THE ROLE OF ATTITUDE AND PURCHASE POWER IN BRAZILIAN URBAN TRANSPORT BEHAVIOUR

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ABSTRACT

The revision of the study “The motivation of the new Brazilian urban population transport profile – Image and opinion survey of the Brazilian urban transport” published by the Ministry of Cities in 2003, has allowed the development of a cause-and-effect behavioural model using the multivariate analysis technique called SEM (structural equation modelling). This model connects the urban transport user socio-economic characteristics and attitudes relating to the system quality with their modal choice. As result of ten Brazilian cities survey, the behavioural model showed the supremacy of the socio-economic characteristics over attitudes as explaining variables of transport behaviour. On the other hand, in specific cases, attitudes can be useful to explain the behaviour of user segments. These results confirm the structural heterogeneity of transport users’ behaviour, but do not mean that aggregate model transferability is impossible.

Keywords: Transport Behaviour, Transport Survey, Structural Equations, SEM

OBJECTIVE

The objective of this study is to develop a cause-effect structural model that relates the social-economical characteristics of urban transport users with their attitudes regarding transport systems quality and displacement behaviour expressed by their modal choice and the frequency of usage of the city’s available modes. Through this model, the existence of a behaviour structural heterogeneity of urban transport users proposed by Pendyala, (1998) will be verified in practice, as well as the “transferability” of the model itself.

LITERATURE REVIEW

Structural Equation Models

SEM Formulation

The use of structural equations in transport engineering modeling is still not very common, although this tool is of great utility in the analysis of complex relations among socioeconomic variables, land use characteristics, psychological factors, traveller's perceptions and attitudes and transport behaviour (VAN ACKER et. al. 2007; SHIFTAN et. al., 2008). One of the reasons for the limited development of studies of this nature is the difficulty in obtaining data different from the usual socioeconomic indicators in Brazil. Another factor is the difficulty in identifying and in dealing with multiple user segments. Hence, the approach black-box, with demand aggregated modeling and the use of techniques that establish direct relations between cause and effect are mostly used, however with a limited contribution to the transport behaviour theory and its relations with urban diversity, design and density. Normally the gap between demand aggregate model and the real observed demand can be filled by supply models that are very specific and complex, making it impossible to construct a theory of transport behaviour.

The term structural equations or "Structural Equation Modeling" (SEM) refers to a statistical method of assessing and modifying theoretical models through the construction and validation of manifest and latent variable relations that supposedly describe a given phenomenon. This method solves simultaneously the problem of evaluating an indirect measuring system of non observable variables and also the problem of defining the causal structure between dependent and independent variables (LATIF, 2000). Through structural equations, it is possible to analyze holistically a phenomenon (BAGOZZI, 1994) and distinguish analytic subgroups through the variations of structural models used in modeling.

The SEM technique represents theoretical models through pathway diagrams (figure 1) composed of independent latent variables (ξ) and dependent latent variables (η). In these diagrams, variables ξ and η are measured indirectly by manifest independent variables (x) and manifest dependent variables (y). The pathway diagram is a graphic representation of a system of equations in which the arrows indicate the causal relations direction among the variables (BOLLEN, 1989).

The relationships represented in a pathway diagram (Figure 1) correspond to the structural model, the X measuring model and the Y measuring model (LATIF, 2000; JÖRESKOG; SÖRBOM, 2003). The structural model represents the relationship between dependent and independent latent variables also known as exogenous and endogenous constructs (HAIR et al, 2005). In the pathway diagrams, this model corresponds to the network formed exclusively by circular elements.

The measuring models represent the relations between the latent variables and their correspondent X or Y "manifestations". The X measuring model corresponds to the network connecting the circular elements ξ and rectangular elements X. The Y measuring model correspond to the network of circular elements η and rectangular elements Y.

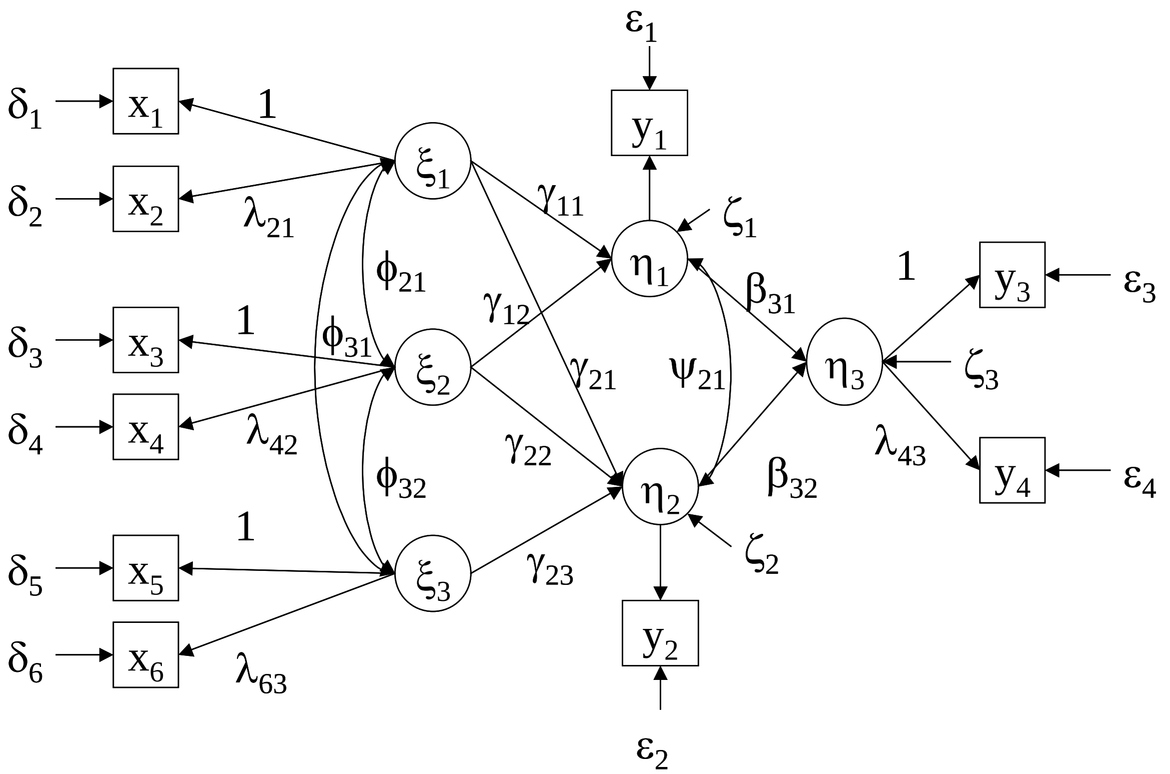

Figure 1: Example of a pathway diagram used in the SEM method.

In figure 1, it can also be seen a set of bi-directional curved arrows representing the linear correlations between independent and dependent latent variables (ϕ e ψ).

The equation parameters estimation process is based in a set of rules, developed by Sewall Wright (BOLLEN, 1989), that establishes a correspondence between the pathway diagram parameters with the correlation or variance-covariance matrices (LATIF 2000). The quality of the theoretical structural model is assessed by the consistency between the estimated covariance or correlation matrices and the ones observed in the sample (ULLMAN, 2001)

There is extensive literature about SEM, discussing more appropriately its mathematical formulation, applications and interpretation forms (GOLDBERGER; DUNCAN, 1973; BOLLEN, 1989; LATIF 2000). In this study, however, only the elements necessary for the SEDU survey behavioral modeling were considered. For the readers interested in further information, it is worth mentioning that SEM is also presented under different terminology, such as: Pathway Analysis (WRIGHT, 1914 apud BOLLEN, 1989); Dependency Analysis (BOUDON, 1965); Variance Structure Analysis and Confirmatory Factorial Model (LATIF, 2000); Latent Variable Analysis (DILALLA, 2000); or Trajectory Analysis (BABBIE, 2005).

Applications

In Golob (2003), it can be found a wide literature review about structural equations application in transport research between 1976 and 2001. Golob took part in 23 of the 62 cases cited specifically in the transport area. Based in his experience, this author identifies types of application (1) travel demand modeling using cross-sectional data; (2) dynamic travel demand modeling using panel data; (3) Activity-based travel demand modeling; (4) attitude, perceptions and hypothetical choice studies; (5) organizational behaviour and value studies; and (6) drivers behaviour studies.

In the first application category is explored the relationships between attitudes, behavior, socioeconomic characteristics and spatial restrictions with travel characteristics, such as travelled distance, travel time, motives, modal choice and travel sequence. Other applications of individual transport research include the evaluation of attitudes and behavior influence in the approval of transport public policies. There are also studies simply aiming to test hypotheses about conceptual causal models or to identify market segments and their respective displacement behavior particularities.

The second category of applications also explores the attitudes and behavior effects on travel demand characteristics, but including the effect of time by analyzing surveys done in successive periods. The dynamic models allowed the study of the past behavior effect on attitude, as well as the comparison between transport demand evolution and other types of demand.

According to Golob (2003), one of the most promising applications of structural equations is in Activity Analysis support. This third type of application employs pathway diagrams to evaluate the direct and indirect effects among the social activities, its localization, duration time and its demand as well as its relation with household and personal characteristics.

The fourth type of application focuses on concurrent hypothesis tests on causal relations between attitude, behavior and past behavior. In this category are the pioneering structural equations works developed in the transport planning area. One of the issues that have been widely studied through causal modeling is the debate about the principle validity of declared and revealed preference researches. According to Golob (2003), the tests performed presented evidence that declared preference is a function of the revealed preference, and not the contrary.

Another application observed by Golob (2003) is the study of transport companies administrators attitudes regarding traffic jam mitigation policies or transport in general. In its essence, these studies differ only in the behavior characteristics of the decision makers. In these cases, the assumption that the decision makers are rational and possess the perfect information and their costs and benefits evaluation are more reasonable.

Finally, the last contribution of SEM to transport planning is in the investigation of drivers behavior. Generally, the relations between driver's lifestyles, psychological and socioeconomic characteristics and the conditions of the environment in which they interact during their travels such as traffic conditions and vehicular, road or communication technologies.

Other studies carried out after the research published by Golob in 2003 can be classified in same way. Studies that fall in the first SEM application category include Challa (2004), Van Acker (2007) and Lin & Yang (2010), in the second can be mentioned Choo (2004) and in the fourth Noriega Vera (2003), Zhou et al (2005), Shiftan et al (2008). In 2004, Challa under Dr. Pendyala orientation submitted his Master's dissertation to the Department of Civil Engineering of University of South Florida. In this work, seven structural models are tested for the aggregate analysis of the relations between socioeconomic variables and work motivated travel characteristics in Florida. Before Challa, Lu and Pas (1999) did a similar study applying SEM in a disaggregate analysis of the effect of socioeconomic data and type of occupation in travel behavior characteristics.

In 2004, two doctorate theses applying SEM in transport were presented. The first one in Davis, University of California (Choo, 2004) and the second in São Paulo, at Escola Politécnica (NORIEGA VERA, 2003).

Choo (2004) studied a 50 years time series in order to assess the impact of the advance in telecommunications technology in travel demand with the use of a structural model. His model evaluates the causal inter-relation of travel demand, telecommunications, land use, economic activities and socioeconomic variables. The model results indicated that travel demand and advance in telecommunications have a mutual positive effect.

In Noriega Vera and Waisman (2004), approaching the issue of sustainable transport, three structural models were tested correlating the environmental attitude of a set of individual motorized transport users, their socioeconomic characteristics and their attitude towards changing to environmentally sustainable transport modes. The models indicated that the behavior of individual motorized transport users is more influenced by their dependence on the motor vehicle than by their positive environmental attitudes. This result is coherent with the work done by Garling, Fujii and Boe (2001) whose tested behavioral model suggested that habits resultant from repeated choices become more important in the determination of behavior than the attitudes.

In Zhou et al (2005), transport user segmentation was proposed according to attitudes and socioeconomic and behavioral characteristics, aiming to determine which were the local market transport segments necessities in a study area and which were the motivations that drove the modal options in these segments. Through a structural model correlating socioeconomic characteristics and attitudes, the authors identified substantial behavior differences among the segments, especially between male and female travelers.

SEDU Survey

The study carried out by the SEDU - Urban Development Special Department, in 2002 – "Motivations that drive the new displacement profile of the Brazilian urban population –

Image and Opinion Survey of Urban Transport in Brazil" (SEDU, 2002) – represents the main resource for the development of this study, given the value of the information gathered. What makes this study especially attractive to this academic research is the abundance of data, its national scope and the quality and level of detail of local information.

A household survey, carried out by SEDU throughout 2002, gathered the opinion of 6.959 people, interviewed in ten Brazilian cities. These chosen cities represent the regional social-economic differences in Brazil as well as the differences in the size of urban infrastructure. The cities chosen were: Belém (PA – Pop. 1.437.600), Belo Horizonte (MG – Pop. 2.452.617), Campina Grande (PB – Pop. 383.764), Curitiba (PR – Pop.1.851.215), Fortaleza (CE – Pop. 2.505.552), Goiânia (GO - Pop. 1.281.975), Porto Alegre (RS – Pop. 1.436.123), Rio de Janeiro (RJ – Pop. 6.186.710), Salvador (BA – Pop. 2.998.056) and Teresina (PI - Pop. 802.537).

The field survey done by SEDU was based in a 5 page questionnaire with 32 questions, ten of them were related to the interviewee socioeconomic status and the remaining questions were dedicated to transport and urban environment. The questionnaire was created and analyzed according to five themes defined by SEDU: "User Characterization" (12 questions), "User Concept of Urban Transport" (6 questions), "User Evaluation of Urban Transport" (10 questions, "User Satisfaction with Public Transport" (2 questions) and "User Change of Habits" (2 questions).

For the "User Characterization", the requested information was related to gender, age, income, level of education and occupation. This information was used to define the interviewee social-economic profile. But besides these items, specific questions were also included to define the role of the interviewee as a transport user. So there were questions asking which transport mode was used and with what frequency.

The second set of information measured the interviewee knowledge level about the urban transport net in their respective cities. The questions related to "User Concept of Urban Transport" are about the transport modes known by the users, the modal options available to them, their preferences, and their perceptions regarding the responsibility roles of public and private entities in relation to transport services and also about their perception of other users. Still inside this theme, there is an evaluation of the user's view on "Terminals that comprise the Transport System", albeit in a hidden form and merging with questions about concepts and opinions.

In the theme "User Evaluation of Urban Transport", opinions about the quality of the various transport modes available are asked as well as suggestions for quality improvement. An interesting aspect of this theme is the evaluation of the interviewee general satisfaction regarding the quality of life in their respective cities and their opinion about the several dimensions that comprise the quality of the urban environment such as: health, education, safety, housing and leisure.

The fourth theme "User Satisfaction with Public Transport" focused on the Cost/Benefit relation. Two questions were posed: the first asked their opinion about the tariffs of the public transport modes and the second asked a joint evaluation of the amount paid and the quality of service received.

Finally, the last subject approached by the survey was the competition between public and individual transport. In the theme "Users Change of Habits" the interviewees were asked if they had changed from public to individual transport or vice-versa and why.

Attitude and Behavioural Modelling

The theoretical basis for the structural model used in this study is the multi-attribute attitude model developed by Martin Fishbein in the early 70's. This model represents one of the more fundamental elements for the development of the attitude theory in marketing and psychology. It is the starting point for the rational action theory, planned behaviour and the enterprise theory (ROBERTSON; ZIELINSKI; WARD, 1984; SALOMOM, 2002; ZINT, 2002). In transport planning, the influence of the Fishbein model is also observed in the formulation of cause-effect structural models, as well as in the discussions about the relations among past behaviour, image, opinion, attitude and future behaviour (THØGERSEN, 2001; NORIEGA VERA e WAISMAN, 2004).

It is not the objective of this review to cover every aspect of the applications of attitude causal models and transport behaviour since the subject is very vast, but going through the examples present in the cited references and the time interval between them, it is possible to conclude that apart from the differences of their specific purposes and methodologies there was no change as to its theoretical chain. In fact, the models currently available did not evolve from the planned behaviour theory to the enterprise theory.

METHODOLOGY

In order to meet the objectives of this study, the modelling process and the data analysis was divided in six steps: conception of the cause-effect model, data bank suitability evaluation, segmentation of transport users, data analysis, model design and model evaluation.

The first step consists of the formulation of a hypothesis, consistent with the theoretical development about the subject and latent variable selection for structural representation. Each latent variable constitutes a dependant and independent variables measuring system, which must be represented by a set of observable variables (observable indicators). These indicators are not necessarily defined in the conceptual model phase, but must be considered, in order to help the construction of causal relations among the latent variables.

The second phase was necessary due to the fact that this study used information already available instead of making a new and exclusive survey. In order to use the SEDU (2002) database, it is necessary to verify which variables measured by the survey are useful to the adopted theoretical model. This verification checks conceptual methodological elements. The first deals with the variable theoretical validation and the second with the technical feasibility and its use in the formulation and estimation of a structural equations model.

The third step was the segmentation of transport users in more homogeneous sets according to their social-economical characteristics, attitudes and transport behaviour. The cluster analysis method applied was the “two-step clustering” due to its capacity to deal with large quantity of data and the existence of clear criteria to determine the ideal cluster number based on the clustering process performance. This performance is measured through the Schwarz information criterion (BIC).

The fourth step is associated with the second. At this moment some data treatment is done to solve two basic types of issue. Some variables can be useful to the theoretical model, but due to the measurement format are not compatible with the structural equation estimation method. In this condition the possibility to transform such variables into more adequate indicators is verified. The second issue concerns a set of variables that are theoretically and methodologically adequate, but incomplete for a certain segments of the sample, that is why the data treatment is done after segmentation. A simple way of dealing with this issue is not to consider the incomplete cases. However, this procedure must be followed by an evaluation of the causes that generated the data loss in order to avoid the inclusion of a bias in the estimated model. This evaluation can be performed by the significance test of the distribution profiles of each variable before and after the data treatment.

The fifth methodological step is model design and estimation. The design consists of a simple description of the adopted variables and their function in the independent and dependent latent variables measuring models. It is also necessary to specify the parameters to be estimated for structural equations design that represent the cause-effect hypothesis to be tested. After the connect variables specifications an adequate estimation method must be chosen, according to the variable type. In the case of discrete variables the most indicated method is the least square weighted method.

Finally, after the estimations of the model parameters and the verification of their statistical significance, the interpretation follows. The first analysis is done on the standard model in order to assess the manifest variables and also to assess the impact of each independent latent variable over the dependent latent variables. The second analysis is performed using the standard model as well as the non-standard model. It consists of the evaluation of the direct and indirect impact of the independent manifest variables over the dependent ones. By means of a signal through the paths that connect them in causal standard model.

CASE STUDY

The theoretical model adopted was the structure proposed by Noriega and Waisman (2000), but focusing only on the questions related to the users, social-economical conditions, to the image constructed by the users about the city’s transport system and to their transport behaviour. This model was chosen because it is consistent with the approaches adopted in the survey about behaviour theory and transport behaviour developed so far (PAIVA JUNIOR, 2006).

From the assessment at the SEDU (2002) database with more than thirty variables, a minimum set of variables for the measuring of the Noriega and Waisman (2004) model was identified. Among these variables the available transport mode weekly utilization frequency in each city had to be simplified through the classification of the survey model into categories as follows.

- Maximum weekly frequency of public transport utilization – same as maximum utilization frequency of the following models : local bus, urban bus, subway, urban railway, train or boat or ferry boat, Alternative transport;
- Maximum weekly utilization frequency of other motorized transport modes – same as the maximum utilization frequency of taxi and mototáxi;
- Maximum weekly utilization frequency of individual transport – same as maximum utilization frequency of individual vehicle and motorcycle;
- Maximum weekly utilization frequency of non-motorized transport – same as maximum utilization frequency of bicycles and other modes.

Among the questions concerned in the SEDU (2003) survey, the social-economical variables were selected for the use characteristic measuring model, three variables related to the user's attitudes and for variables related to transport behaviour were also chosen. According to Bagozzi (1994) it is recommended that a latent variable has at least three manifest variables as indicators to allowing the assessment of measuring errors. The behaviour variables were adopted fully but for the remaining variables a simplification was chosen. The social economical and attitude variables were chosen among the available and more significant ones according to a specific factorial analysis for each latent variable (Tables 1 and 2).

The first step in a factorial analysis is to decide the number of factors to be considered. There are several methods for it, but here, was chosen the Kaiser Method, that selects the factor with eigen variables equal or greater than 1. For the user characteristics measuring model, with four variables only two factors comply with the Kaiser criteria, indicating the need of two latent variables to describe the user's characteristics. However, since there is no sufficient number of manifest variables, age is dismiss and the user's characteristics are represented only by income, education and purchasing power because they constitute the component with the greatest explained variance (Table 1).

Applying the same criteria for the manifest variables of attitude, from table 2 it can be concluded that the best variables to represent user attitude are local bus service assessment, traffic conditions assessment and general view of the city´s transport service. The remaining variables are not considered since they are not sufficient to construct a new latent variable.

So, variables Attitude to bus service, Attitude to city traffic conditions and Attitude to transport system conditions were selected through this factorial analysis and no further use of this technique was applied in this paper.

Table 1 – Observed Factors (User character)

Component (rotated)	1	2
Eigen values	2,033	1,021
Explained Variance (%)	50,824	25,516
Accumulated Explained Variance (%)	50,824	76,341
Age	-0,033	**0,987**
Family Income	**0,808**	0,108
Education	**0,773**	-0,187
Purchase power class (Classe)	**0,884**	-0,029
Estimation method: Principal Component	Varimax Rotation	

Taking the variable selected above, the complete model structure can be now represented by figure 2. It this structure all the manifest variables are polytomic and the measuring nodes have at least three manifest variables reasonably correlated, as confirmed by factorial analysis. In the structural equations model, showed in the figure 2, the dependent latent variables are represented by η and the independent by ξ , the parameters to be estimated are γ which establishes the influence of independent latent variables over manifest variables and ϕ that represent the correlation of latent variables.

Table 2 – Observed Factors (Attitudes)

Component (rotated)	1	2
Eigen Value	1,570	1,133
Explained Variance (%)	31,406	22,653
Accumulated Explained Variance (%)	31,406	54,059
Attitude to city bus service quality	**0,773**	0,002
Bus fare	0,174	**0,877**
Bus Cost/benefit	0,375	**-0,586**
Attitude to city traffic conditions	**0,518**	0,011
Attitude to transport system conditions	**0,731**	-0,141
Estimation method: Principal Component		Varimax Rotation

Considering the selected variables (table 1 and 2) for the theoretical model (figure 2), the method “two-step-cluster” (TSC), a clustering analysis, indicated three large user segments and one small group of outliers. Although all the variables in the model are considered in the clustering process, the variable that contributed the most for the distinction of groups is the purchasing power as can be seen in table 3 which represents the group’s distribution form by purchasing power class. Therefore a simple, but reasonable description of the Brazilian urban transport users segment is that group 1 is represented mainly by people from classes A1 to B2, group 2 mainly by people from class C and group 3 mainly by people from class D.

After the segmentation phase the next step is the assessment of data availability for all ten variables in all the sub samples. The survey SEDU (2002) interviewed 6.959 transport users but for the data analysis the sample must be considered by city surveyed and by identified segment and in these subsample all the cases must be completely filled. The incompletely filled cases were simply excluded from the analysis (Table 4) because it was confirmed that generation process of these uncompleted cases is random, therefore the exclusion will not lead to any unwanted bias in the analysis. After the database filtering, 5.865 valid cases were selected and separated in samples by city and user segment for the theoretical model test in each one of the samples.

It can be noted that for Belem, Belo Horizonte, Curitiba, Rio de Janeiro and Salvador, same samples are below the 120 cases that are recommended by the literature in order to keep the minimum rate of 5 cases for estimated parameters. The analysis was developed in the same way and only group 1 from Belem could not be tested because the sample was very small and the model did not fulfil the minimum requirements of the absolute adjustment indexes.

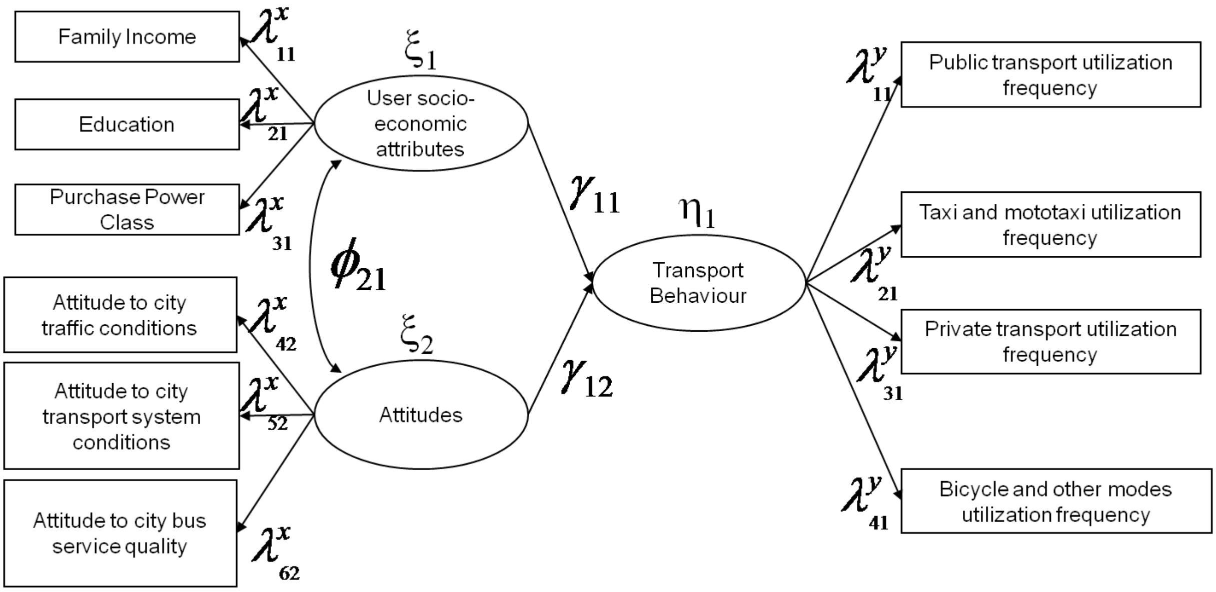

Figure 2 – Structural model and manifest variables selected.

To verify the random nature of the generation of incomplete cases, a χ^2 test was utilized to check if the variables distribution profile was affected by the exclusion of incomplete cases. This test was done for all the proposed model variables and none of the cases the null hypothesis was rejected. The distribution profile variance was considered random and non significative.

Table 3 – Clusters distribution according to purchase power class (Classe)

	Grupos									
	Outlier (-1)		1		2		3		Total	Total
Classe	Cont	%	Cont	%	Cont	%	Cont	%	Cont	%
A1	8	6,21%	74	5,06%		0,00%		0,00%	82	2,18%
A2	25	17,59%	390	25,33%	10	0,64%		0,00%	425	10,65%
B1	28	17,59%	520	28,87%	100	5,16%	2	0,07%	650	13,63%
B2	45	25,40%	557	27,91%	446	19,94%	1	0,02%	1049	18,74%
C	44	19,89%	283	12,49%	1827	72,03%	244	9,32%	2398	33,07%
D	36	11,03%	10	0,34%	54	2,23%	1975	81,47%	2075	19,60%
E	6	2,30%		0,00%		0,00%	274	9,12%	280	2,13%
Total Global	192	100,00%	1834	100,00%	2437	100,00%	2496	100,00%	6959	100,00%

82% 72% 81%

With the confirmation of the data reliability and suitability the fifth step of the analysis process is model design and estimation. The model structural relations were coded in a language specific for the statistical software used taking the variables and model parameters already described in figure 2. The method ADFG (Asymptotically Distribution Free Gramian) of the software STATISTICA 99 (STATSOFT, 1999), was used for the estimation of structural model parameters. This estimation method is equivalent to the general weighted least square method available in LISREL 8.54 (JÖRESKOG; SÖRBOM, 2003).

Table 4 – Number of cases available, excluded and valid to theoretical model.

City	Cases	Excluded	Valid	Grup 1	Grup 2	Grup 3
Belém	695	141	554	45	246	263
Belo Horizonte	725	143	582	233	254	95
Campina Grande	645	78	567	171	153	243
Curitiba	625	167	458	202	172	84
Fortaleza	695	112	583	173	195	215
Goiânia	665	110	555	172	154	229
Porto Alegre	694	63	631	171	287	173
Rio de Janeiro	795	169	626	107	307	212
Salvador	695	47	648	116	208	324
Teresina	725	64	661	134	172	355
Total	6,959	1,094	5,865	1,524	2,148	2,193

Because the model was estimated for each one of the ten cities surveyed, in table 6 it is shown the model fit indexes for each city to make the comparison of adjustment in each sample easer. The indicators that comply with the literature recommended limits are shown in bold. As can be seen, according to most indicators, the proposed theoretical model fits well with the observed data in almost all the cities surveyed. Some limits are exceeded but that does not necessarily mean that the analyses are not valid.

In table 5 the absolute fit indicators RMSEA, GFI and AGFI were simultaneously satisfactory in all cities, except Teresina and Belém. Regarding to χ^2 (ADFG), despite of the high level observed in some cases , the proportion limit of five times de degrees of freedom (HAIR et al, 2005) was respect in most cases. At last, all cities fail in the RMS test. But, the RMS test, as like as the χ^2 (ADFG) test, measure just the discrepancy between an estimated matrix and an observed. As χ^2 (ADFG) was acceptable in most cases the RMS was taken just as a warning.

In table 6 you find the standard coefficients of the proposed structural model estimated to each city surveyed. As the objective of this research is to understand the inner relationships of theoretical model the non standard coefficients were omitted because they are not necessary to the analysis. In this table all bold coefficients have a 95% confidence level or higher.

The results in table 6 indicate that the estimated model coefficients estimated for one city are significant distinct from the coefficients estimates to another city (Ortuzar, Willumsen, 2001). But the meaning of the structural models relationships can be interpreted in the same way, because there is no coefficients signal changes in the structural models in the most of the cases.

To facilitate the coefficient analysis between all cities, an average coefficient was calculated. This coefficient there is no statistical meaning; it is just a way to resume the information of ten models into one structural model (figure 3).

Table 5 – Model assessment by city

Indicador de Ajuste (limites)	Teresina	Salvador	Rio de Janeiro	Porto Alegre	Goiania	Fortaleza	Curitiba	Campina Grande	Belo Horizonte	Belém
Root Mean Square Error of Approximation (RMSEA<0,08)	0,086	**0,047**	**0,058**	**0,061**	**0,056**	**0,04**	**0,029**	**0,061**	**0,042**	0,081
Goodness of Fit Index (GFI>0,90)	**0,959**	**0,984**	**0,973**	**0,965**	**0,979**	**0,985**	**0,985**	**0,975**	**0,984**	**0,968**
Adjusted Goodness of Fit Index (AGFI>0,90)	**0,929**	**0,972**	**0,953**	**0,94**	**0,964**	**0,974**	**0,974**	**0,958**	**0,972**	**0,945**
Asumptotically Distribution Free Gramian χ^2 (ADFG<5xdf)	187,465	**77,717**	**98,470**	**107,890**	**87,175**	**62,021**	**44,186**	**99,365**	**65,021**	**148,379**
Degrees of freedom (df)	32	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**
P-level >0,05	0,000	0,000	0,000	0,000	0,000	0,001	0,074	0,000	0,000	0,000
Root Mean Square (RMS<0,05)	0,104	0,065	0,11	0,075	0,079	0,057	0,053	0,082	0,075	0,113

Making a path analysis in the structure of figure 3 is possible to see the impact of each manifest variable over the latent variables. For example, the impact of purchase power class over public transport utilization frequency and individual transport utilization frequency is inverse because the product of the coefficients 0,907, 0,711 and -0,270 is negative and the product of 0,907, 0,711 and 0,094 is positive.

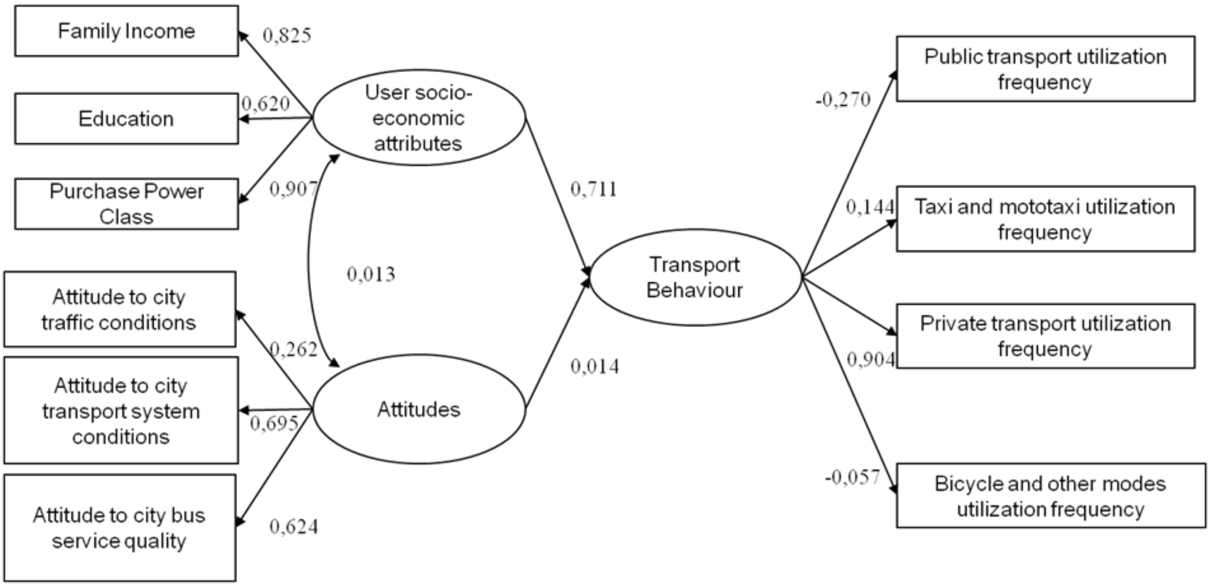

Figure 3 – Structural models and standardized average coefficients from table 6.

Table 6 – Model II standardized estimative

Parâmetro	Média Geral	Cidade									
		Teresina	Salvador	RJ	POA	Goiania	Fortaleza	Curitiba	CG	BH	Belem
λ^x_{11}	0,825	**0,905**	**0,846**	**0,781**	**0,856**	**0,798**	**0,851**	**0,821**	**0,868**	0,832	**0,690**
λ^x_{21}	0,620	**0,634**	**0,643**	**0,669**	**0,636**	**0,661**	**0,568**	**0,642**	**0,719**	**0,566**	**0,464**
λ^x_{31}	0,907	**0,926**	**0,931**	**0,885**	**0,853**	**0,914**	**0,900**	**0,923**	**0,934**	**0,886**	**0,924**
λ^x_{42}	0,262	**0,179**	**0,423**	**0,350**	**0,149**	**0,143**	**0,333**	**0,211**	**0,190**	**0,294**	**0,352**
λ^x_{52}	0,695	**0,360**	**0,794**	**0,756**	**0,528**	**0,557**	**0,564**	**0,777**	**1,000**	**0,758**	**0,856**
λ^x_{62}	0,624	**0,851**	**0,587**	**0,572**	**0,921**	**0,667**	**0,701**	**0,587**	**0,343**	**0,648**	**0,365**
ϕ_{21}	0,013	**-0,143**	0,020	-0,063	**0,148**	0,046	-0,093	0,086	0,001	0,011	**0,121**
λ^y_{11}	-0,270	**-0,255**	-0,229	**-0,222**	**-0,033**	**-0,367**	**-0,274**	**-0,489**	**-0,340**	-0,286	**-0,207**
λ^y_{21}	0,144	0,063	0,309	**0,404**	0,188	-0,027	**0,167**	**0,123**	-0,027	0,086	0,153
λ^y_{31}	0,904	**0,988**	0,884	**0,781**	0,505	**1,000**	**0,959**	**0,922**	**1,000**	1,000	**1,000**
λ^y_{41}	-0,057	**-0,231**	**0,036**	0,135	-0,034	**-0,121**	-0,065	0,037	**-0,131**	**-0,015**	**-0,181**
γ_{11}	0,711	**0,840**	0,719	**0,627**	0,993	**0,589**	**0,751**	**0,640**	**0,797**	**0,631**	**0,519**
γ_{12}	0,014	-0,018	-0,034	0,063	0,042	-0,015	0,005	0,082	**-0,097**	**0,010**	**0,100**

In de example above the model shows, as expected, that the increase purchase power is related with the reduction of public transport utilization frequency and increase of individual transport utilization. This analyse is valid to all surveyed cities, as shown in table 6.

In table 6, we also observe that the user´s quality perception has little relation with their transport behaviour because the non reliability of that coefficient and his insignificant magnitude (0,014). From this cause-and-effect model we can conclude that there is no significant relation between the user's service quality perception and the transport mode demand in the cities observed.

CONCLUSION

The objective of this study was to evaluate the urban transport user's attitude in relation with their social-economical condition and their travel behaviour by using a behavioural model. Such model was designed considering the data available from an opinion survey carried out in ten Brazilian cities. Because the survey was not conceived for this study, most part of the methodology was dedicated to data validation and suitability analysis to make their use possible in the structural equations modelling process.

This task resulted in a drastic reduction in the number of variables suitable for analysis as well as a reduction in the number of cases considered, reducing the model and restricting the scope of the conclusions in the name of its reliability.

Together with the main issue of the behavioural model, two questions inherent to the modelling process were answered here. The first is the effect of the population heterogeneity over the model conclusion validity. The second refers to the use an estimated model for one context when applied in a different context, i.e., its "transferability".

The theoretical model was tested in two clustering levels. In the first, it was observed that in all the cities, the attitude measurement contributed very little to the explanation of transport behaviour. On the other hand, when the model is applied to different users segments, specific behaviour can be identified. In general, the segments with lower purchasing power follow the behaviour identified by the aggregated model and as the purchasing power increases the differences between the clustered and disaggregated models grow. In some cases, attitude and social-economical condition is equally important to explain the travel behaviour and in other cases, none of the variables is relevant.

These models results can be associated with differences in users lifestyles. As group 3 has a low purchasing power (class D), its consumption pattern and type of social activity are strongly driven by budget restrictions: so the quality of transport service does not influence their travel behaviour because they have no other option. But for group 2 (class C), with a slightly better purchasing power, there are more transport options available and in this case the service quality evaluation becomes as relevant as its price.

As for group 1, comprised mainly by classes B2 to A2, the low sensitivity between the social-economical variables and attitude is probably due to the sophisticated lifestyle they lead. This group's resources are high enough that individual transport is not only an accessible option, it is often the only option considered. In this case, the transport behaviour structural model must consider other variables such as power, prestige, status, pleasure (JENSEN, 1999) or safety.

These results show that the transport users' heterogeneity exists and is sufficiently strong to produce desegregated models distinct from the aggregated models. This aspect is known in theory, but it was made clear in this paper with the use of surveyed information among users. Therefore, conclusions or public policies based in aggregated models are restricted and must necessarily consider the cost-benefit analysis of the modelling level. The study suggests that, for the 10 studied cities, the interpretation of the transferability of cause-effect structure parameters is adequate. However, for disaggregated models this characteristic was not verified.

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