THE MONITORING RESULTS OF ACCESSIBILITY OF THE TRANSPORT ENVIRONMENT FOR PEOPLE WITH DISABILITIES LIVING IN THE CITY OF RIVNE

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Abstract

This work is the result of research carried out by an initiative group in the city of Rivne to assess the accessibility of the transport environment for people with disabilities. The rights of people with disabilities to access transport services were researched by studying the accessibility of vehicles for people with disabilities. The monitoring was carried out by means of questionnaire method, conducted survey, registration (observation) and expert evaluation. The questionnaire was attended by 100 people, among them: disabled people with diseases of the musculoskeletal system (20 people); visually impaired people (28 people); hearing impaired people (22 people); parents of children with cerebral palsy and autism (30 people). The monitoring results are presented in the form of graphs, tables and diagrams. Based on the expert assessment, a summary table of recommended indicators for evaluating the accessibility of transport system elements was obtained. A list of priority measures was proposed to create an accessible urban transport environment. The results of the monitoring are the basis for further investigation of the problem of transportation of people with disabilities.

Keywords: people with disabilities; public transport; age structure; questionnaire method; transport network; transport environment

1. Introduction

A transport network is a collection of all communication routes that connect cities, towns and localities. It allows people to fulfill their needs through movement. Public transport is the basis of population mobility due to its spatial rationality, capacity and environmental friendliness [10].

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But not everyone can use the transportation system equally, especially in the city. The reasons for that are certain obstacles inherent in the transport infrastructure. The lack of adaptation of the transportation system to the needs of people with disabilities leads to discrimination of this segment of the population, to impossibility of their social realization and to practically absent labor activity (Figure 1).

Fig. 1. Obstacles to the movement of people with disabilities

The task of modern society is to ensure of people with disabilities to have the same rights and responsibilities as other members of society.

In real life the failure to implement the enacted legislation impedes the realization the rights of people with disabilities. They are faced with some signs of discrimination because the state does not provide availability of public transportation adapted to the needs of people with disabilities, special facilities for entry and exit of wheelchairs, or special social programs.

The development of the global community in recent years has provided the implementation of high requirements for the accessibility of social infrastructure for people with disabilities. This requirement is also relevant for transport infrastructure. According to the National Transport Strategy of Ukraine (up to 2030) the special attention is paid to the issue of improving the quality of passenger transport in accordance with EU legislation [15], including ensuring accessibility of transport services and creating a free environment for moving for all citizens including persons with disabilities and other low-mobility groups of the population.

To solve this problem, it is relevant to justify the directions of organization of transportation of people with disabilities by urban and long-distance passenger transport and to provide specific recommendations on the choice of vehicle fleet, its modernization and the formation of routes.

2. The Analysis of Known Studies

The works of scientists (Grisé Emily, Boisjoly Geneviève [9], Goltz G. [8], Lubin Andre, Deka Devajyoti [12], Wińska Monika, Gzik Aleksandra [18], Ewhrudjakpor Oi, Poliaková Adela, Poliak Miloš [7], Carmien Stefan, Dawe Melissa [5] and others) were devoted to the issues of formation of the city transport infrastructure and its optimization.

Grisé Emily, Boisjoly Geneviève and others [9] have developed a methodology that can be used by public transport agencies to organize an efficient public transport network for wheelchair users.

Lubin Andre, Deka Devajyoti [12], Bezyak Jill L., Sabell Scott A. and Gattis Robert H. [4] have exposed the role of public transportation in providing access to work for people with disabilities. Based on the surveys, the authors conclude that barriers to access to the public transport system are necessary.

Carmien Stefan and Dawe Melissa [5] reveal the results of the work of American scientists on the interdisciplinary project "Mobility for All". The project is aimed at creating conditions for people with disabilities who use public transport. The article presents the concept of organizing transportation systems that are accessible and easy to use for all segments of the population, including people with disabilities.

The analysis of these works gives us an idea of the main indicators of the work of passenger transport, operating costs for its maintenance, the methods of organizing urban transportation, the methodology for assessing the quality of transport services, etc. But the authors do not pay attention to the organization of transportation of people with disabilities that reduces to a certain extent the social orientation of these works.

The development of socialization of passenger transport has led to the emergence of interesting and meaningful studies, among which the works of Mun E. [13], Lillie Erin, Alvarado Beatriz E., Stuart Heather [11], Delmelle, E., Casas, I. [6], Naberushkina E. [14], Bennett Roger, Vijaygopal Rohini, Kottasz Rita [3], Ajmi Faiza, Abdallah Sawssen Ben, Othman Sarah Ben [1] are noted.

The analysis of these works made it possible to identify the main directions for improving the organization of the transport system for people with disabilities:

1. the development of standard transport service systems that will operate on the basis of information and communication technologies; the creation of mechanisms of economic incentives and the development of programs for ensuring the accessibility of vehicles [1];
2. carrying out logistic evaluation of objects [9, 4, 2];
3. the application of a model of a logistic system for servicing people with disabilities by urban transport that is based on the analysis of links of the logistics chain of movement of people with disabilities from departure to destination point [6, 11, 3];
4. the increase in the number of low-floor passenger vehicles [13, 15].

Nevertheless, research into the organization of transportation services for people with disabilities is not sufficiently covered in the literature, despite changing attitudes towards people with disabilities. There are practically no systematic studies of this issue that would take into account the influence of all external factors on the formation of indicators of quality of transport service. The systematic approach will allow to form a model of the organization of transport service and to optimize the cost of transport support from the point of view of carriers and customers of passenger transportation.

The basis for the construction of this model was a monitoring research of the access of people with disabilities to vehicles. The results of this research are summarized in this article.

3. The Main Purpose of the Monitoring Research

The purpose of monitoring the accessibility of transport services for people with disabilities is the creation of a basis for systematic analysis and synthesis of processes that develop in the system "transport - person" with emphasis on identifying the basic principles of its functioning, the nature of contradictions and the causes that lead to the problem in the logistics system transportation of people with disabilities. The results of the monitoring are the basis for establishing a list of measures to improve transport services.

4. Research Methodology

In order to study the accessibility of vehicles for people with disabilities, a working group was organized to monitor of the realization of the rights of people with disabilities to have access transport services. Monitoring was carried out by means of questionnaire method, conducted survey, registration (observation) and expert evaluation.

The required number of respondents was determined by the formula:

$$n = \frac{Z^2 \cdot N \cdot \rho \cdot q}{(\Delta^2 \cdot N + Z^2 \cdot \rho \cdot q)} \tag{1}$$

where:

n – the sample volume; Z – the coefficient of confidence, which is determined by the table of critical points of normal distribution (95% with a marginal error of 10%); N – the general population (6537 people); ρ and q – selective fractions; Δ – the margin of error of representativeness (0.05).

We have the required sample size of 95 people.

The questionnaire was attended by 100 people including people with disabilities.

Target monitoring group:

1) disabled people with diseases of the musculoskeletal system (20 people);
2) visually impaired people (28 people);

3) hearing impaired people (22 people);
4) parents of children with cerebral palsy and autism (30 people).

The age structure of the monitoring group is shown in Figure 2 (Figure 2 takes into account the age of children of the fourth monitoring group).

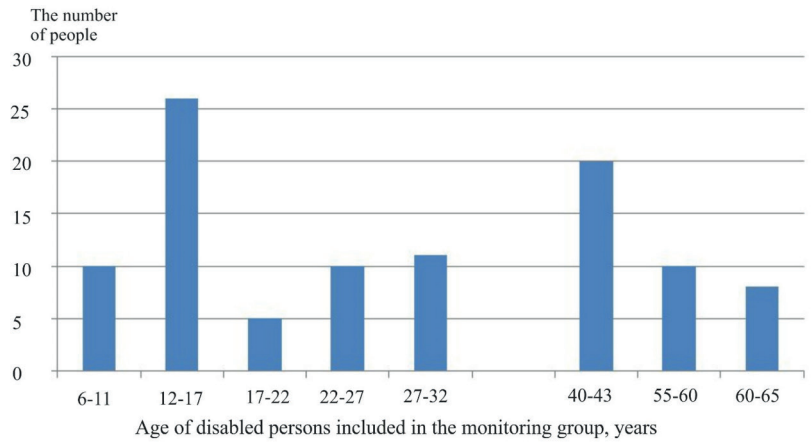

Fig. 2. The age distribution of the monitoring group

The monitoring group included 67 women and 33 men.

The workload of the monitoring group was evaluated for the (18-65) years (Figure 3).

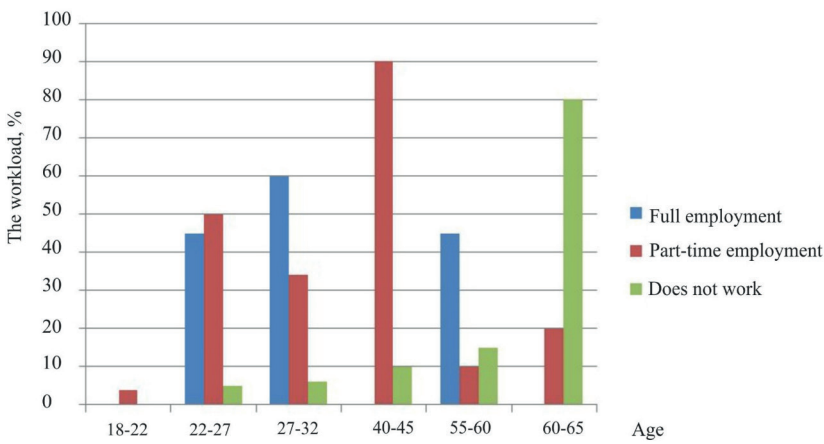

Fig. 3. The workload of the monitoring group

The conducted survey also identified what modes of transport are preferred by the members of the monitoring group (Figure 4).

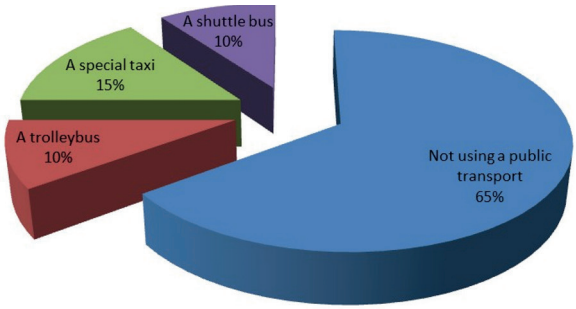

Fig. 4. Types of transport used by people with disabilities

One of the key tasks of monitoring is assessing the level of accessibility of the environment for people with disabilities. Accessibility means giving all members of society, including people with disabilities, equal access to facilities and services, including transportation. Members of the working group and the monitoring group were involved in assessing the availability of monitoring. The following elements of the logistics system were selected for evaluation:

- transport park;
- transport interchanges;
- individual transport;
- specialized transport (property of organizations of disabled people);
- pedestrian crossings;
- parking places for transport;
- system of organization of transportation.

The expert assessment of accessibility of people with disabilities to transport services was carried out in three stages:

1. Preparatory stage: formation of the expert commission and selection of the nomenclature of indicators of accessibility of transport park, transport interchanges, individual transport, specialized transport (property of organizations of disabled people), pedestrian crossings, parking places of transport, systems of transportation organization, which are subject to expert evaluation.
2. Stage of expert evaluation: selection of the procedure for assigning expert evaluation and interviewing experts.
3. Stage of mathematical and statistical processing of the received data: generalization of individual expert assessments, determination of consistency of individual expert assessments and objectivity of collective expert assessments.

The first stage. The nomenclature of accessibility indicators was used to perform the first stage. It should be noted that there is no indicator that can estimate the accessibility of the transport environment, as shown by the analysis of known methods ([17, 2]). Therefore, the list of evaluation criteria was adopted by a monitoring group comprising lecturers of the Department of Transport Technologies and Technical Services of National University of Water and Environmental Engineering, Rivne, Ukraine).

The expert evaluation was carried out according to the following criteria:

1) the safety of transportation;
2) the possibility of injury;
3) the mobility of the population;
4) culture of transport service;
5) the quality of transportation;
6) the degree of adaptation of vehicles;
7) the degree of adaptation of pedestrian crossings;
8) the degree of adaptation of stops and parking to the needs of people with disabilities.

It is known that for the expert method it is advisable to select experts who should be highly qualified specialists in this field. Seven experts were involved in the expert evaluation: two teachers, three representatives of the disability union and two chief engineers of transport enterprises.

The second stage. At this stage of the expert evaluation, ranking of the indicators involved in the accessibility assessment was conducted.

The ranking of the data was carried out by seven experts for eight objects of examination. The results of the expert evaluation, namely the ranking of the individual quality indicators of the studied standardization entities, were presented in the form of tables computing the sum of their Ri grades.

In the third stage, the estimation of the overall consistency of the experts' opinions was expressed by the coefficient of concordance K_u, which was calculated by the formula:

$$K_u = \frac{12 \cdot S}{n^2(m^3 - m)} \tag{2}$$

where: S – the sum of the squares of the deviation of the sum of the ranks of each object of examination from the average sum of the ranks; n – the number of objects; m – the number of observations.

To calculate this indicator, it was determined the square of deviations for each parameter Δ_i^2 (formula 3) and the total sum of squares of deviations S (formula 4).

Deviation of sum of the ranks of each accessibility criterion is:

$$\Delta_i = R_i - T \tag{3}$$

$$S = \sum_{i=1}^{m} \Delta_i^2 \tag{4}$$

where: R_i – the sum of ranking evaluation of experts on each criterion i - m; T – the average sum of ranks.

The obtained value of the coefficient of concordance was evaluated for significance using the Pearson coefficient, by multiplying it by the number of experts and the number of freedoms (n-1). The result obtained was compared with the table value [16].

In order to identify the most significant individual indicators of accessibility of the transport environment, the coefficients of gravity are calculated:

$$q_i = \frac{R_i}{\sum R_i} \tag{5}$$

Then direct measurements were made of the weighting factors of each accessibility indicator in order to establish their significance. The weight of each indicator q_i was calculated by the formula (5), and the weighting factors q_{i0} of the significant indicators for which the condition $q_i > 1/m$ was satisfied was calculated by the formula (6).

The determination of the weighting factors of the significant indicators q_{i0} made it possible to select the most significant of all m indicators.

$$q_{i0} = q_i^* / \sum_{i=1}^{m} q_i^* \tag{6}$$

where: q_i^* – the weighting factor of the most significant indicators for which the condition $q_i > 1/(m.)$ is satisfied.

5. The Monitoring Results of the Transport System

Conducted surveys showed that 80% of people with disabilities in the 60-65 age range are unemployed and 20% - are only partially employed. People with disabilities in the 22-27 age range are better employed, and these members of society need accessible vehicles. The main reasons why people with disabilities do not work are: 34% – their health status, 45% – transport barriers and only 21% for other reasons.

The results of the expert assessment of the accessibility of the transport environment are given below. Before evaluating accessibility, it was necessary to sort evaluation criteria chose by us.

Table 1 – Expert assessment of accessibility of the transportation system for people with disabilities

Experts	Ranking evaluation of indicators								Sum
	1	2	3	4	5	6	7	8	
1	2	5	3	4	2	0	0	0	16
2	2	6	3	4	2	0	0	0	17
3	2	6	4	5	3	0	0	0	20
4	2	6	4	5	3	1	1	1	23

Table 1 – Expert assessment of accessibility of the transportation system for people with disabilities, cont.

Experts	Ranking evaluation of indicators								Sum
5	2	6	4	5	3	1	1	1	23
6	3	6	4	5	2	0	0	0	20
7	2	6	4	5	3	0	0	0	20
The sums of ranking evaluation of each expert	15	41	26	31	18	2	2	2	137
Arithmetic mean									19.57
The difference between the sum of expert evaluation and the arithmetic mean	-4.57	21.43	6.43	11.43	-1.57	-17.57	-17.57	-17.57	
Square of difference	20.88	459.24	41.34	130.64	2.46	308.7	308.7	308.7	1580.7
The coefficient of concordance									0.77

The value of the coefficient of concordance is 0.77, which indicates a high consistency of opinions of experts.

Let us check its significance according to the Pearson criterion: 7 0.77 (8-1) = 37.73. The Pearson table criterion at 1% significance level is 18.5 and at 5% it is 14.1. Both are smaller than the calculated value. That is, at a significance level of 1%, a significant calculated coefficient of concordance is accepted.

Similarly, a ranking evaluation was conducted for indicators of assessing the availability of the following elements of the logistics system: transport park, transport interchanges, individual transport, specialized transport (property of organizations of disabled people), pedestrian crossings, parking places of transport.

The data analysis of the Table 1 shows that for most experts the main indicators of accessibility of the system of transportation for people with disabilities are the possibility of injury and the culture of transport services. All other indicators were less important, having received lower rankings.

The results of the mathematical calculations of the weighting factors of each indicator of accessibility of the transportation system for people with disabilities are presented in the Table 2 and the diagrams in Figure 5.

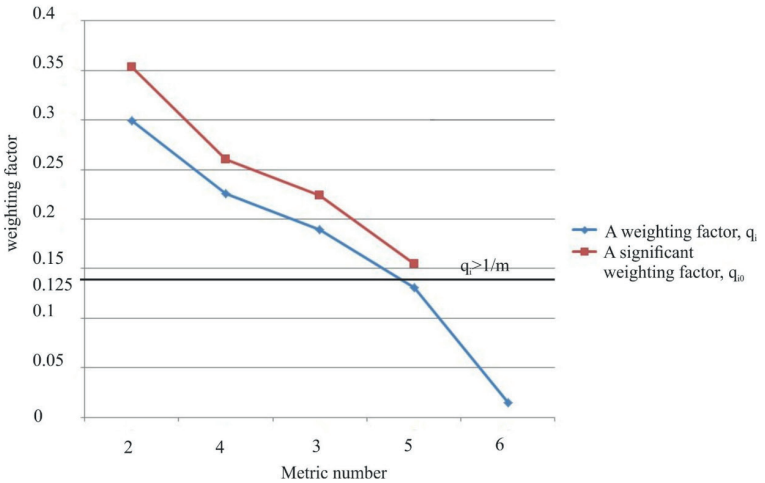

Fig. 5. Scale of order to determine the significance of the weighting factors of importance of the accessibility indicators of the transportation organization system

Expert evaluation of other elements of the logistics system was carried out similarly. Below are the results of the calculations of the weighting factors of each availability index of transport park and transport interchanges (Figures 6, 7). Indicators 1, 2, 3, 4, 5, 6, 8 and 1, 2, 3, 6, 8 were used for evaluating.

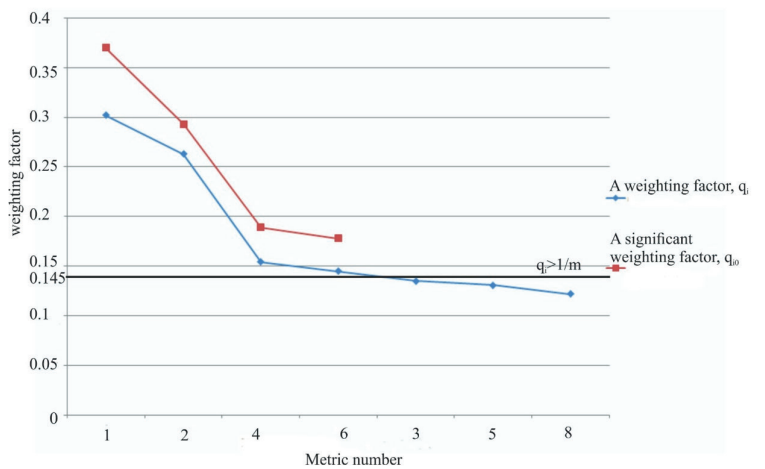

Fig. 6. Scale of the order to determine the significance of the weighting factors of the indicators of availability of transport park

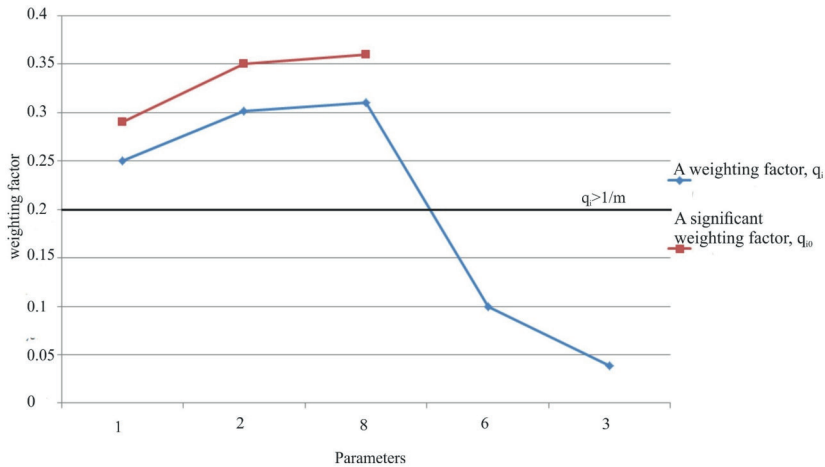

Fig. 7. Scale of the order to determine the significance of the weighting factors of the indicators of accessibility of the transport interchanges

Analyzing the results of the calculations made by the expert method, it could be concluded that the most significant weighting factors of the above indicators for the system of transportation for people with disabilities are: q_{20}=0.353, q_{40}=0.267, q_{30}=0.224, q_{50}=0.155 – the possibility of injury; culture of transport service; mobility of the population; quality of transportation; and for transport park are: q_{10}=0.37, q_{20}=0.263, q_{40}=0.189, q_{60}=0.178 – safety of transportation; the possibility of injury; culture of transport service; the degree of fitness of the vehicles; for the availability of transport interchanges are: q_{10}=0.29, q_{20}=0.35, q_{80}=0.36 – safety of transportation; the possibility of injury; the degree of adaptation of stops and parking to the needs of people with disabilities. These indicators indicate the level of availability of elements of the logistics system.

The generalized results of assessing the accessibility of the transport system by the expert method are shown in Table 2.

Table 2 – Indicators for assessing the accessibility of the transport system obtained by the expert method

Elements of the transport system	Availability metrics are in order of decreasing importance q_{i0}
transport park	safety of transportation; the possibility of injury; culture of transport service; the degree of fitness of the vehicles.
transport interchanges	the degree of adaptation of stops and parking to the needs of people with disabilities; the possibility of injury; safety of transportation.

Table 2 – Indicators for assessing the accessibility of the transport system obtained by the expert method, cont.

individual transport	the degree of fitness of the vehicles; safety of transportation; mobility of the population; the degree of adaptation of stops and parking to the needs of the disabled.
specialized transport (property of organizations of disabled people)	safety of transportation; the degree of fitness of the vehicles; mobility of the population.
pedestrian crossings	the degree of adaptability of pedestrian crossings; the possibility of injury.
parking places of transport	the degree of adaptation of stops and parking to the needs of people with disabilities; culture of transport service; the possibility of injury.
system of organization of transportation	the possibility of injury; culture of transport service; mobility of the population; quality of transportation.

From a scientific point of view, these results cannot be considered highly accurate given the subjectivity of evaluation. But these results are adopted by us to formulate conclusions on the results of monitoring and directions for improving the transport environment in the absence of the methods for the accessibility assessment of the environment.

6. Conclusions

The results of our monitoring have shown that Rivne's transport environment is characterized by a low accessibility for people with disabilities who are unable to move within the city on their own. A key problem for people with disabilities as regards using public transport is its unsuitability for people with physical disabilities. This problem leads to a limitation of the life of certain segments of the population, their high social dependence and low level of employment.

The monitoring has found that the main problems for making public transport available are:

- the lack of specialized facilities for people with disabilities;
- the unsuitability of public transport to the needs of people with disabilities, in particular the absence of low-floor transport, sound signals and other facilities;
- the unsuitability of stops for taking up and setting down of passengers with disabilities (lack of sound signals of the arrival of transport, tactile signs for orientation in space, etc.);
- the absence of special integral curbs on pedestrian crossings and sound signals of traffic lights that leads to a significant increase in the risk of emergencies.

A key task that needs to be solved for social equality of people with disabilities is creating a transport environment adapted to their needs. The following measures are proposed to solve this problem in Rivne:

- Introduce the fixed public transport routes to ensure access to transport services for people with disabilities.
- Equip city stops with an electronic scoreboard with accessibility map of city transport services which will contain information about the movement of vehicles equipped with sliding ramps. Provide a duplicate map for visually impaired passengers by the Braille code stand.
- Provide sound signals to all types of passenger transport.
- Equip public transportation stops and pedestrian crossings with accessibility requirements for people with disabilities.
- Equip electronic boards of the schedule of traffic with sound signal.
- Carry out tenders for the carriage of passengers with disabilities taking into account the requirements for equipping the transport with devices for people with disabilities (platforms, voice messages, signal buttons, etc.).

The conducted monitoring studies are the basis for further investigation of the problem of transport service for people with disabilities. In the course of further research it is planned to justify the model of organization of transport service and optimize the costs of transport support from the point of view of carriers and customers of passenger transportation.

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