Psychological reasons for university students' preference for environmental modes of transportation

Mikhail Leontev1*

1National Research Moscow State University of Civil Engineering, 26, Yaroslavskoye shosse, 129337, Moscow, Russia

Abstract. This study examined the influence of environmental norms, beliefs, and responsibility on preferences in the use of environmental transportation by students of technical universities. The author analyzed the use of ecological transportation by university students, linking the components of the Norm Activation Model (NAM) with the use of ecological transportation; analyzed the indicators that determine consumer satisfaction with public ecological transportation services using the example of an urban electric bus. The recommendations on transition to eco-transport and improvement of public transport organization on the example of the urban electric bus on the basis of the obtained results were proposed. This will help increase passenger satisfaction and, consequently, increase the number of passengers of public ecological transport.

1 Introduction

It is clear that today's megacities need a transportation policy that reduces the need to travel by individual vehicles and strengthens public transportation. Speed, quality of service, flexibility, convenience and accessibility are important advantages of individual modes of transport. As a consequence, those who can afford a private car are consistently abandoning public transport [1]. This process is also facilitated by rising incomes. Until recently, the primary mission of public transport was aimed at meeting the individual requirements of the population and the less well-off members of society, but today public transport should contribute to reducing traffic jams, traffic safety and preserving the environment.

Private cars cause a large amount of air pollution and consume more fossil fuels than ecological transport [2]. Problems of traffic jams, which are typical for large cities, are becoming more and more serious and are now extend to medium and small cities. Transport problems are also related to environmental aspects, urban and regional development problems, safety issues, economic and time costs for citizens, and differences in the interests of transportation companies, the state and passengers. International experts agree that public transport in the modern world determines the economic development of cities and regions by almost a third [3]. In this regard, a global consensus on the priority development of urban public transportation is needed.

* Corresponding author: miillen@rambler.ru

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (http://creativecommons.org/licenses/by/4.0/).
Of course, urban rail is a good choice and destination for urban public transportation, but its high construction and maintenance costs and its too high capacity are only suitable for large cities. Understanding the factors affecting the operation of buses, the important role of the bus in the urban transport system, is necessary [4]. When planning the development of public transport it is necessary to implement measures to switch the users of private cars to bus passengers.

Choosing how to move is influenced by both personal characteristics and the characteristics of the mode of transport. According to previous studies, the reasons influencing the choice of mode of transportation can be of a physical and psychological nature [5].

Many previous studies have attempted to explain mode choice using objective physical characteristics. Factors such as frequency of vehicle use, cost of travel, and travel time have generally been used to estimate the preferred mode of travel [6]. Public transportation characteristics such as convenience, reliability, comfort, and availability of vehicles are also thought to be related to the choice of transportation mode [7], and the influence of social factors such as age, personal income, occupation, and family size on vehicle ownership has been tested [4].

According to research, a person's attitude towards the use of transportation is an important psychological factor that influences the actual choice of transportation [8]. However, this influence may be uneven due to different characteristics of localities, social strata and local habits. The attractiveness of public transport is often determined by the level of comfort of the trip. Comfort in this case is provided not only by the use of modern vehicles, but also by the effective organization of road traffic, the creation of convenient transport and interchange hubs and the integration of various modes of transport into a unified, reliably managed system [7].

Based on an analysis of the influencing factors, it is possible to explain how transportation mode choice studies have been implemented. In the beginning, mode choice was measured through physical characteristics, but the next stage of research went further in explaining the motivation that leads to mode choice. Studies have clearly shown that psychological factors (e.g., habits, purpose of travel, perceived reliability of mode of transportation, and social issues) can effectively complement and even dominate physical external factors [9].

According to Gifford R., pro-environmental behavior can be defined as behavior that is carried out with the intention of changing (usually for the good) the environment [10]. Van der Werff E. et al. define pro-environmental behavior as behavior that deliberately aims to reduce the negative consequences of human impacts on the living and non-living world [11].

Researchers consider the factors and circumstances that cause the formation and implementation of environmental friendly behavior. The main groups of determinants have been identified: psychological or personal determinants (values, attitudes, beliefs, goals, norms, intentions, motivation, etc.), social (gender, age, education, social norms, etc.), situational (e.g. the ability to choose different actions), etc. The psychological variables related to pro-environmental behavior when using transport means are significant in our research (personal norms), beliefs and values [11].

Encouraging people to switch from car use (single or occasional) to sustainable modes of transport, including active transport (e.g. cycling, scootering), public transport (e.g. bus, tram) and electric cars, can alleviate urban environmental problems. In particular, individuals who drive or use more than one mode of transport (other than a car) for all their journeys over a period of time have the potential to switch to sustainable modes of transport for targeted journeys [12]. Individuals who frequently use only one environmentally friendly transportation are more likely to use a gasoline car compared to those who alternatively use several environmentally friendly modes of transport. Thus, a better understanding of vehicle
usage or eco-driving can provide important insights that can be incorporated into policy measures.

The introduction of environmentally friendly public transport vehicles in cities is undoubtedly relevant; it can be considered a big step towards a 'green economy'. The electric bus is a relatively new type of green transport and is now being widely implemented in Moscow. In connection with the transition to environmentally friendly transportation, it is important to assess consumer satisfaction with urban public transport services. A.R. Rakhmatullina defines this type of satisfaction as an emotional response of consumers to the perceived quality of transportation and service associated with a rational assessment of quality parameters and prior experience of consumers [13].

This study examines the use of environmental transportation by university students. Students, as a group with high social mobility, can make numerous and complex journeys. The transportation of students from their place of residence to university accounts for a significant proportion of the total daily use of public transport in most towns [14]. University students often use more different types of transport compared to the rest of the townspeople [15], demonstrating a higher probability of switching between different types of eco-friendly transport. One should keep in mind the influence of the individual's time perspective on pro-environmental behavior, thoughts and decisions [16], including pro-environmental trend in the use of different transportation.

The Norm Activation Model (NAM) (owned by Shahlom Schwartz) applied in this study is one of the well-known psychological theories that investigates causal structural relations in explaining environmentally friendly behavior [17]. The NAM includes three components: 1) consequence awareness (AC), 2) attribution of responsibility (AR) and 3) personal norms (PN). According to the theory, the causal structural chain is activated by the individual's pro-environmental behavior. Consequence awareness is when individuals are aware of the adverse environmental consequences of their actions, such as using a petrol-powered car. It is assumed that AC actualizes AR, which means that individuals take responsibility for the consequences of their behavior. Finally, AR affects PN. "Personal norm" is the central concept of the Norm Activation Model (NAM) [18]. It reflects a sense of moral obligation to perform or refrain from a particular action. In addition, the described model includes such variables as "awareness of the problem", "effectiveness of the result", "attribute of responsibility" [19, 20].

The aims of the study were: 1) identify the particular use of pro-environmental modes of transport by university students; 2) to find out the relationship between NAM components and pro-environmental transport use by university students; 3) to identify and measure indicators that determine customer satisfaction with public eco-transport services using the example of an urban electric bus. Research objectives: to develop a questionnaire to assess the impact of NAM components on the pro-environmental use of transport; 2) to provide some recommendations based on the findings

2 Methods

The research method was a survey. A cross-sectional survey was conducted at technical universities in Moscow. Data was collected from 114 students. Male respondents accounted for 57% of the total sample. People aged 19-25 accounted for 78% of the total sample, people aged 26-35 accounted for 19%, and people aged over 35 accounted for 3% of the total sample.

Based on the average number of daily trips, the majority of respondents (68% of the total sample) travelled between 4 and 6 times a day. Respondents participated in the study voluntarily, free of charge. Secure data storage and confidentiality of anonymous responses were ensured.
Because the purpose of the study was to examine the use of different modes of transportation among university students, the questionnaire asked several questions, including: "How often do you use each mode of transportation during the academic week when traveling to and from university (except during the winter season): bus, electric bus, manual bicycle, electric bicycle, scooter/moped, motorcycle, gasoline/diesel car (driver or passenger), electric car (driver or passenger). It is not possible to use some modes of transportation during the winter season, so the winter season was excluded. Also, rail modes of transportation were not surveyed. The survey was conducted on a 5-point Likert scale from "1" never use to "5" use five or more days a week.

A validated instrument of the Norm Activation Model (NAM) (was used to measure students' pro-environmental norms and beliefs [19]. The original version of the NAM consisted of 18 items aimed at examining the components of this theory: awareness of the consequences (AC), 2) attribution of responsibility (AR), and 3) personal norms (PN). These components were the scales of the questionnaire and were rated on a five-point Likert scale ranging from 1 - "strongly disagree" to 5 - "strongly agree".

The AC measure included six items, such as "Car use reduces scarce resources such as oil" and "Car use impairs quality of life in the city due to noise and air pollution". These items have been tested and confirmed in previous studies examining pro-environmental behavior and transportation use among the population. The AR measure also contained six items, such as "I am responsible for environmental problems caused by car use" and "My contribution to solving problems caused by car use is insignificant". The questionnaire included six items about PN, such as "If I were to buy a new car, I would most likely buy an eco-friendly car" and "I would increase my self-esteem if I used other modes of transport more often instead of a car". The PN related items covered the moral and personal commitment to either reduce the use of petrol/diesel cars or increase the use of environmentally friendly modes of transport. The questionnaire also included items related to age, gender, social status.

The study also used a self-assessment questionnaire; respondents were asked to rate their overall satisfaction with environmental public transport services (electric buses) and the individual factors affecting it. The questionnaire was compiled after reviewing relevant studies, consultations with passengers and stakeholders.

3 Results

The findings showed that 61% of the students used one type of eco-transport. About 26% of the respondents reported using two or more modes of eco-driving. Meanwhile, the share of electric cars was about 5%.

Among the respondents who reported using one mode of eco-transport, around 43% walk to and from university and 83% use only public transport. The majority of students (around 97%) who use two or more modes of eco-transport use a combination of different modes of individual and public transport.

Exploratory factor analysis (EFA) is often used to identify hypothetical relationships or underlying structures between measured variables. Since the NAM measures used in this study have been widely validated and used in previous studies, we applied confirmatory factor analysis (CFA) to test for consistency with the three-factor structure previously outlined in the literature. Statistical indicators: RMSEA, comparative fit index (CFI) and Tucker-Lewis index (TLI) were used as fit indices to determine the fit of NAM measurements to the proposed model [20]. RMSEA values below 0.06 and CFI and TLI values ranging from 0.90 to 0.95 reflect adequate model fit [21]. The chi-square index ($\chi^2$) with appropriate level of significance was also presented. In addition, $\alpha$ coefficient (Cronbach's alpha) was calculated to test the reliability of the scale.
CFA results for the NAM measurements confirmed that the three-factor representation was reasonably consistent with the data ($\chi^2 = 353.76$, df = 104, p<0.001, RMSEA = 0.052, CFI = 0.92, TLI = 0.91). Cronbach’s coefficient $\alpha$ confirmed satisfactory reliability of all three factors: AC ($\alpha=0.81$), AR ($\alpha=0.82$) and PN ($\alpha=0.86$).

The underlying NAM constructs (AC, AR and PN) were confirmed by the findings. In terms of the NAM causal chain, awareness of the consequences (AC) was positively correlated with attribution of responsibility (AR), and AR was also positively correlated with personal norms (PN).

The following factors influencing satisfaction with urban public transport services (electric buses) were selected for the self-assessment questionnaire: 1) availability of empty seats; 2) comfortable conditions in saloon (railings, seats, sufficient legroom, comfortable ceiling height); 3) frequency of trips; 4) waiting time, not rush hours; 5) cleanliness of saloon; 6) traffic reliability; 7) convenience of stops location for passengers; 8) comfort at stops (shelter, benches); 9) sufficient number of vehicles in the route; 10) reasonable prices for trip; 11) personal security of passengers; 12) availability of information boards at the bus stops; 13) electric buses provide short travel time; 14) drivers and conductors behave properly.

Table 1 below provides descriptive statistics on overall satisfaction with public transport (electric buses) and the factors that influence it. Percentages of the total number of respondents are shown.

<table>
<thead>
<tr>
<th>Factor number</th>
<th>Average</th>
<th>Dissatisfied</th>
<th>Dissatisfied rather than satisfied</th>
<th>Neutral</th>
<th>Satisfied rather than dissatisfied</th>
<th>Satisfied</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.8</td>
<td>1.4</td>
<td>17.6</td>
<td>17.6</td>
<td>24.3</td>
<td>39.2</td>
</tr>
<tr>
<td>2</td>
<td>3.63</td>
<td>3.3</td>
<td>20.3</td>
<td>15.2</td>
<td>31.1</td>
<td>29.1</td>
</tr>
<tr>
<td>3</td>
<td>3.3</td>
<td>6.8</td>
<td>23.6</td>
<td>29.1</td>
<td>14.2</td>
<td>26.4</td>
</tr>
<tr>
<td>4</td>
<td>3.49</td>
<td>7.5</td>
<td>18.9</td>
<td>20.9</td>
<td>23.0</td>
<td>29.7</td>
</tr>
<tr>
<td>5</td>
<td>3.28</td>
<td>2.7</td>
<td>27.0</td>
<td>23.0</td>
<td>10.8</td>
<td>36.5</td>
</tr>
<tr>
<td>6</td>
<td>2.8</td>
<td>5.4</td>
<td>31.1</td>
<td>30.4</td>
<td>16.2</td>
<td>16.9</td>
</tr>
<tr>
<td>7</td>
<td>4.4</td>
<td>1.4</td>
<td>1.4</td>
<td>12.2</td>
<td>27.0</td>
<td>58.1</td>
</tr>
<tr>
<td>8</td>
<td>3.5</td>
<td>4.7</td>
<td>12.8</td>
<td>32.4</td>
<td>25.7</td>
<td>24.3</td>
</tr>
<tr>
<td>9</td>
<td>3.7</td>
<td>4.1</td>
<td>14.9</td>
<td>19.6</td>
<td>29.7</td>
<td>31.7</td>
</tr>
<tr>
<td>10</td>
<td>3.2</td>
<td>8.1</td>
<td>31.8</td>
<td>18.9</td>
<td>10.8</td>
<td>30.4</td>
</tr>
<tr>
<td>11</td>
<td>2.7</td>
<td>18.9</td>
<td>24.6</td>
<td>15.5</td>
<td>23.6</td>
<td>17.6</td>
</tr>
<tr>
<td>12</td>
<td>3.8</td>
<td>4.8</td>
<td>9.5</td>
<td>26.4</td>
<td>18.9</td>
<td>40.5</td>
</tr>
<tr>
<td>13</td>
<td>4.1</td>
<td>1.4</td>
<td>5.4</td>
<td>16.9</td>
<td>31.1</td>
<td>45.3</td>
</tr>
<tr>
<td>14</td>
<td>3.5</td>
<td>6.8</td>
<td>15.5</td>
<td>31.1</td>
<td>18.2</td>
<td>28.3</td>
</tr>
<tr>
<td>15</td>
<td>4.0</td>
<td>1.4</td>
<td>9.5</td>
<td>16.2</td>
<td>33.1</td>
<td>39.9</td>
</tr>
</tbody>
</table>

Note: 15 - Assessment of overall satisfaction with public transport services (electric buses).

Table 1 presents descriptive statistics of general satisfaction with public transport (electric buses) and various factors affecting it. It turned out that Moscow university students are mostly satisfied with existing public transport services, the average score was 4.0 (the range of average scores is from 1 to 5). About 40% of respondents were satisfied with the services provided, although only 1.4% were “not satisfied” and 16.2% were undecided. The majority of respondents were satisfied, 33% were “rather satisfied”. Thus, of the 114 respondents, 73% are satisfied with the public transport services (electric buses) in Moscow.

Statistical distribution of frequencies of respondents' perception of specific service quality parameters that affect their satisfaction with existing public transport services (electric buses) in Moscow is shown in Table 1. Specific service quality attributes of electric buses that affect passenger satisfaction are generally perceived well.
For example, indicator 13 (electric buses provide short travel times) with an average score of 4.1, indicated 31.1% in the "rather satisfied" column and 45.3% in the "satisfied" column, meaning that over 76% of passengers are satisfied with their electric bus travel time.

Similarly, the following factors showed high average scores: convenience of stops location for passengers (7) with an average score of 4.4; availability of information boards at the bus stops (12) with an average score of 3.8. More than 85 percent of passengers are satisfied with the location of stops for passengers and more than 58 percent of passengers are satisfied with the presence of information boards at stops. Thus, in fact, all of the variables showed an average score of more than 3 and meet the expectations of passengers in the city of Moscow.

In other words, out of 14 analyzed indicators, 12 quality attributes of public transport services (electric buses) in the city of Moscow were perceived satisfactorily by passengers. Only two indicators (6 and 11) lagged behind passenger expectations (traffic reliability and personal security of passengers); in fact, passengers were undecided on indicator 11. This shows that passengers of public transport (electric buses) are generally satisfied with the services provided.

4 Discussion

This study examined students' eco-transport preferences and satisfaction with electric bus use. The Norm Activation Model (NAM) was applied to examine the structural relationships between awareness of the consequences, attribution of responsibility, and personal norms on environmental transportation choices.

Understanding how and to what extent environmental beliefs and other psychological factors contribute to the use of one or more modes of environmental transportation can have an impact on public transportation planning.

The socially desirable behavior associated with eco-driving can be elicited through specially designed campaigns using university information resources. Encouraging students to use more than one type of environmentally friendly transportation can reduce the likelihood of switching from a green vehicle to a gasoline/diesel vehicle. On the other hand, which is consistent with previous studies \cite{1,4,6,17,19}, those students who reported stronger personal norms and commitments to the environment tended to use one mode of environmental transportation. The age of the students did not have a clear correlation with the use of environmental transportation.

Municipal and city authorities can plan and carry out activities to increase the availability of all routes of green modes of transport in order to activate the moral obligation of people to reduce the use of gasoline and diesel cars and to switch to green modes of transport.

The study showed that passengers in Moscow are mostly satisfied with public transport services (electric buses). Factors influencing passenger satisfaction are: comfortable conditions in saloon, frequency of trips, transport waiting time, cleanliness of the saloon, traffic reliability, convenience of stops location for passengers, comfort at stops, sufficient number of vehicles on the route, reasonable prices for trip, personal security of passengers, availability of information boards at stops, short travel time, proper behavior of drivers and conductors.

5 Conclusions

Based on the results obtained, we can offer the following recommendations: to increase the frequency of traffic, this contributes to the organization of dedicated lanes for public transport. It is necessary to install video surveillance systems in electric buses, as well as at
bus stations and stops to insure security. Public transport stops should be designed according to the principles of green infrastructure with an elegant design, with a sufficient number of benches and canopies installed at stops.

Existing roads should be repaired and maintained, and deferred road projects should be completed in time to have an efficient network of urban roads. This will not only reduce travel time by electric bus, but will also increase the availability of this mode of transport and help it cover more areas in the city [23].

Further research can be associated with the modification of questionnaires and application of factor analysis, as well as with the survey in different cities and comparison of the identified satisfaction factors based on the survey of residents of these cities. The research will not only give an idea of the applicability of analysis methods to qualitative data, but will also be aimed at the formation of the scale of assessment of passenger satisfaction with public transport services, which will become part of the methodology serving to improve the quality of transportation. Thus, the works devoted to the issues of measuring the satisfaction of passengers of public transport are useful for the parties interested in finding solutions for the development of transport.

References


