

Modeling Transportation Preferences of Urban Residents: The Case of Poland

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Abstract. The paper presents the application of selected methods of multivariate statistical analysis including factor and conjoint analyses in terms of modeling transportation preferences of urban residents. The introduced methodologies can be useful tools for local authorities while designing solutions in order to improve the competitiveness of public transport to private transport. The results of the studies presented in the article are part of the research project implemented in 2010–2013 under a title. “Reference model of city logistics and the quality of life”. For the study undertaken in this paper, three medium-sized cities, located in the western part of Poland, were selected.

Keywords: Transportation preferences · Factor analysis · Conjoint analysis

1 Introduction

Life in the city and the areas directly adjacent to cities is becoming more and more burdensome. The main reason for this situation, besides environmental pollution and security threats, is constantly increasing number of residents which cause difficulty with moving. The effect of dynamic urban development in urban and industrial agglomeration is often congestive transportation also called congestion. The problem of congestion is the subject of numerous studies [1–6].

The growing wealth of societies and consequently a greater access to passenger cars is responsible for the significant increase of the motorization index with a simultaneous fall in public transportation usage [7]. Forecasts of the European Commission indicate that passenger individual transportation will have increased by 51 % by 2050, while the public transportation will further deteriorate [8].

The impact of transport on the urban environment depends on many different factors. A special place among them takes the implementation of the transportation service, which is an important part of strategy for urban transport. The right choice of development strategy, especially public road transport can help to solve the problems of traffic organization. It is important in this case the proper identification of existing and future challenges that the transport system faces [9] and the formulation of

transport development programs that meet indicated tasks in changing environmental conditions [10].

The purpose of the study is an attempt to model transportation preferences of urban residents in one of medium-sized city in Poland. In this paper the selected methods of multivariate statistical analysis including factor and conjoint analyses were proposed. The study results can be a useful tool for local authorities in order to design solutions that improve the competitiveness of public transport to private transport. The results of the studies presented in the article are part of a project implemented in 2010–2013 titled “Reference model of urban logistics and the quality of life”.

The structure of the paper is as follows. The second section presents the significance of the application of multidimensional statistical analysis in order to identify citizens’ transportation preferences and behaviors. The next section introduces research results. The final part of the paper presents conclusion.

2 The Study of Transportation Preferences and Behavior of Urban Residents

Modeling of travelers’ transportation behavior is a part of a more complex modeling process of a trip, which is conditioned, among others, by the density of urban networks and associated with the traffic noise or lengthening of the travel time, [11]. An important element of this process is to study the preferences of buyers, in this case travelers. Knowledge of the preferences and transportation behavior of the inhabitants is essential in the process of shaping transportation offer. Particularly important in this regard are studies on: the identification and prioritization of traffic demands and satisfaction with services and comprehensive assessment of the quality of transportation services. It is assumed that the fundamental postulates reported by residents to the urban transport sector are: punctuality, directness, frequency and availability, making up the level of passenger satisfaction with the services provided.

An important problem in the course of a lot of research is the correct interpretation of numerous, interlinked information. The solution to the problems with too much individual information can be e.g. a reduction in dimensionality and search for the interplay of many factors, e.g. on the basis of factor analysis.

Factor analysis is used to convert the mutually correlated system of variables into a new system of variables to be determined as common factors mutually uncorrelated, comparable with an output system [12–14].

Another method of measuring the preferences of buyers is conjoint analysis. The essence of conjoint analysis is to evaluate a set of profiles (real or hypothetical products and services) described with the selected attributes (explanatory variables) in order to obtain information about the overall preferences for the profiles (a set of values of the dependent variable) made by the respondents to the survey.

The complexity of the test procedure in the framework of conjoint analysis requires decision-making at every stage of research including among others determining the form of the model (depending on model variables, model preferences), the choice of how to collect data (solid profiles, pairwise comparisons, the presentation of pairs of attributes), the choice of the presentation profiles (physical product, the product model,

a verbal description of figure), the scale of preferences (non-metric, metric) estimation method (metric: MONANOVA, PREFMAP, LINMAP, CCM, Metric: KMNK, MSAE, probabilistic: MNW, EM), assessing the credibility of the model (rating accuracy, reliability assessment), the interpretation of the results of measurements and the sample size determined mostly on the basis of earlier research (typical test is usually from 300 to 550 respondents) [15].

In the work the analysis of travelers’ preferences was based on the research sample, which consisted of adult residents of three Polish cities of West Poland who were between 18 and 70 years of age. An attempt was selected from the population at random. The total sample size was set at 1,600 inhabitants.

3 The Results of Travelers’ Transport Preferences

The respondents evaluated 12 different quality criteria concerning urban transport services, estimated from the available literature on the subject studies of this type. In the study of exploration the following dimensions of evaluation were considered: punctuality and frequency of the line, safety and travel conditions in vehicles, the conditions of waiting at bus stops, the availability of public transport, ticket prices and the immediacy of connections.

The research found that 12 of the original criteria for the quality of services can be reduced due to the application of factor analysis to two factors. The first derived factor mainly explains determinants associated with conditions of movement within the city offered in urban transport services. The variables described by this factor include the four most frequent transport demands: travel time, convenience - access to public transport, cost and safety.

The second factor is related to the additional (supplementary) areas of offered transport services, such as courtesy of drivers, access to information about the time of service delivery and readability of timetables. The system of variables forming the defined dimensions is shown in Table 1.

Table 1. The results of the factor analysis

Factor 1	Factor 2
punctuality of vehicles (x_1),	courtesy of drivers (x_9),
frequency of vehicles (x_2),	the overall quality of the information (at bus stops, in vehicles and on vehicles) (x_{10}),
travel safety (x_3),	readability and simplicity of memorizing timetables (x_{11}),
the conditions of traveling in vehicles (x_4),	the opportunity to comment on the functioning of public transport (x_{12}).
the conditions of waiting at bus stops (x_5),	
accessibility to public transport (x_6),	
ticket prices (x_7),	
directness of connections (x_8).	

During the study the significantly higher impact of variables was confirmed which was described by the first appointed agent to assess the quality of transport services, mainly including: ticket prices, travel time, service frequency and distance from a bus stop to the place of residing. For further research using conjoint analysis indicated variables (criteria) were used described by the first factor directly connected with the ongoing transport services. The validity of these variables was assessed by most respondents. The participants of the study felt that price, time, frequency, and further distance of a bus stop from home are the most important criteria for the quality of transport services.

Respondents were asked to evaluate a set of 12 profiles out of 36 possible variants generated by the method of orthogonal plan. Utility values that each respondent is associated with a given level of the variable set by means of a least-squares method with artificial explanatory variables. After estimating the relative partial utility the validity of each considered variable was specified.

The results obtained during the study confirmed the findings of other authors [16, 17]. In fact, all of the criteria related to the fundamental postulates of lading are significant while choosing the public transport as a means of movement within the city. The lowest percentage was obtained for criterion: time travel. Time travel for residents of medium-sized cities, with relatively close distances to overcome, is not a criterion as significantly influencing the preferences of the inhabitants as the other analyzed variables.

The highest preferences identified during the research (maximum score profile) relate to services provided by the urban public transport characterized primarily by low price, high frequency of the circulation, with close proximity to the bus stop from the place of residing (Fig. 1). In contrast, the travel time can be as long as in the case of travelling by car. Time travel for residents of medium-sized cities is not a decisive factor for the travelers' preferences related to the choice of public transport.

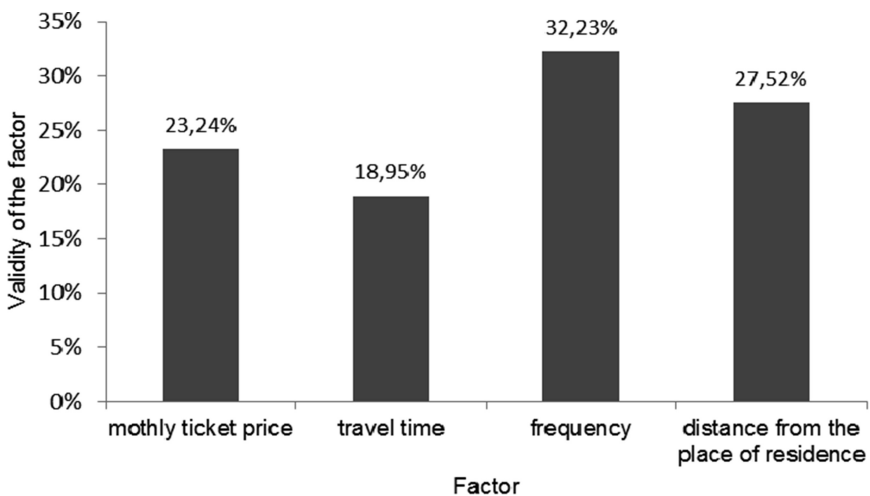


Fig. 1. The relative importance of the attributes

4 Conclusions

The problem of many cities, beside the surge in the number of cars,¹ it is also a significant increase in road freight transport, which puts a burden on municipal systems. Easy transportation within cities is also impeded due to housing development in suburban areas and placement outside concentrated urban housing large shopping centers. The solution to traffic problems of cities should be adequate to the implementation of transport policy allowing to increase the competitiveness of public transport and consequently reducing congestion, noise and pollution while increasing security. Public transport except that reduces traffic is more environmentally friendly than individual transport by car. Due to the constantly decreasing interest in this form of travel, it is important to take proper measures to encourage residents to use this kind of transport. It is also vital to monitor the quality of service offered by the public transport services.

The presented results of the modeling transportation preferences of urban residents with the application of the methods of multidimensional statistical analysis allowed to identify the comprehensive travelers' preferences. From a practical point of view, these studies are significant because of the possibility of simultaneous comparison of many individual preferences of travelers. It is also important opportunity to introduce the proposed methods to a comprehensive and more complex modeling of transport behavior.

The results of carried out studies clearly indicate that price, frequency and distance from the main stops are the key factors affecting the assessment of the quality of public transport in medium-sized cities. Travel time due to the rather short distances turned out to be a less important factor. It will be certainly more important aspect in the case of residents of large cities, more congested and less efficient in communication.

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¹ According to the Energy & Transport in Figs. 2006, European Commission Luxembourg, 2007, the number of private cars per 1,000 inhabitants increased from 15 in 1970 to 323 in 2007.

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