Relevant aspects of automobile users behaviour: a study under the sustainable consumption concept in the transportation sector

L. A. Noriega & J. Waisman
Department of Transportation Engineering,
Escola Politécnica da Universidade de São Paulo, Brazil

Abstract

This paper focuses on the analysis of relevant behavioural factors affecting automobile users under alternative public policies intended to reduce individual transport demand.

The theoretical basis of this study is the sustainable consumption concept that, along with the sustainable production concept, leads to the re-definition of existing supply and demand patterns in order to guarantee the future generation's demands.

A conceptual model was proposed, and subjective factors affecting car users' behaviour were analysed. This model encompasses different behavioural approaches related to the fields of Economics, Psychology, Sociology and Education.

A survey was conducted, with an intentional non-probabilistic sample, among 176 auto users, mainly college students and white-collar workers, older than 18 years. The casual relationship between individual mobility and different behavioural factors ("beliefs", "beliefs", "social norms", "easing and boundary factors"), the socioeconomic profile and the weekly distance travelled was verified through the application of factor analysis techniques, multiple regression and structural equation modeling. Results obtained show a close relationship among these factors and the adoption of different behaviours and mobility strategies.

Keywords: automobile users behaviour, public policies, urban mobility, sustainable environment.

1   Introduction

The growth of Brazilian economy in the last decades was supported by imports substitution and government incentives to the auto industry and civil works and has influenced both urban and transport public policies.

São Paulo Metropolitan Region, with 18 million habitants and a fleet of 6 million vehicles, comprises 38 municipalities and a total area of 8,000 km^2. This region concentrates 18% of the Brazilian GNP.

The lack of integration between public policies of transport and land use produced strong impacts on mobility, car / public transport usage, urban structure and life quality.

In 1967, 32% of all motorized trips were made by individual transport; 35 years later, this value had risen to 51%. On the other hand, public transport trips decreased, in the same period, from 68% to 49% of all motorized trips.

Car users are known as agents of the urban scene willing to satisfy (and increase) their individual mobility. According to this hypothesis, the main objective of this paper is the analysis of car users behaviour regarding public and individual transport usage, motorized or not, and the different factors (such as "values", "beliefs", "social norms", "easing and boundary factors" affecting the adoption of a given behaviour and mobility strategy, the "socio-economic profile", the "average weekly travelled distance" by individuals, in order to support the formulation of public policies that change individual mobility.

2   Relevant aspects of car users behaviour based on sustainable consumption approach

In recent years some studies tested the influence of multidisciplinary factors, like economic and moral factors (Hansen and Schrader [7]); attitudes, abilities, motivation and opportunities (Ölander and Thorgersen [10]; Thørgersen [16]), that influence individual behaviour to accept public policies, specifically the ones that could guide the individual to a more sustainable behavior. Most of the behavioural studies, mainly the ones related with environmental consciousness, began in the 1960`s. Few of them were published in the Journal of Environmental Education and Journal of Environmental Psychology. The insertion of sustainable consumption on behavioural models aims to represents an opportunity to change consumption patterns and to use multidisciplinary approaches to study that problem, as stated at the 1992 Earth Summit on Sustainable Development, in Rio de Janeiro.

Multiple approaches from Psychology, Economy and Education, related to individual behavior, and Sociology, related to group and organizations behavior, are important to identify the influence of different factors of intrinsic and extrinsic nature that affect all individuals, mainly, in relation to morality. Their close relation to the problem being studied will be useful to understand the impact of public policies to manage individual mobility in the city. More specifically, it is premised that a transportation demand management policy

could be a mix of legal, economic and educational measures, punishing the ones that pollute and preserving the rights of those that did not overdo.

2.1 Conceptual model for sustainable transportation

Figure 1 shows a pre-defined set of factors that influence car users behaviour, considering a possible impact on individual mobility by implementing public policies on transport area. This model is an adaptation of Fishbein and Ajzen [5], considering the impact of several intrinsic and extrinsic factors affecting individual behavior, like the ones specified by the different approaches listed in the previous section.
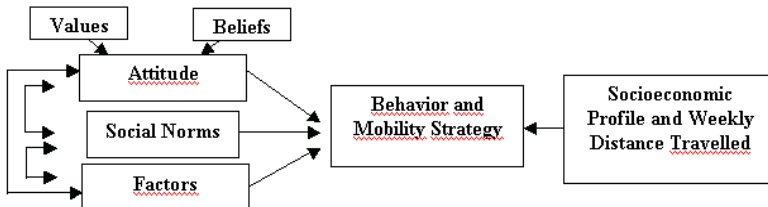

Figure 1:   Conceptual model of sustainable behavior in transportation.

"Attitudes", as a result of interaction between beliefs and values, were considered intrinsic to a human being, while "social norms" and "easing and boundaries factors" were considered of extrinsic nature. The former two factors measure individual perceptions over different angles, like the ones related to regulations, economic enforcements, information availability and structural (politic and cultural) aspects impacting human behavior. Considering its nature, this study prioritizes perception and motivation data for transportation demand analysis purposes, in addition to "distance travelled", by mode and motive of travel, and "socioeconomic profile".

Values and beliefs are constantly influenced by socioeconomic and political changes, being fundamental total individual is decision making process (Fishbein and Ajzen [5] and Schwartz [12, 13]). Someone perceives its context reflecting over it, even without any rationality or analytical process. The first authors focus his attitudinal analysis on beliefs while the former focuses on moral values. It is important to notice that values and beliefs are complementary and in some cases they could be misunderstood.

"Beliefs" are considered subjective truths, recognized by somebody as a habit or an inaccurate image of reality captured by our senses. Sometimes they represent a lack of reflection and hide false ideas, preconceived or manipulated, representing a deep confidence, without rational justification. Fishbein and Ajzen [5] stated that beliefs refer to somebody subjective probability judgments concerning some aspect of his/her world, considering a self-understanding and the environment around him/her. S/he will measure the acceptance of an object or event by stating an attribute, either positive or negative. The attribute represents an assessment that produces a favorable or unfavorable feeling in relation the object or the event.

Schwartz [14] believes that "values" are trans-situational goals that changes in importance and serves as guide-principles. In addition, values are important for some social institutions, motivate and serve as a justification of acts and are assimilated through socialization. "Values" are derived from human needs, considering their biological and social nature and the preservation or survival of social group. They have specific weights and interact with other values, considering the impact on somebody motivation. The impact on motivation is related to a decision making process and, as a result, the decision could match or mismatch individual values (Schwartz [14]).

Values and beliefs determinate attitudes, it means, they will be used to make a subjective judgment of some situations and will be determinant to take a position or attitude over it. Attitudes are also considered a predisposition of behavioural change. In some situations, like mobility management, values and beliefs are important indicators of a predisposition to change car user is behaviour gradually (Jensen [8]).

A person also judges the adoption of a behavior by the existence of social norms. They establish the best way to live in society. S/he believes that an act should be socially accepted and other people opinion about the fulfillment of a public policy will serve as a mechanism of acceptance by the group (Campbell [4]; Buchholz [3]).

The presence of "easying and boundary factors" is studied (Ajzen [1]) as the existence of a subjective control over his/her behavior. Considering the existence of opportunities or alternatives that impact a perceived behavioural control, their availability assessment will determine the adoption of a new behaviour. An assessment of the structural conditions could be favorable only if the new situation is consistent with his/her wishes or unfavorable when it is not what s/he wishes. As mentioned, depending on the analysis of what somebody do and on the structural conditions that impacts his/her way of living, s/he will be self-satisfied, not necessarily considering group satisfaction. That analysis also includes the cost incurred in the adoption of any behavior (Salomon and Mokhtarian [11]).

Finally, the incidence of a "socioeconomic profile" (sex, family monthly income, background, professional activity, number of car owned) and "weekly distance traveled (by mode and motive), reflects recent trends and changes on the transport area, mainly because an increasing number of trips are due to the access of women to the job market, the need to transport family members under 18 or over 65 years old where they need to go or even the kind of activity a person do during the day increases his/her mobility. All these aspect have an impact on urban transportation, increasing the number of daily trips in the city.

In accordance to figure 1, behavior is the result of the impact of all the aspect listed above and their combination. Several arrows are stating the relation between all factors and behaviour. The figure also showed an arrow that indicates the influence of socioeconomic and weekly distance traveled by mode and motive. These factors have a direct impact over behavior, considering that transportation demand is derives from the daily activities s/he do (Mokhtarian and Salomon [9]).

3   Model evaluation

The research happened in the city of São Paulo. Participants were car users, intentionally in the city of São Paulo and selected to participate on the survey. All participants filled a questionnaire divided in five sections. In each section were used psychometric scales, Likert for beliefs and Semantic Differentiation for values, open questions and metric scales to collect all information needed to analyze the factors mentioned in previous sections. Approximately 600 questionnaires were distributed and 35% of them returned. Only 176 were used.

The sample is composed of 124 males and 52 females, aging between 19 and 30 years old (104 – 59.1%). Most of them have a college degree or is enrolled in an undergraduate course (133 – 75.6%). They are mainly students (58 – 33.0%) and employees (46 – 26.1%). They have a mean monthly family income of 6 minimum salaries (162 – 94.7%). The minimum salary at the time the research was performed was US$ 70.00.

Those participants with a family monthly income greater than US$ 420.0 only have one car and those with family income between US$836.4 and US$3345.6 have 2 or 3 cars. Only those ones with monthly income superior to US$1672.8 have 4 or 5 cars at home.

In a seven day week, in São Paulo city, 38.6% of the participants pointed out that use bus and 33.2% use metro or train as an alternative mode of transportation. An additional information indicates that 75.0% of them use cycles or walk to exercise. The main motives for daily trips are work (95.0%), school (72.0%) and recreation (34.4%).

Considering the nature of the data collected, there were used three techniques of analysis to achieve the objective of the study: factor analysis, multiple regression models and structural equation modelling. The packages used were SPSS, version 8.0, and Statistica, version 5.0.

3.1 Multiple regression and structural equation modelling

These analytical techniques were chosen to understand individual behavior, considering the relation between two or more independent variables.

For multiple regression purposes stepwise and backward procedures were used to determine the right number of variables included in the model. In every set of included variables F, r^2 and r coefficient were observed. Other test identified the quality of adjustment of each model, like variance inflation factor (VIF) that tested the inexistence of multicollinearity among independent variables.

The most important variables included in the model of multiple regression are statistically represented by the best beta-coefficients. For example, socioeconomic profiles appeared to have beta-coefficients equal to -0.274 for the model, intentionally, called "individual car user behavior" (see table 1) and 0.341 for the model that represents the mobility strategy: change transportation mode, from individual to collective (see table 2).

Table 1:   Use of individual transportation – multiple regression.

Dependent Variable	Car use preference (1 to 7 days).		
Independent Variable	Coefficient	*t*	Beta
Constant	2,618	4,544	
Easying and Boundaries Factors			
Lack of better alternatives	-0,199	-2,029	-0,198
Weekly Distance Travelled			
Automobile	-0,288	-3,236	-0,308
Socioeconomic Profile			
Family Income	-0,264	-2,787	-0,274
$R^2 = 0,258$ (R^2 adjust $= 0,231$)			
F = 9,609 (p= 0,000)			
N = 87			

Table 2:   Change transportation mode: from individual to collective –
multiple regression.

Dependent Variable	Change transportation mode		
Independent Variables	Coefficient	*t*	Beta
Constant	-3,170	-5,115	
Easying and Boundaries Factors			
Not necessary	-0,167	-1,678	-0,166
Weekly Distance Travelled			
Automobile	0,368	3,563	0,355
Socioeconomic Profile			
Family Income	0,341	3,423	0,341
$R^2 = 0,308$ (R^2 ajusted $= 0,279$)			
F = 10,552 (p= 0,000)			
N = 75			

This model confirmed the importance of one subjective variable "easying and boundaries factors" related to the behaviour adopted. In addition, two other variables were included, socioeconomic profile and weekly distance traveled. The importance of this subjective-behavioral variable is consistent with prior studies of Mohktarian and Salomon [9], that showed the use of subjective-behavioral variables, like availability of opportunities or alternatives, to predict the adoption of a specific behavior.

Although the regression technique could identify linear casuality among different variables that impact human behaviour, this kind of model is restricted to predict just one relation at a time, and not simultaneously, as the model showed in figure 1. Another alternative technique that allowed the modeling of simultaneous relations between dependent and independent variables is the structural equation modeling (SEM)

SEM showed the restriction previously mentioned was reduced and tested by existing theories of different aspects that impact car user behavior. It was used maximum likelihood estimation (MLE) to obtain the different correlation coefficients between the endogenous, exogenous and latent variables. MLE was preferred because results were not influenced by the sample size (Hair et al. [6]). Considering the use of qualitative variables, all models obtained were validated according to different model fit measures. Those measures were defined based

on its utility to this research (Bentler [2]), like goodness of fit index, significance level, Chi-square, between others. These kind of absolute measures are important when considering the relation between correlation matrix and the model obtained, and the sample size. The relation between Chi-square and degrees of freedom, that should be between 1.0 and 3.0, is important to identify the causal relation of the data used (Bentler [2]).

Other indexes adopted also establish the model fit. For example, goodness of fit index (GFI), point the best global fit when the index is near one. The root mean square residual (RMSR) and the root mean square error of approximation, that do not pre-define a maximum or minimum limit, considering sample size representation and stated that the model obtained and the correlation matrix fit well (Hair et al. [6]).

In the "Car Use Preference" model the socioeconomic profile have a correlation coefficients of -0.31 (figure 2) and Mode Change model have a correlation coefficient of 0.18 (figure 3). There were obtained more than one strategy models to test best fit, not necessarily representing the optimum. In the regression models, car use preference and mode change, socioeconomic profile was the second most important variable, considering only as socioeconomic profile only family income (see tables 1 and 2). The other variable, weekly distance traveled by mode have a correlation coefficient of -0.22 for car use preference and -0.08 for the mode change strategy. In the regression models this variable is the most important between the others. Both techniques showed the importance of socioeconomic profile and distance traveled by mode for the two models.
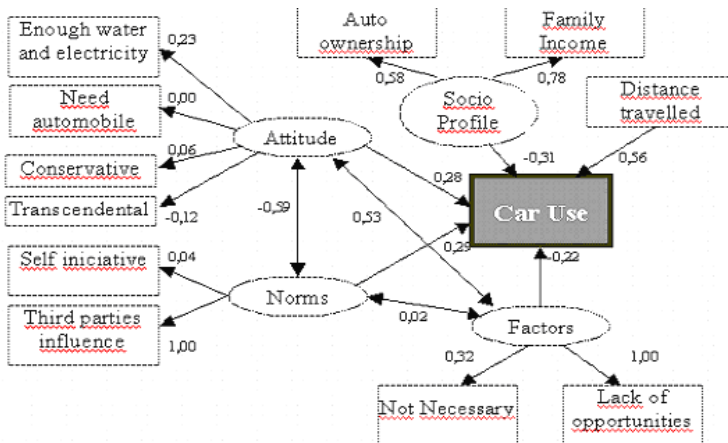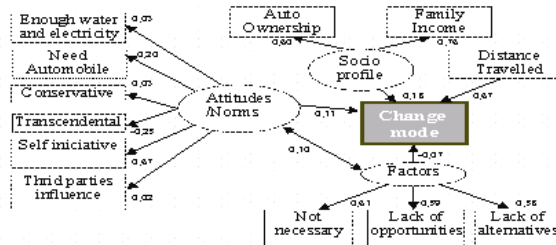

Figure 2:   Car use preference – SEM.

Figure 3:   Alternative model: merging attitudes and social norms – change transportation mode.

The most important aspect of SEM model is the correlation coefficients of latent variables showed in figure 2 and 3. In the car use preference model "Attitudes", "Social Norms" and "Easing and Boundaries Factors" correlation coefficient were 0.28, 0.29 and -0.22, respectively (figure 2). It means that not only the former "Easing and Boundaries Factor" variable is important, as noted by the regression model, but the other variables have an important weight on behaviour prediction.

The same results are shown in the model "changing mode of transport" (figure 3), which has a better fit, considering the fact that other models were obtained previously. The new latent variable, with a correlation coefficient of 0.11 ("Attitude/Social Norm") is an important element of analysis, considering the fact that in some cases social norms could influence attitudes. The other remaining latent variable, "Easing and Boundaries Factor" has correlation coefficient of -0,07. This model fit better, considering the absolute fit measures listed above. The other models merge the three subjective variables into one and excluded the socioeconomic and weekly distance traveled by mode from the models; however the indexes obtained were not the best of all of them.

4   Conclusions

The presented models showed some intrinsic and extrinsic aspects studied in order to understand automobile users behaviour regarding both usage limitations and strategic actions adopted in the last 5 years to improve individual mobility within the city. The models have also confirmed the importance of several aspects that influence users behaviour and the applied modeling techniques – multiple regression and structural equations – showed useful and complementary.

According to the answers obtained by interviews, the formulation of public policies to restrain excessive car usage, must consider the following aspects:

- survey participants showed more interest towards comfortable transport alternatives. This comfort relates to the acceptance of public policies that guarantee their freedom and satisfy their mobility needs, specially the individual modes of transportation;

- campaigns oriented to increase public awareness regarding car use in the city of São Paulo, such as the campaign "Within the city without my car", showed few impacts on participants, that did not realized opportunities or alternatives on it. Its more likely these campaigns will result in discomfort to car users, than offering priority to satisfy their mobility needs (Tertoolen et al [15]);
- isolated actions, such as the mentioned campaign, have not enough impact to influence car users perception related to benefits resulting from public transport daily usage, if there are no alternatives that allow them to maintain or improve their individual mobility;
- car users focus is centered on improving their individual mobility. Then, transport demand should be influenced through actions merging transport and urban infrastructures and the use of several instruments (regulation, economics and information).

Efficient tools to orientate behaviour change related to individual mobility must be defined by planners. Even though some effective and immediate tools have reduced individual mobility, such as car shifts and urban tolls, some informative or educational tools can succeed in medium and long terms. The use of these tools would be part of an integrate plan to solve the urban transportation problems in cities with high the levels of traffic congestion, like São Paulo.

References

[1] Ajzen, I., The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, v.50, n.2, p.179-211, December, 1991.

[2] Bentler, P.M., Multivariate analysis with latent variables: causal modeling. In: FORNELL, C. (ed.). *A second generation of multivariate analysis*. Volume 1: Methods. New York: Praeger, p.121-177, 1982.

[3] Buchholz, R. (1998) The ethics of consumption activities: a future paradigm? *Journal of Business Ethics*, v.17, n.8, p.871-882, June, 1998.

[4] Campbell, C., *The romantic ethic and the spirit of modern consumerism*. Oxford: Basil Blackwell. 320p.,1989.

[5] Fishbein, M., Ajzen, I., *Belief, attitude, intention and behavior*: an introduction to theory and research. Massachusetts: Addison-Wesley Pub. 578p, 1975.

[6] Hair, J. et al., *Multivariate data analysis.* New Jersey: Prentice Hall. 730p, 1998.

[7] Hansen, U., Schrader, U., A modern model of consumption for a sustainable society. *Journal of Consumer Policy*, v.20, n.4, p.443-468, December, 1997.

[8] Jensen, M., Passion and heart in transport - a sociological analysis on transport behavior. Transport Policy, v.6, n.1, p.19-33, January, 1999.

[9]   Mokhtarian, P. L. and Salomon, I. (1994) Modeling the choice of telecommuting: setting the context. *Environment and Planning*, v.26A, n.5, p.749-766.

[10]   Ölander, F. and Thørgersen, J. (1995) Understanding of consumer behavior as a prerequisite for environmental protection. Journal of Consumer Policy, v.18, n.4, p.345-385, December.

[11]   Salomon, I. and Mokhtarian, P. L. (1997) Coping with congestion: understanding the gap between policy assumptions and behavior. Transportation Research, n.2D, n.2, p.107-123, June.

[12]   Schwartz, S. H. (1970) Elicitation of moral obligation and self-sacrificing behavior: an experimental study of volunteering to be a bone marrow donor. *Journal of Personality and Social Psychology*, v.15, n.4, p.283-293, August .

[13]   Schwartz, S. H. (1973) Normative explanations of helping behavior: a critique, proposal and empirical test. *Journal of Experimental Social Psychology,* v.9, n.4, p.349-364, July.

[14]   Schwartz, S. H. (1994) Are there universal aspects in the structure and contents of human values? *Journal of Social Issues,* v.50, n.4, p.19-45, Winter.

[15]   Tertoolen, G., Van Kreveld, D. and Verstraten, B. (1998) Psychological resistance against attempts to reduce private car use. Transportation Research, v.32 n.3, p.171-181, April.

[16]   Thørgersen, J. (1999) Spillover process in the development of a sustainable consumption pattern. *Journal of Economic Psychology*, v.20, n.1, pp.53-81, February.