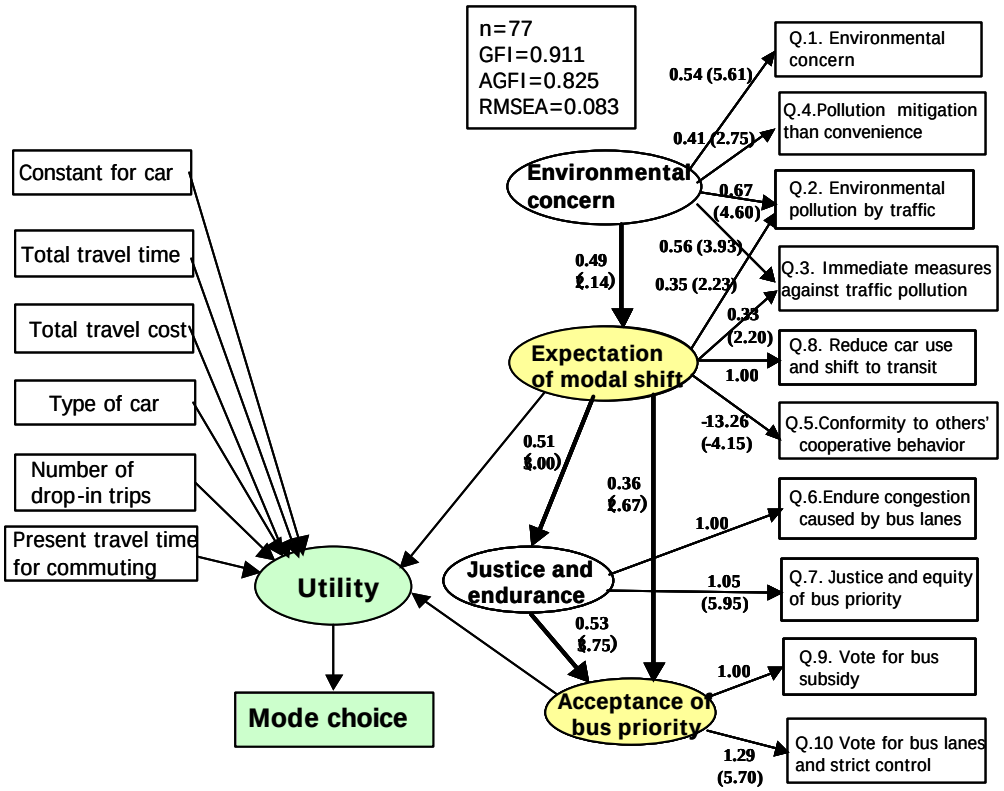

Figure 4. Integrated choice and latent variable model, Niigata.

Table 2. Estimated mode choice model, Niigata.

Explanatory variables	**Without latent attributes**	**With latent attributes**
Constant for car	1.24 (2.50)	5.33 (5.60)
Total travel time (car, bus)	-4.97 (-4.76)	-5.59 (-4.96)
Total travel cost (car, bus)	-0.31 (-3.97)	-0.34 (-4.17)
Type of car (general=1, mini=0)	1.07 (4.06)	1.03 (3.58)
Number of drop-in trips (car)	0.34 (4.27)	0.38 (4.63)
Present travel time for commuting (car)	-1.14 (-2.42)	-1.32 (-2.56)
Expectations of modal shift (car)	-	**-0.21 (-3.74)**
Acceptance of bus priority measures (car)	-	**-0.47 (-2.60)**
Number of samples	462	462
L(0)	-320.23	-320.23
L(ß)	-217.07	-197.30
$?^2$	0.322	0.384
Adjusted $?^2$	**0.313**	**0.373**
Correctly hitted ratio	76.6%	79.7%

6. Latent variable and mode choice model for Yogyakarta

Figure 5 shows the SEM for the acceptability of bus priority measures in Yogyakarta. We have tried to estimate various kinds of structure, but could not reach a solution. This is a model with the highest GFI (GFI=0.874), but less than the required level of 0.9. The variable of Q.4 was required to exclude from the model. A path parameter estimate for Q.5 has a positive sign, which must be negative theoretically since reduction of car use must correspond to decreasing percentage of others' transit use when one is likely to change into transit use. Low and insignificant t-values for the two paths among "environmental concern", "justice and endurance" and "expectation of modal shift" indicate that fundamental environmental concern influences neither on the expectation of modal shift and using transit, nor on the justice and endurance of bus priority measures. On the other hand, the direct factors of "expectation of modal shift" and "justice and endurance" can be influencing on the "acceptance of bus priority measures".

The Estimated results of mode choice model are shown in Table 3. The model without latent attributes does not reveal satisfactory statistics such as a low value of the adjusted log-likelihood ratio (ρ^2), and low t-values of "total travel time" and "total travel cost". All variables of individual attribute (specific variables to car choice), which satisfy a required sign condition, show a reasonable behavior and life-style in Indonesia. It should be noted that "air conditioned bus or not" is an important factor to choose mode even though an air-conditioned bus has not been operating in Yogyakarta. We tried to integrate the choice model with the latent attributes of the SEM, but even a latent attribute of "acceptance of bus priority" could not be included in the model since its t-value was very low and insignificant. Car-users are asking to provide a better level of service such as a comfortable air-conditioned vehicle in order to change into bus use, and such a level of bus service is a more important determinant than psychological factors such as environmental concern and acceptance of bus priority measures.

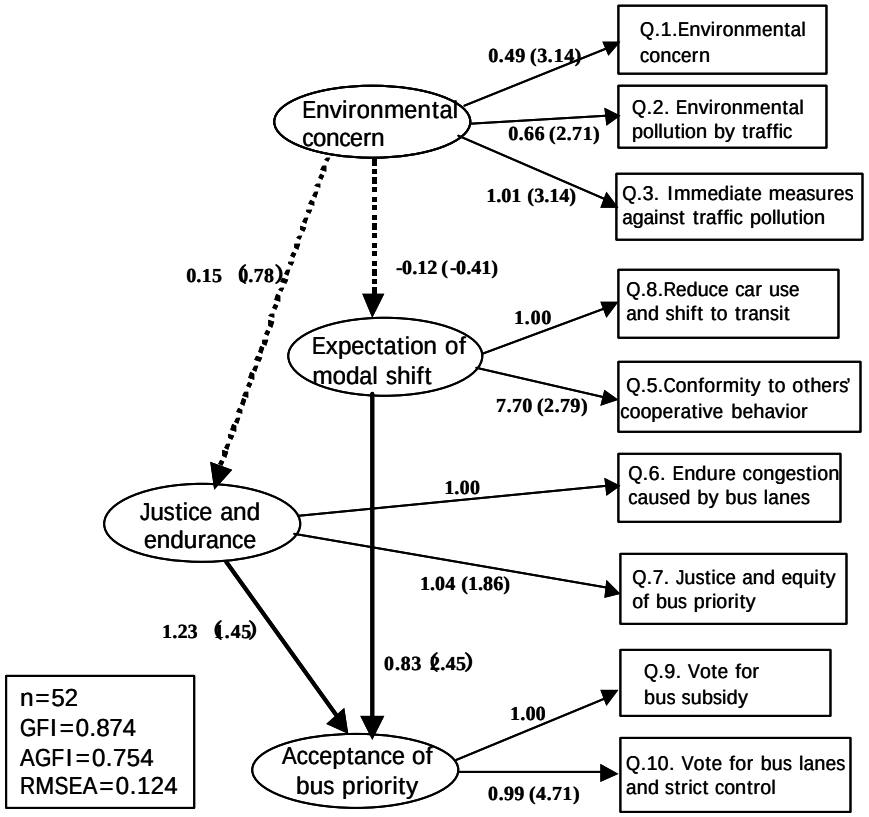

Figure 5. Structural equation model, Yogyakarta.

Table 3. Estimated mode choice model, Yogyakarta

Explanatory variables	**Without latent attributes**	**With latent attributes**
Constant for car	-1.640 (1.68)	-1.377 (1.27)
Total travel time (car, bus)	-0.989 (-0.81)	-0.990 (-0.81)
Total travel cost (car, bus)	-0.161 (-1.31)	-0.161 (-1.31)
Household size (car)	0.520 (4.47)	0.510 (4.31)
Number of cars owned	0.213 (2.61)	0.224 (2.65)
Ownership of drivers licence (car)	0.292 (1.13)	0.268 (1.02)
Occupation (car) (student=1, others=0)	-0.644 (-1.83)	-0.629 (-1.78)
Age under 20 (car)	-1.530 (-3.12)	-1.547 (-3.15)
Age over 51 (car)	-1.297 (-3.34)	-1.299 (-3.34)
Work beginning time before 8:00 (car)	0.729 (2.80)	0.768 (2.83)
Work ending time after 17:00 (car)	2.164 (4.40)	2.158 (4.36)
Air conditioned bus (bus)	**0.742 (3.25)**	**0.742 (3.25)**
Acceptance of bus priority measures (car)	**-**	**-0.047 (-0.55)**
Number of samples	415	415
L(0)	-287.66	-287.66
L(ß)	-236.34	-236.19
$?^2$	0.178	0.179
Adjusted $?^2$	**0.154**	**0.152**
Correctly hitted ratio	68.4%	67.5%

7. Discussion

The paper first presented two hypotheses, i.e. a causal relation to the acceptance of bus priority measures and the integration of mode choice model and latent variables of the SEM. The study for Niigata using the data of car-commuters (77 persons) yielded support for both of the causal structure and the integrated choice and latent variable model. We estimated another SEM and an integrated model using the data of all commuters (128 persons) and achieved almost the same results (Iwasada & Matsumoto, 2004).

The causal structure for Niigata implies that the higher environmental concern car users have, the more they intend to reduce car use and shift into public transit. Here, conformity to others' cooperative behavior, or expectation of others' intentions was found to be another factor to car use reduction. This is also called as the social pressure hypothesis (cf. Jacobsson, Fujii and Garling, 2000). When they faced with the introduction of bus priority measures such as bus exclusive lanes and government subsidy, justice of the measure and endurance of increased traffic congestion (i.e. impacts of the measure) determine the acceptance of bus priority measures as a separate factor.

The left-hand factors of the integrated choice and latent variable model for Niigata show changes driven by the introduction of structural measures, and the right-hand factors show changes driven by the introduction of psychological measures. As already discussed, the two latent variables of "expectation of modal shift" and "acceptance of bus priority" will be strengthened when fundamental environmental concern improves. And, more strengthened "acceptance of bus priority" will make it more feasible and practical for a local government to introduce a structural measure of bus priority. The advancement of "environmental concern" has the two paths leading to modal shift into P & BR. One is a direct psychological impact on "acceptance of bus priority". The other is an indirect psychological impact on the feasibility of bus priority measure. Here, more important

findings are the former one: the advancement of "environmental concern" can contribute directly to more modal shift into P & BR.

The study of Yogyakarta using the data of car users (52 persons) yielded support for neither the causal structure nor the integrated choice and latent variable model. We also tried to develop an integrated choice and latent variable model using the data of motorcycle users (144 users). The SEM revealed statistically that psychological causal relation could exist from "environmental concern" to "acceptance of bus priority", but no integration of choice and latent variable model could be achieved.

We admit that there might be a problem about the phase of data collection and the reliability of collected data in Yogyakarta. Data collection was carried out by personal interview, but it might be hard to make all respondents understand the questionnaire correctly. The study for Yogyakarta, however, tells us that people in Yogyakarta are much concerned about the environmental problems due to car and motorcycle use, but show a little less support for bus priority measures than in Niigata. They suggest that psychological factors such as environmental concern and acceptance of bus priority measures do not influence on modal choice of commuters. Car-users are requiring bus companies to provide a better level of service such as a comfortable air-conditioned vehicle of bigger size, and such a physical level of bus service seems to be a more important determinant than psychological factors in order to shift into bus use.

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