Capacity Development for Sustainable Urban Transportation in Developing Countries

Metin Senbil
COE Researcher, Graduate School for International Development and Cooperation
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima, 739-8529, Japan
Phone: +81-82-424-4342 (ext. 5997) / e-mail: senbil@hiroshima-u.ac.jp

Akimasa FUJIWARA
Professor, Graduate School for International Development and Cooperation
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima, 739-8529, Japan
Phone & Fax: +81-82-424-6921 / e-mail: afujiw@hiroshima-u.ac.jp

Junyi ZHANG
Associate Professor, Graduate School for International Development and Cooperation
Hiroshima University
1-5-1 Kagamiyama, Higashi-Hiroshima, Hiroshima, 739-8529, Japan
Phone & Fax: +81-82-424-6919 / e-mail: zjy@hiroshima-u.ac.jp

Abstract

To make urban transport sustainable, effective and efficient, first and foremost, there is a need for capacity development—capacity is defined as the ability to deal with problems in efficient and effective ways—in developing countries. Apart from many important capacity related problems such as lack of adequate infrastructure, older vehicle population, etc., policy makers in developing countries have to consider changing individual behavior to realize sustainable urban transportation policies. Assuming individual capacity as the effect of attitudes—personal ideas and opinions—on the travel behavior, we incorporate individual capacity into a travel demand model—Bivariate Binary Probit model of private car ownership and its use for commute trip. To do so, we make use of three individual capacity related factor variables, i.e., Factor 1: transport sensitive, Factor 2: attentive citizen, Factor 3: selective citizen, obtained by Factor analytic methods from thirteen attitudinal variables—individual importance ratings on general and transportation related issues. Underlying variables for both transport sensitive and attentive citizens receive positive weights from their respective factor variables; for selective citizens, five out of nine underlying variables received negative factor weights. We find significant effects of individual capacity on private car ownership and its usage for commute trips. However, the results are

Journal of International Development and Cooperation, Vol.14, No.3, Special Issue. 2008, pp. 57-69

mixed for sustainable urban transportation policies. Transport sensitive and selective citizens are more inclined to own private cars, and use them (at least) for commute trips; only attentive citizens are found to have negative effects on both. These results are further discussed within the context of persuasive communication for capacity development in urban transportation.

Keywords: urban transportation; developing country; sustainability; environment; capacity; capacity development; individual capacity.

1. Scope and background

In developing countries, economic development which is generally attached the highest priority renders most of the other issues unattended. Among these unattended issues are those that fall into the sphere of sustainability, which is popularly known as “meeting the needs of the present without compromising the ability of the future generations to meet their own needs” (WCED, 1987, p.43). During the past thirty years, sustainability has gained importance in the face of problems such as environmental degradation, depletion of non-renewable resources, over-consumption of renewable resources, loss of biodiversity, emissions of dangerous gases and increasing stress on the geo-ecological stability of the earth, social inequity, etc. Tracing these problems to their original sources one can frequently come across phenomena closely related to urban transportation because current practice of urban transportation cause problems such as congestion, air pollution, CO_2 emissions, social exclusion, etc., that are closely related to sustainability in many respects in both developed and developing countries at varying degrees (Greene and Wegener, 1997).

Especially in developing countries, nature and intensity of the urban transportation problems seem to be more serious (Faiz and De Larderel, 1993; Gakenheimer, 1999; Gwilliam, 2003), not to mention a bleak future in terms of energy consumption (IEA, 2004) and its looming environmental, social and economical consequences. The future prospects of urban transportation in developing countries imply an aggravated vicious circle of increased car ownership, car use and energy consumption. For example, a study by Dargay and Gately (1999) finds the effect of income on car ownership is highest around US$5000 per-capita GDP level—according to this, relatively low income countries such as China, India, Pakistan, Turkey and Mexico display the highest potential for rapid increases in car ownership levels. Moreover, another study by Ingram and Liu (1998) expects car ownership to increase at a rate more than income growth. Probably, this is due to the poor condition of transportation services supplied and social forces that magnify the private vehicle ownership levels. These social forces are partly be explained by social determinism that car ownership sustains a mobility level exclusively associated with the middle class life styles (Dupuy, 1999; Vasconcellos, 1997). As regards energy consumption, a study conducted by IEA reports surges in oil consumption by developing countries—between 2002-2030, two thirds of the global increase in oil consumption is expected to occur in developing countries; in 2030, developing countries exceed developed countries in terms of total oil consumption, a significant portion of which is estimated to be consumed by the transportation sector (IEA, 2004, page 64-67).

For sustainable urban transportation—to reduce energy consumption and environmental load, to improve equity and safety, and to alleviate economical problems in urban transportation—strategies so far deployed relate to different interrelated realms and allocate different weights to behavioral, technical, institutional, and administrative aspects (ECMT, 1995). For example, transportation control and demand management policies might include spatial and/or temporal restrictions of private vehicles as well as strategies to shift demand to public transit and non-motorized modes or to decrease solo-driving. To obtain successful results in these policies, the

required organizational infrastructure implies harmonious and comprehensive organization of activities related to research, jurisdiction, planning, budgeting and funding, public relations, and application, with proper feedbacks carried out at critical points to streamline the whole process. Another example, reducing private vehicle use by (re)organizing land use, e.g., integrated transportation and land use policies, calls for cross-disciplinary approaches, and comprehensive ways to deal with the existing problems (e.g., Willson, 2001). Again, efforts are needed to supplement planning and related institutions as well as to improve organizational skills.

Clean and energy-efficient private vehicles point to different alternative strategies to decrease environmental emissions from a very different policy perspective in which a mixture of hard (i.e., enforcement) and soft (e.g., financial incentives) measures is necessary (Kessler and Schroeer, 1995). Information and communication technologies so far deployed for better supply and efficient use of transportation services and infrastructure—commonly known as intelligent transport systems (ITS)—are regarded as positive contributors to both better air quality management and increased energy efficiency. A natural pre-condition to the applicability of such systems is the existence of an established (telecommunications and transportation) infrastructure in addition to huge financial and organizational investments (see Sussman, 2005 for relevant discussions).

However, benefits derived from these strategies (or level of success in achieving objectives) would vary from one place to another regarding the existence of state dependency and heterogeneity, possibly induced by urban forms and land use patterns, individual attitudes and lifestyles, organizational, institutional and physical infrastructures, etc. Nevertheless, an overwhelming portion of these strategies is proposed, applied, and calibrated in the contexts of developed countries (see ECMT, 1995; Litman, 2003). A natural corollary to this leads us to consider the ability to devise different strategies, to use different resources and tools in effective and efficient ways for successful proceeding of these strategies. Above all, what becomes critical is the ability to change the ways how individuals and organizations conduct their daily routines. Inevitably, this underlines the importance of institutional infrastructure, information and knowledge creation related to urban transportation, use of information for institution building and policy making.

1.1. Capacity and capacity development

In the literature of development economics, all these are reduced to, and referred to collectively by, “capacity”—the ability to deal with problems in efficient and effective ways (e.g., Hayami and Godo, 2005). However, putting everything into this generic term makes the subject matter very complicated to work with. Nevertheless, in terms of both existing conditions and future prospects as outlined above, presumably there is a capacity problem in tackling urban transportation problems and issues in developing cities.

Regarding this, we propose a point of view for capacity development in developing countries following Matsuoka et al (2006) who devise an Actor-Factor approach within the framework of Social Capacity Development for Environmental Management. We assume, similar to Matsuoka et al (2006), that the actors for capacity development in urban transportation consist of government-public sector, private sector and households/individuals. We also assume that factors for capacity development consist of policies and measures, human and organizational resources, and knowledge and technology.

The critical point in all these might be the challenge of establishing the link between sustainable transportation policies and the quality of life experienced by households and individuals (Steg and Gifford, 2005). Apart from many important capacity related problems such as lack of adequate infrastructure, older vehicle population, etc., policy makers in developing countries have to consider changing individual behavior—we shortly refer to the household and individual’s capacity as individual capacity—to make policies related to sustainable transportation realizable, effective and economically efficient. In this respect, individual capacity constitutes an

important dimension in attaining sustainable transportation objectives. Thus, the focus of this study is the individual capacity, which is regarded critical for the success of the urban transport related policies. In the section that follows, individual capacity variables are incorporated into a travel demand model, which is a bivariate binary Probit model of private car ownership and its usage for the commute trip. Specifically, we try to represent the individual capacity as a collection of factors derived from attitudinal variables that are considered to have latent relationships with the individual capacity (more on this in Section 2.1).

2. A model of individual capacity and travel demand: the case of Jabotabek region

In the model, individual capacity is defined as the effect of attitudes—personal ideas and opinions—on the travel behavior. Personal ideas and opinions are consistent with the definition of attitudes that can be given as "tendencies to evaluate an entity with some degree of favor or disfavor, ordinarily expressed in cognitive, affective, and behavioral responses" (Eagly and Chaiken, 1993, p. 1). Therefore, attitudes are closely related to behavior by which attitudes find an expression (Ajzen and Fishbein, 1977; Eagly and Chaiken, 1993). Two principles for this close relationship to be unearthed are aggregation—using multiple attitude measures for behavioral disposition—and compatibility of attitudes and behavior and in action, target, context or time (Ajzen and Fishbein, 1977).

In the transportation literature, attitudes are generally regarded to reflect experience as formed through past behavior suggesting a cyclical relationship between the two (Dobson et al, 1978; Tardiff, 1977; Tischer and Phillips, 1978). Therefore, attitudes are generally selected to be more directly related to the phenomenon being studied maintaining a certain level of consonance with the principles of aggregation and compatibility mentioned above. For example, a study evaluating a congestion pricing project (Golob, 2001) regards attitudes as stated preferences and uses attitudes—fairness or unfairness, scales of agreement—as part of a combined attitude and behavior model. Another study by Kitamura et al (1997) uses attitudes that are broader in scope, e.g., pro-environment, urban villager, and reports findings strongly supporting the effect of attitudes on travel demand.

In this study, we include attitudes that cover broader issues such as education and safety because of the close connection between attitudinal dispositions on these issues and the individual capacity—in this sense, it can be said that we are also referring to the subjective norms, which includes the individual's normative beliefs and motivations (Fishbein and Ajzen, 1975). The aim in capacity development is to change attitudes in the desired directions to attain the desired outcomes. This mostly requires different modes of persuasive communication. At this point, psychology offers insights into the problem at hand, i.e., persuasive communication on attitude changes. Working on different theories related to persuasion on attitude change, Petty and Cacioppa (1996) delineates two routes to persuasion, i.e., central route and peripheral route approaches (pp. 35 – 36). Central route emphasizes directly the issue in consideration while peripheral route emphasizes anything else such as other consequences of a certain attitude. The individual capacity variables used in this study are directly related to the realms of both routes to be exploited in different ways.

2.1. Model structure

We propose a bivariate binary Probit regression model of private car ownership and its usage for commute trips which allow us to observe the effects of independent variables simultaneously. Bivariate binary Probit regression model depends on simultaneous observation of two discrete binary observed-dependent variables, i.e., y_{i1} *and* y_{i2}. Based on the observed dependent variables that take binary discrete values, underlying continuous dependent variables, z_{i1} and z_{i2}, can be expressed as:

$$\begin{aligned} z_{i1} &= \boldsymbol{\beta}_1' \mathbf{x}_{i1} + \varepsilon_{i1} \\ z_{i2} &= \boldsymbol{\beta}_2' \mathbf{x}_{i2} + \varepsilon_{i2} \end{aligned} \quad , y_{ij} = 1 \text{ if } z_{ij} > 0,\ y_{ij} = 0 \text{ otherwise},\ j = \{1, 2\} \qquad (1)$$

where i denotes an observation; $\boldsymbol{\beta}$ and $\mathbf{x}$ stand for the vectors of parameters and the independent variables respectively; ε_{i1} and ε_{i2} are random variates distributed jointly as standard Bivariate Normal and a free correlation parameter, ρ, i.e., BNV [0,0,1,1,ρ]. Based on the equation given above, the log- likelihood function of the sample can be given as:

$$\log L = \sum_i \log \Phi_2 \left[q_{i1} \boldsymbol{\beta}_1' \mathbf{x}_{i1}, q_{i2} \boldsymbol{\beta}_2' \mathbf{x}_{i2}, q_{i1} q_{i2} \rho \right] \qquad (2)$$

where Φ_2 stands for the standard Bivariate Normal distribution; q is an indicator variable such that $q_{im} = 2y_{im}$-1, $m = \{1, 2\}$. The model is estimated by using LIMDEP Version 8.0 econometric software (Greene, 2002). The dataset used in the model is a 10% random sample retrieved from a household person-trip survey conducted in Jabotabek

Table 1. Descriptive Statistics

		Min.	Max.	Mean	Std. Deviation
1	Private car ownership	0	1	0.18	0.14
2	Private car use for commute trip	0	1	0.15	0.35
3	Age	13.00	88.00	36.66	10.39
4	Sex (1=male, 0= female)	0.00	1.00	0.85	0.36
5	High education dummy (=1)	0.00	1.00	0.33	0.47
6	White collar occupation dummy (=1)	0	1	0.51	0.50
7	High income dummy (if Household income = 9→1)	0	1	0.02	0.15
8	Household size	1.00	10.00	3.48	1.44
9	Commute trip distance (km.)	0.52	90.22	19.03	11.38
10	Distance from city center (km.)	0.84	64.74	19.32	12.15
11	Length of freeways in the zone of residence (km.)	0.00	8.31	1.76	1.51
12	Length of streets in the zone of residence (km.)	1.10	1,777.56	75.37	98.58
13	Land use mix [0-1]	0.00	0.74	0.23	0.18
14	Daily travel time expenditure (minutes)	2.00	780.00	104.85	76.51
15	Number of daily trips	0	8	2.44	1.15
16	Factor 1: Transport sensitive	-6.12	1.53	0.00	1.00
17	Factor 2: Attentive citizen	-5.60	1.76	0.00	1.00
18	Factor 3: Selective citizen	-3.28	3.88	0.00	1.00
Sample size		41,804 (persons)			
		1,485 (residential zones)			

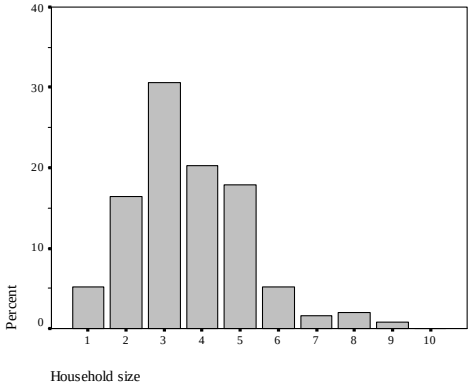
metropolitan area (Jabotabek MA hereafter) of Indonesia by Japan International Cooperation Agency (JICA) in 2003—total number of individuals in the Jabotabek person trip database is 433,125. After organizing the random sample only for employed individuals, a total sample size of 42,804 individuals is obtained for the model estimations. The study area, Jabotabek MA is located on the northern seaboard of Java Island of Indonesia and includes the province of DKI Jakarta—the capital city of Indonesia—and the surrounding regencies of Bogor, Bekasi and Tangerang. The whole Jabotabek MA is approximately 6800 km^2 and has a population around 21.5 million, which constitutes 10% of the population of Indonesia.

Pertinent variables used in the model are presented in Table 1. According to the sample statistics, 18% of the workers' households own at least one private car. Commute trips taken with private car constitute 15% of all commute trips, this ratio increases to 73% for households with private cars. The rows from three to eight in Table 1 constitute individual and household characteristics. According to these variables, the sample consists of mostly middle-aged—87% of the sample fall in between 20 and 40 years of age, male (85%), and moderately educated individuals—only 33% of the sample had received higher education, and an ignorable part, i.e., eight persons in ten thousand, has received no formal education.

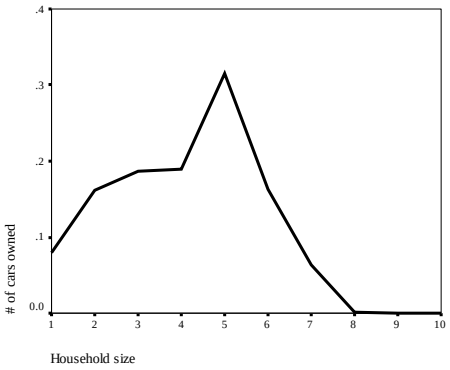
According to the Jabotabek person trip database, households are generally populous: 42.1% of households have between four and six members, another 30% have three members; 97.8% of all households include six members at most (Figure 1a). Car ownership increases with household size up to six members beyond which it reduces to nothing (Figure 1b). Household income is based on the monthly income in domestic currency, i.e., Indonesian Rupiah, falling in any one of the nine intervals represented by integers from one (the lowest, i.e., below 600,000 Indonesian Rupiah) to nine (the highest, i.e., more than 7,500,000 Indonesian Rupiah). According to household income (Figure 1c), 75% of all households have monthly incomes lower than 2,000,000 Indonesian Rupiah—this is equivalent to 222 US Dollars approximately in 2003. Although mostly dominated with the low income households, there is a positive relationship between household income and private car ownership in Jabotabek MA—the correlation between income and car ownership is 0.67 (p=0.00). In the model, we incorporate household income as a dummy variable indicating high income, i.e., more than 7,500,000 Indonesian Rupiah. An interesting preliminary result worth to mention is that the positive bivariate correlation between household size and private car ownership changes to negative when the relationship between the two is controlled with the household income, which is considered to be one of the most effective determinant of private car ownership and its use—income causes private car ownership, which consequently increase travel demand by private cars (for example, see Kain and Beesley 1965, Kitamura 1989, Golob 1990, Dupuy 1999).

The rows from nine to thirteen in Table 1 constitute variables characterizing residential location and land use of residential zone, all of which have been calculated by using GIS utilities. All together there are 1485 zones in the analyses—areas of these zones range between 24 ha and 6634ha, average zonal area is 458ha. Commute trip distance is the direct line distance between centers of the residential zone and employment zone; when both zones overlap in case of an intra-zonal commute, we assume the commute distance is equal to the half of the average of vertical and horizontal extents of the zone. Land use mix variable is calculated similar to the methodology proposed in Cervero and Kockelman (1997). This variable is an entropy measure of urban land uses taking values between zero, i.e., perfect dominance of a single land use, and one, i.e., equal shares of all land uses. This entropy measure is calculated according to the following formula:

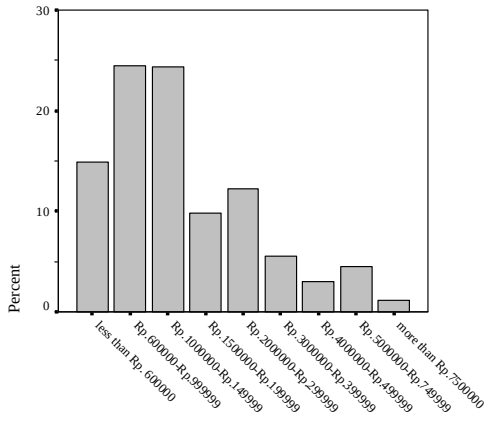
$$\frac{\sum_k p_{jk} \ln\left(p_{jk}\right)}{\ln(6)} \tag{3}$$



a



b



c

Figure 1 Distributions of household size (a), car ownership (b), and monthly income (c) in Jabotabek MA (Total sample size: 157,707).

where *k* is the urban land use type (1: residential, 2: industrial, 3: commercial, 4: educational, 5: governmental, 6: park) and *j* are the number of available urban land uses in the residential zone.

The distance from the city center is calculated as the direct-line distance (in kilometers) from the center of residential zone to the Istiqlal Mescid, a religious land mark in DKI Jakarta city center. Length of streets and length of freeways supply information about road supply in residential zones. The rows fourteen and fifteen supply information about daily mobility in terms of travel time expenditure, and number of daily trips. In the model, both private car ownership and its use are hypothesized to be subject to the same set of independent variables except daily mobility variables, i.e., travel time expenditure and number of daily trips, which are postulated to have effects on private car usage only.

The next three rows, from sixteen to eighteen, in Table 1 present information about factor scores, which are retrieved from two groups of variables which are obtained from Jabotabek person trip database. We assume that these three variables of factor scores represent individual capacity: Table 1 supplies information about Factor 1, Factor 2, and Factor 3 which are derived by Factor Analytic methods (Principal Components) from attitudinal

variables. These attitudinal variables are measured by personal importance ratings—between 1 (not important at all) and 5 (very important)—on popular issues concerning transportation, education, environment, etc. (Table 2). The first factor variable, Factor 1 is derived from four variables which consist of importance rating on issues directly related to the transportation issues[1], hence to the central route given above, concerning public bus transit, public rail transit, transport demand management and enforcement policies, transport related environmental issues. As all factor scores are positive, Factor 1 reveals information about transport sensitive individuals. The remaining two factors (Factor 2 and Factor 3) are derived from nine variables about the importance ratings on general issues[2], i.e., education, housing, floods, garbage, poverty, safety, public facilities, environment, and health care, which constitute the peripheral route in persuasion. Having positive factor loadings on all of the variables (i.e., issues), the second factor, Factor 2 indicates how attentive a citizen is the individual among the population. Factor 2 accounts for 41.01% of the total variation existing in nine variables. The last factor sweeps another 13.64% of the total variation, however with negative factor scores on some of the issues eliciting selectivity among issues. Thus, we regard the second factor revealing information about selective citizens.

Table 2. Underlying Variables and Extracted Factors†

		Factor 1 Transport sensitive	Factor 2 Attentive citizen	Factor 3 Selective citizen
	Variance accounted	52.62%	41.01%	13.64%
Transport related issues	Public bus transit	+0.75		
	Public rail transit	+0.78		
	Traffic management and enforcement policies	+0.74		
	Transport related environmental issues	+0.63		
General issues	Education		+0.61	+0.16
	Housing		+0.65	−0.10
	Flooding		+0.65	+0.47
	Garbage		+0.63	+0.48
	Poverty		+0.51	+0.30
	Safety		+0.73	−0.02
	Public Facility		+0.57	−0.64
	Environment		+0.69	−0.45
	Health care		+0.70	−0.16

† Eigen values higher than 1.0 are used as the criterion to extract factors. Keiser-Meyer-Olkin measures are 0.73 and 0.81 for Factor 1, and Factor 2 and Factor 3 respectively.

[1] Related question in the survey reads as “How of much important are the following issues regarding urban transportation sector?”

[2] Related question in the survey reads as “How much important are the following issues regarding the central government?”

With respect to the first two factors, private car owners in the sample score more than the non-owners. Based on the sample data, it is more probable that the car owners are high-income individuals who are generally more educated than the rest of the population. Accordingly, this might indicate that these individuals are more sensitive to the general and transport related issues than the rest of the population: high educated people scores higher in terms of Factor 1—transport sensitive—and Factor 2—attentive citizen. However, the same group of individuals scores lower in Factor 3—selective citizen. This might indicate that they are ignorant to the issues that are specifically related to a population group, e.g., health care, safety. As regards sex, men score higher in terms of the last two factors which might indicate that men are more politically oriented or more inclined to be sensitive to general issues than women. On the other hand, women score higher in terms of the first factor.

2.2. Estimation results

The parameter results of the model estimation are presented in Table 3. According to the results, a high correlation parameter is estimated with high significance indicating car ownership affects usage of private cars for commuting purposes strongly—the causal link between the two is also reported by Kitamura (1989) in a broader context. Private car ownership and its use are both positively affected by age. In case of a private car ownership attained at early ages, its use for trips establishes itself in the activity-travel behaviors firmly (Kitamura 1989); in time, private car use persists and becomes habitual which is mostly the result of being a senior member of automobile club (Dupuy, 1999). However recent research into the habitual car use report that it can be overcome by inducing policies, e.g., economic disincentives, seasonal free public transit, in certain times and contexts, and with careful planning (see Bamberg et al, 2003; Fujii and Kitamura, 2003; Jakobsson et al, 2002). The effect of sex, i.e., male commuter, is insignificant on car ownership, however highly significant on car use, which is positive. This indicates that private car ownership is more of a household decision, but the usage of the private car is more sex oriented, which is an intricate part of household interactions (Zhang and Fujiwara, 2006).

Dummy variables indicating high education and white-collar occupation are positively effective on both private car ownership and its usage for commute trips. This is partially intuitive given the information that, generally in developing countries, especially in their urban sectors, education level and white collar populations are increasing as well as per capita incomes (e.g., see The World Bank, 2004). Accordingly, positive effects of these variables together with the positive income effect support the information about motorization trends in developing countries given in the introduction part.

On the other hand, the results obtained for land use variables are various. Spatial separation between residence and work place measured by commute trip distance is a significant contributor to both private car ownership and on its use. However, we have to note there might be reverse causality in this case: spatial separation might equally be caused by private car ownership too. A surprising result obtained is the negative effect of distance from the city center on private car ownership and its use. Together with the residence-work place separation, we can conclude that individuals who live in DKI Jakarta but work at a location far from the residential location are more inclined to own a car and use it for commuting purposes. Another reason for this might be that, in outlying areas of Jabotabek MA, commuters live and work in relatively close proximities which might decrease both the ownership and usage of private car. Freeway supply emerges as a significant contributor to both private car ownership and its usage for commute trips—the effect is higher for private car ownership. This supports the general consensus in the literature that road supply increases motorization (see Kenworthy and Laube, 1996). In the context of developing countries, road supply is significantly lower than the developed countries, thus freeway added to the existing network significantly improves accessibility (Giuliano, 1995). Consequently, in areas with freeway access, accessibility improvement supplied to private car might increase ownership levels.

Table 3. Estimated model parameters

	Private car ownership		Private car use for commute trip	
	Value	t-stat	Value	t-stat
Constant	−2.37	-49.24	-2.87	-44.85
Age	0.02	17.92	0.03	23.43
Sex (1=male, 0= female)	0.03	1.16	0.22	7.33
High education dummy	0.90	43.30	0.88	35.06
White collar occupation dummy	0.66	27.97	0.54	19.47
High income dummy	1.84	18.90	0.61	12.82
Household size	-0.01	-2.67	-0.06	-7.49
Commute trip distance (km.)*100	0.04	3.01	0.17	2.92
Distance from city center (km.)*100	-0.53	-4.30	-0.60	-4.60
Length of freeways in the zone of residence (km.)*100	2.07	3.60	1.27	2.14
Length of streets in the zone of residence (km.)*100	-0.04	-0.38	-0.00	0.02
Land use mix [0-1]	0.01	0.25	-0.02	-0.45
Daily travel time expenditure (minutes)			-0.00	-0.76
Number of daily trips			0.05	6.97
Factor 1: Transport sensitive	0.13	12.48	0.13	11.04
Factor 2: Attentive citizen	-0.04	-3.94	-0.02	-1.77
Factor 3: Selective citizen	0.03	2.84	0.13	12.97
ρ	0.94			308.24
Log-likelihood function with constant values	−29,988.90			
Log-likelihood function without Factor variables	−21,031.97			
Log-likelihood function at convergence	−19,824.62			
df (with constant values)	30			
df (without Factor variables)	27			

We have postulated that mobility variables, i.e., travel time expenditure and the number of trips, have effects on only private car usage for commute trips. According to their coefficient estimates, only the number of trips has a significant effect which is positive. This supports the idea of trip-chaining made easier with the private car—from another perspective, Hensher and Reyes (2000) reports supportive finding that trip chaining behavior is an important barrier to the public transit usage.

Individual capacity, which is assumed to be inherent in the three factors with varying degrees, is used to explain both private car ownership and its usage for commute trips. Factor 1 which reveals information about

sensitivity to transport related issues has positive effects on both private car ownership and its usage. Individuals who are concerned about the transport issues might see the private car ownership and its use an escape from transport problems that are relatively more experienced by the non-car owners. Factor 2, eliciting attentive citizens, turns out to be negatively effective on both private car ownership and its usage. Factor 3 which supplies information about selective citizens, similar to the first factor, has positive effect on both private car ownership and its usage—its effect on private car usage is slightly more than 4 times than the private car ownership.

Inspecting Table 2, one can see that selective citizens devalue the importance of environmental issues among other issues. This point enables us to further explore the positive effects of Factor 3—selective citizens. Based on the information that car owners are more probable among selective citizens, car owner's lack of environmental concern promotes or at least does not hinder private car ownership and its usage. In this regard, Fransson and Gärling (1999) inform us that pro-environmental behavior is dependent on environmental concern. Therefore, policies directed to close this gap will help to decrease private car ownership and its use. Besides, these policies might link private car ownership and its use with issues related to sustainability. In this context, persuasive communication gains critical importance in changing individual beliefs, attitudes, and, ultimately, behaviors and actions. For example, mobility management, which mostly draws on persuasive communication, adopts soft measures to increase patronage of a targeted transportation mode, e.g., public transit, by attracting a targeted group, e.g., private car users, (see Fujii, 2004; Jones, 2003; Taniguchi and Fujii, 2007). To this end, educational campaigns and public relations become critical to change general public opinion, which, in turn, can be harnessed for decreasing private car ownership and its use. However, the existence of the positive coefficient estimates among individual capacity variables complicates the subject matter in terms of which issues education and public relations should concentrate.

3. Summary and discussion

The nature of economic development and urbanization in developing countries has created conditions different from developed countries. Especially, priority given to economic development has dwarfed other developmental issues such as public education, sanitation, clean water supply, waste disposal, urban transportation, etc. Among these, urban transportation in developing countries poses a critical importance in terms of sustainability. Prospects of urban transportation in developing countries, if continues on the business-as-usual track, indicate fast motorization, which would jeopardize global sustainability targets. Therefore, business-as-usual practices have to be changed significantly in order not to enter a vicious circle, which might easily weaken economic development in developing countries. Low level private car ownership and relatively higher level public transit usage in developing countries both point to challenges and opportunities simultaneously. The most important challenge in this regard is the capacity problem that developing countries lack in many respects to intervene in the prevailing developments. Therefore, sustainable transport policies cannot produce expected results; moreover, they might be ineffective at all. For this reason, capacity development is the first and foremost precondition for sustainable urban transportation in developing countries.

Latent individual capacity, which is observed by a collection of attitudes—personal ideas and opinions—is found to be effective on the travel behavior in this study. Specifically, it is found that different dimensions of individual capacity have different effects on private car ownership and its usage as a commute trips mode—mainly, attentive citizens show positive effects in reducing motorization and private car use; however, selective citizens and transport sensitive individuals show adverse effects. Thus we might conclude that the model results suggest specially designed policies, such as educational campaigns, effective information dissemination and public

relations, targeting special groups. This mostly fits to the capacity development framework given above in which the government and the private sector have important roles in increasing and exploiting the individual capacity.

References

Ajzen, I. and Fishbein, M. (1977), Attitude-behavior relations: a theoretical analysis and review of empirical research, Psychological Bulletin, 84, 888–918.
Bamberg, S. Rölle D. and Weber C, (2003), Does habitual car use not lead to more resistance to change of travel mode? Transportation, 30, 97–108.
Cervero, R. and Kockelman, K. (1997), Travel demand and the 3D's: density, diversity, and design, Transportation Research D, 2, 199–219.
Dargay, J. and Gately, D. (1999), Income's effect on car and vehicle ownership worldwide: 1960-2015, Transportation Research A, 33, 101–138.
Dobson, R., Dunbar, F., Smith, C., Riebstein, D. and Lovelock, C. (1978) Structural models for the analysis of traveler attitude-behavior relationships, Transportation, 7, 351–363.
Dupuy, G. (1999), From the "magic circle" to "automobile dependence": measurements and political implications, Transport Policy, 6, 1–17.
Eagly, A. H. and Chaiken, S. (1993), The psychology of Attitudes, CA, Thomson/Wadsworth.
European Conference of Ministers of Transport (ECMT) (1995), Urban Travel And Sustainable Development, Organization for Economic Co-operation and Development, Paris.
Faiz, A. and De Larderel, J. A. (1993), Automotive air pollution in developing countries: outlook and control strategies. The Science of The Total Environment 134, 325–334.
Fishbein, M. and Ajzen, I. (1975), Belief, Attitude, Intention And Behavior: An Introduction To Theory And Research, Reading, MA, Addison-Wesley.
Fransson, N. and Gärling, T. (1999) Environmental concern: Conceptual definitions, measurement methods, and research findings, Journal of Environmental Psychology, 19, 397–408.
Fujii, S. (2004) Mobility management, Traffic and Economics, 65, 21–30 (in Japanese).
Fujii, S. and Kitamura, R. (2003) What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change, Transportation, 30, 81–95.
Gakenheimer, R. (1999) Urban mobility in the developing world, Transportation Research A, 33, 671–689.
Golob, T. F. (1990) The dynamics of household travel time expenditures and car ownership decisions, Transportation Research A, 24, 443–463.
Golob, T. F. (2001) Joint models of attitudes and behavior in evaluation of the San Diego I-15 congestion pricing project, Transportation Research A, 35, 495–514.
Greene, W. (2002), LIMDEP Version 8.0, Econometric Software Inc. New York.
Greene, D. L. And Wegener, M. (1997), Sustainable transport, Journal of Transport Geography, 5, 177–190.
Guiliano, G. (1995), The weakening transportation-land use connection, Access, 6, 3–11.
Gwilliam, K. (2003), Urban transport in developing countries, Transport Reviews, 23, 197–216.
Hayami, Y. And Godo, Y. (2005), Development Economics: From The Poverty To The Wealth Of Nations, Oxford, UK, Oxford University Press.
Hensher, A. H. and Reyes, A. J. (2000), Trip chaining as a barrier to the propensity to use public transport, Transportation, 30, 341–361.
Ingram, G. K. and Liu, Z. (1998), Motorization and road provision in developing countries, The World Bank

Policy Research Paper No: 1842.
International Energy Agency (IEA). (2004), World Energy Outlook 2004, Paris, International Energy Agency, Organization for Economic Co-operation and Development.
Jones, P. (2003) Encouraging behavioral change through marketing and management: what can be achieved? Presented at the 10th International Conference on Travel Behavior Research, Lucerne, Switzerland.
Jakobsson, C. Fujii, S. and Gärlin, T. (2002), Effects of economic disincentives on private car use, Transportation, 29, 349–370.
Kain, J. F. and Beesley, M. E. (1965), Forecasting car ownership and use, Urban Studies, 2, 163–185.
Kessler, J. and Schroeer, W. (1995), Meeting mobility and air quality goals: strategies that work, Transportation, 22, 241–272.
Kenworthy, J. R. and Laube, F. B. (1996), Automobile dependence in cities: an international comparison of urban transport and land use patterns with implications for sustainability, Environment Impact Assessment Review, 16, 279–308.
Kitamura, R. (1989), A causal analysis of car ownership and transit use, Transportation, 16, 155–173.
Kitamura, R. Mokhtarian, P. L. and Daidet, L. (1997), A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area, Transportation, 24, 125–158.
Litman, T. (2003), The Online TDM Encyclopedia: mobility management information gateway, Transport Policy, 10, 245–249.
Matsuoka, S. Murakami, K. Aoyama, N. Takahashi, Y. and Tanaka, K. (2006), Capacity development and social capacity assessment, S. Matsuoka ed., Social Capacity Development for Environmental Management and International Development, Hiroshima International Center for Environmental Cooperation, Hiroshima University, Japan, 1–24.
Petty, R. E. and Cacioppo, J. T. (1996), Attitudes And Persuasion: Classic And Contemporary Approaches, Colorado, Westview Press,Inc.
Steg, L. and Gifford, R. (2005), Sustainable transportation and quality of life, Journal of Transport Geography, 13, 59–69.
Sussmann, J. M. (2005), Perspectives on Intelligent Transportation Systems, New York, Springer.
Taniguchi, A. and Fujii, S. (2007), Promoting public transit using marketing techniques in mobility management and verifying their quantitative effects, Transportation, 34, 37–49.
Tardiff, T. J. (1977) Causal inferences involving transportation attitudes and behavior. Transportation Research, 11, 397–404.
Tischer, M. L. and Phillips, R. V. (1979) The relationship between transportation perceptions and behaviour over time. Transportation, 8, 21–36.
Vasconcellos, E.A. (1997), The demand for cars in developing countries, Transportation Research A, 31, 245–258.
Willson, R. (2001), Assessing communicative rationality as a transportation planning paradigm, Transportation, 28, 1–31.
The World Bank, World Development Indicators (2004) CD-ROM, Washington D.C., The World Bank.
World Commission on Environment and Development (WCED) (1987), Our Common Future, New York, Oxford University Press.
Zhang, J. and Fujiwara, A. (2006), Representing household time allocation behavior by endogenously incorporating diverse intra-household interactions: a case study in the context of elderly couples, Transportation Research B, 40, 54–74.