Hindawi
Discrete Dynamics in Nature and Society
Volume 2021, Article ID 7430340, 13 pages
https://doi.org/10.1155/2021/7430340

Research Article

Mobility Analysis of Persons with Disabilities

Miodrag Počuč,[1] Valentina Mirović,[2] Jelena Mitrović Simić,[2] and Caglar Karamasa[3]

[1]*Adomne Ltd., Designing and Engineering, Novi Sad, Antona Čehova 1, 21000 Novi Sad, Serbia*
[2]*University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia*
[3]*Anadolu University, Faculty of Business Administration, Eskişehir, Turkey*

Correspondence should be addressed to Jelena Mitrović Simić; mjelena@uns.ac.rs

Received 23 September 2021; Revised 30 October 2021; Accepted 29 November 2021; Published 16 December 2021

Academic Editor: Dragan Z. Marinkovic

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This study presents the results of the research on travel behaviour for persons with different types of disabilities. Persons with disabilities are a group of participants with specific traffic requirements often not included in traffic research and consequently adequate planning of urban transport. To obtain the data, a home interview was conducted on a representative sample. The paper presents the main results of the research and indicates the specificity of the requirements of this group of users. The results are compared with the results of the same research conducted for the development of the Smart Plan of Novi Sad and the results of similar research abroad. The main goal is to obtain a qualitative and quantitative database of the requirements of this group of users as a basis for creating sustainable urban mobility plans.

1. Introduction

People with different types of disabilities, as a specific group of traffic system users, have been neglected quite often in the previous traffic studies [1, 2]. Their socioeconomic characteristics and the specificity of the requirements they have in relation to the traffic system in most cities in Serbia and the wider region are unknown to the community of experts. Due to the lack of adequate information on the scope and specificity of travel requirements of this user group, most traffic development plans only symbolically, without reliable effects, deal with the proposal of measures to improve traffic conditions for persons with disabilities.

The fact that there really are certain requirement specifics is indicated by the research results in the developed cities in Europe and around the world [3–7]. The available data thus show that persons with disabilities (PWDs) make fewer trips compared to persons without disabilities, and those trips are made for different purposes, compared with the usual travel distribution. On the other hand, the PWDs' group itself is quite heterogeneous in terms of the characteristics of traffic requirements, especially when taking into account the type of disability and age.

In the Republic of Serbia, PWDs have not been explicitly covered by previous traffic studies, so the characteristic needs, requirements, and manner of their participation in traffic were still largely unknown to the community of experts. In that sense, the basic problem of the research is the lack of information base, necessary for determining the behavioural pattern of PWDs in traffic. Such a situation quite often resulted in the application of inappropriate solutions in practice, which only further excluded this user group from traffic. To generally improve the accessibility of the traffic system to all citizens, the City of Novi Sad in 2018 created a traffic study [8], which was conducted through a survey of PWDs (residents of Novi Sad and the suburbs). A home interview was conducted on a representative sample to collect data. The mentioned research conducted in Novi Sad created an appropriate information base and determined the basic laws and characteristics of the travel demand of PWDs, but also their attitudes regarding the improvement of the traffic system in the city. The paper presents the main results of the research and indicates basic trip characteristics for persons with different types of disabilities. The obtained information base is compared with the existing data collected by an extensive research of traffic, organized during

2009 [2] and 2017 [1], and the results of a similar research abroad, which is an additional value of this study.

2. Literature Review

According to the research conducted in the United Kingdom [3], the mobility of PWDs averages 1.9 trips/day, compared with 2.7 trips/day, which is the average mobility of persons without disabilities. Also, PWDs make shorter trips, both in distance and in duration. If the age categories are observed, it is noticed that the average mobility of PWDs decreases with age. Looking at travel purposes, PWDs perform fewer business trips than nondisabled people, but have a higher share of trips with other purposes, such as shopping and private reasons. Almost two thirds of PWDs travel by passenger car (as drivers and as passengers), but they participate in the distribution of trips more often as passengers than as drivers compared to persons without disabilities, although more than half of the respondents have a driver's license. When it comes to choosing the mode of transport, there is also a significant impact of age categories in the United Kingdom. For example, in PWDs over 70 years of age there is significantly lower presence of walking (14%) compared with all other age categories in total (21%). According to this research, the percentage of persons without disabilities in that case is identical (20%). A similar structure is observed in the case when people travel as passenger car drivers. Almost 40% of PWD employees who travel to work by car every day stated that they would not change the current mode of transport [3].

A similar pattern of behaviour was observed in the results of a survey of the travelling characteristics conducted in France, in which about 20 thousand households participated [4]. In particular, it was determined that PWDs who stated that they had certain difficulties when travelling, on average made only 1.8 trips/day, compared with the daily mobility of persons without disabilities, which in France is 3.3 trips/day. In this research [4], the average travel time of the respondents was also analysed, which averaged 18 minutes for PWDs, compared with 20.3 minutes for the total population. Observing the distance from the destination, about 48% of the respondents made trips that are within the same municipality, while that percentage for people without disabilities is about 60%.

The travel characteristics of PWDs determined by many research projects conducted in the USA [5] are similar to European countries. This similarity refers to daily mobility and other travel characteristics such as the distribution of trips regarding their purpose and temporal distribution. According to one conducted analysis based on the results of the National Household Travel Survey [9], PWDs have an average daily mobility of about 2.6 trips/day, compared with 3.6 for people without disabilities. In the age category over 65, there is an even greater difference in mobility compared with the rest of the population (2.1 compared with 3.5 trips/day). In terms of the distribution of trips by purpose, PWDs make fewer business trips, as well as trips for the purpose of recreation and entertainment, but have a higher share of trips for the purpose of shopping and medical appointments, compared to persons without disabilities. During the analysis of travelling records, it was determined that as much as one third of PWDs did not make any trips during the day when the research was done, while that percentage of other respondents was 13.4%. Of the total number of PWDs who did not travel that day, over 36% answered that it was because they had disabilities or were "housebound." Regardless of the existence of disability, the most common mode of transport is a passenger car. PWDs travel more often as passengers than as drivers compared with the rest of the population (38.9% compared with 16.1%) [5]. After cars, the second most common type of transport is walking/on foot, and it has been shown that a higher percentage of public transport is used by PWDs. The average length of trips is in line with the previous research results conducted in Europe and also shorter for PWDs. When faced with a travel problem, PWDs usually ask other people to take them to a specific destination, restrict their day trips, or use special passenger transportation services such as ride hailing or taxi rides. [5]. Also, taking into account all modes of transport, persons with disabilities, due to their disability, stated that they used a passenger car less often than they would like [6]. The same research found that public transportation is the first alternative to a car, more often than walking or cycling. However, even when riding on a bus, PWDs face certain obstacles in using this type of transport. The most common reasons are as follows: access to the public transport stop, getting on or off the bus, stopping while waiting for the bus, and getting up/sitting down. However, of all respondents who stated that they had a problem when travelling by public transport, about 31% of them still regularly use this type of transport [5].

In the available literature, one can also find a number of studies that have considered the trips made by persons with a special type of disability, i.e., as one homogeneous group, to establish special behavioural patterns for that group [7, 10–13]. These studies mainly focus on persons with physical disabilities or people with limited sensory abilities. In a study conducted in Japan [7], the trips of visually impaired people were analysed and it was determined that the average daily mobility was 1.6 trips/day, compared with the mobility of persons without disabilities, which was 2.3 trips/day. Of the total number of trips made, 52% of trips were made independently. The trips were most often made on foot (33%) and then by car (27%), train (21%), public transport (14%), taxi (4%), and bicycle (1%). However, in 80% of the journeys made by passenger car, the respondent was accompanied; that is, they participated as a passenger and not as a driver.

A small number of studies have addressed the characteristics of travel for people with developmental disabilities, but the conclusion of most research [10, 11, 14] is that traffic is a key factor determining the level of independence and their ability to travel for a specific purpose and social inclusion. A study conducted in the US state of Minnesota found that the most common form of transportation in this category is a passenger car (as a passenger), walking, public transportation, and, finally, a ride hailing service [11]. A number of respondents expressed a desire for a greater use of

public transport with an explanation that this would further increase their independence in making their trips. In addition, most respondents needed help with work-related trips and shopping. The results of the logistic regression model [11] are in accordance with the previous conclusions, showing that the reasons why persons with disabilities are unable to travel relate to the frequency of travel and the fact that they are public transport users who want to travel for shopping, leisure, and entertainment. The accessibility analysis of public transport facilities has shown that it is extremely important to locate residential facilities of this category of passengers in the areas with well-developed traffic infrastructure, which would lead to greater independence when making trips. In addition to the above, poor reliability of public transport, insufficient number of departures, and difficulties in understanding and interpreting timetables are listed as frequent obstacles to the use of public transport by persons with disabilities.

On exploring new forms of mobility and app-based ride hailing services, such as Uber, the results of 2017 National Household Travel Survey [15] show that adults with disabilities use app-based ride hailing at a much lower rate than adults without disabilities. The authors concluded that it was because persons with disabilities are older, have lower incomes, and live less in larger cities, but even when controlling for these factors, having a disability predicts lower use of app-based ride hailing, which suggests that these new services may not be sufficiently accessible to persons with disabilities.

For the current worldwide topics, such as the COVID-19 pandemic, a large number of studies have recently been conducted examining the impact of COVID-19 on PWDs [16–18]. Findings from those studies suggest that the pandemic is increasing many difficulties with accessing transportation, as well as other essential goods and services that persons with disabilities always face. Travelling during the COVID-19 pandemic is especially challenging for PWDs who use public transportation services more than personal vehicles. Moreover, limited transportation and lower daily mobility put persons with disabilities at increased risk from experiencing social exclusion.

3. Field and Methodology of Research

The survey was conducted exclusively with the citizens older than 6 years and with some kind of disability, not only due to the fact that it is a group of participants whose requirements and characteristics of movement can be considered relevant in some way, but also due to the fact that they have specific requirements regarding their traffic participation. The aim of the research was not to single out PWDs in any way, nor to adapt the traffic system to one group of users, but to additionally acquaint the community of experts with the requirements, needs, and ways of the PWDs' mobility to improve the city traffic system for all citizens.

The data collection included the PWDs living in the area of the City of Novi Sad and its suburbs. Novi Sad, the capital of Autonomous Province of Vojvodina, is in the group of towns of the Danube Region. Due to its favourable geographic position (Figure 1) and good transport links, it has become a dominant socioeconomic center for Vojvodina—in many ways a specific macro-regional and administrative part of the Republic of Serbia. It is the second largest town in Serbia, home to significant scientific, research, and development and professional organizations, and numerous medical, cultural, and educational institutions.

In addition to the urban part of the city, including the settlements of Novi Sad, Petrovaradin, and Sremska Kamenica (with a total of 300 traffic zones), the research also included the settlement of Veternik (with 3 external traffic zones), which is not part of the urban area of the city, but whose citizens were encompassed by the previous surveys as well, conducted during 2009 and 2017.

Great care was taken to include as many zones as possible to be distributed in all parts of the city and populated places where the research was done by applying partial proportionality and designed maps with traffic zones and districts to obtain a complete travel network in as many traffic zones and associated districts as possible. Methodology steps of the research process are shown in Figure 2.

The survey was conducted during May 2018, on official working days (Tuesdays, Wednesdays, or Thursdays) and nonworking days (Saturdays or Sundays). The research implementation was of an exclusive field character and was performed on a random sample with the application of a methodological step. This imposed the need for the interviews to be conducted in person, in the homes/apartments of persons with disabilities, which required a lot of work and a large number of field contacts. At the same time, it brought additional quality to the research in the sense that, in that way, the application of all methodological requirements was made possible, with the complete anonymity and voluntariness of the respondents.

The field researchers conducted an interview with the research participants using a semi-standardized and multistage questionnaire, which consisted of three segments:

(i) The first part contained a group of questions that collected socioeconomic data on the research participants and their household, including those factors decisive for choosing the means of travel and opportunities for greater mobility of PWDs (Figure 3);

(ii) The second part was a diary of their 24-hour travel, during one working day (Figure 4); and

(iii) The third part was a diary of 24-hour travel of respondents, during one nonworking day (Figure 4).

The 24-hour travel diary was filled in for the previous working day from the day of the survey, for Tuesdays, Wednesdays, or Thursdays, while the nonworking day diary was kept for Saturday or Sunday. The method of sample design, sample size, and randomness of the application of the methodological step (Figure 2), with the application of the research reserve, facilitated the analysis of the obtained data by territorial distribution by gender, age, education, occupation, and type of disability.

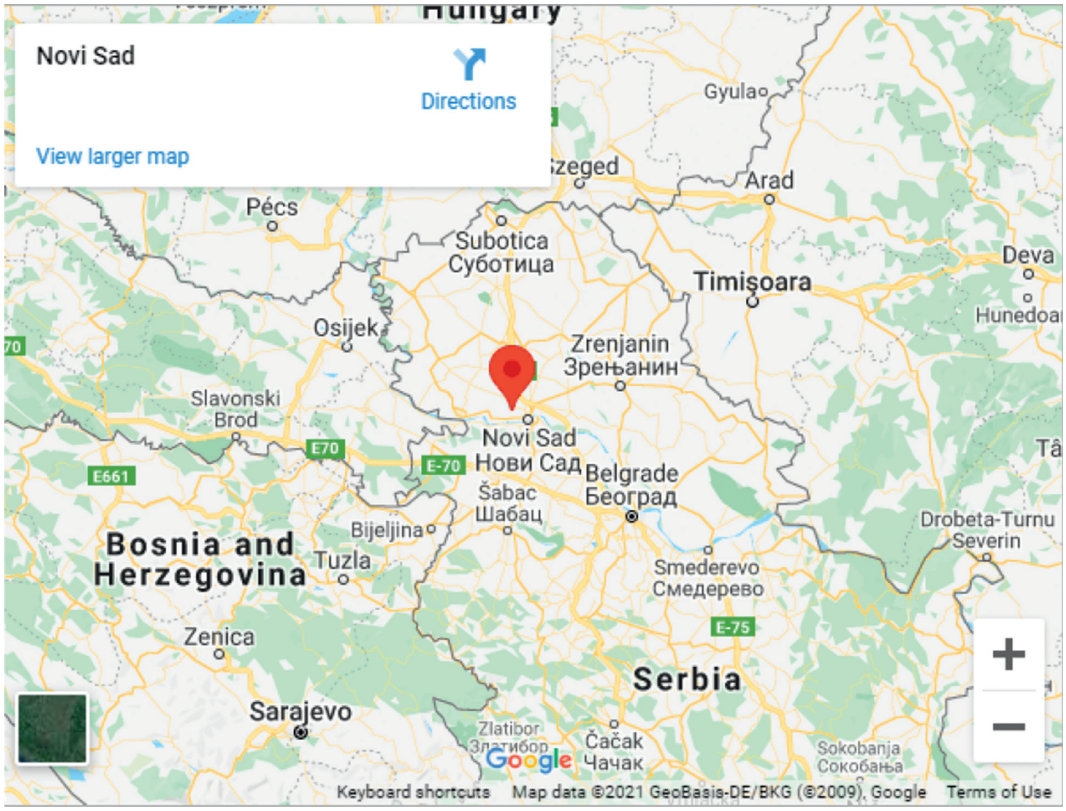


Figure 1: Location of Novi Sad.

4. Analysis of Collected Data

The first segment of the instrument used in the survey of the PWDs facilitated the collection of basic socioeconomic data necessary for further analysis and better understanding of the basic rules and characteristics of the PWDs' travel in the City of Novi Sad and its settlements. With that aim, the following data were analysed: the structure of respondents by gender, age, education, occupation, work-related status—employment, number of household members, apartment size, and disability types. Also, the basic characteristics of their participation in traffic in terms of use of mobility aids, types of aids, independence in movement, persons with whom they travel, and also the possession of a driver's license and/or means of transport were analysed as well (Figure 3).

The second and third segments of the questionnaire, which referred to the 24-hour travel diary of PWDs, provided the collection of the data that can be used to determine all the basic travel characteristics. The data refer to mobility, distribution of trips by purpose, distribution of trips by means of transport, travelling time distribution, and also the length and average duration of a trip. Using the crossover study of the data obtained in this way (from the travel diary) with the previously obtained socioeconomic characteristics, it was possible to determine a large number of different typical elements of the PWDs' participation in traffic. Additionally, it was possible to recognize the problems they face by gender, education, age, occupation, employment, types of disability, and aids or means of transport they use (Figure 4).

The attention was focused on the analysis of travel characteristics of those groups of PWDs with specific requirements in terms of travel. To cover as wide a number of respondents as possible, the data for the mobility aids users (e.g., wheelchair, cane, crutches, walker (and/or similar), and white cane) were analysed regardless of the type of disability, together with the persons who do not use mobility aids and are not independent in their movement/participation in traffic (Figure 5).

Thus, the focus was not exclusively on the types of disabilities, but on the groups of respondents who, due to the (non)existence of certain (pre)conditions in traffic, have difficulties in terms of mobility (independently or accompanied) and making trips.

4.1. Socioeconomic Characteristics of the Respondents. When it comes to the structure of the respondents by gender, the obtained data show that there are an approximate number of men (46.1%) and women (53.9%), although the research used the method of random sampling without quota sampling.

The representativeness by gender was also achieved at the level of the total realized sample, but also observed by settlements in which the research was conducted. The persons with disabilities are evenly distributed in all four places where the research was conducted. All age groups were represented among the respondents, with the PWDs younger than 6 years excluded from the research (Figure 6). The persons from the oldest age group participated in the research the most. The members of other age groups were relatively evenly

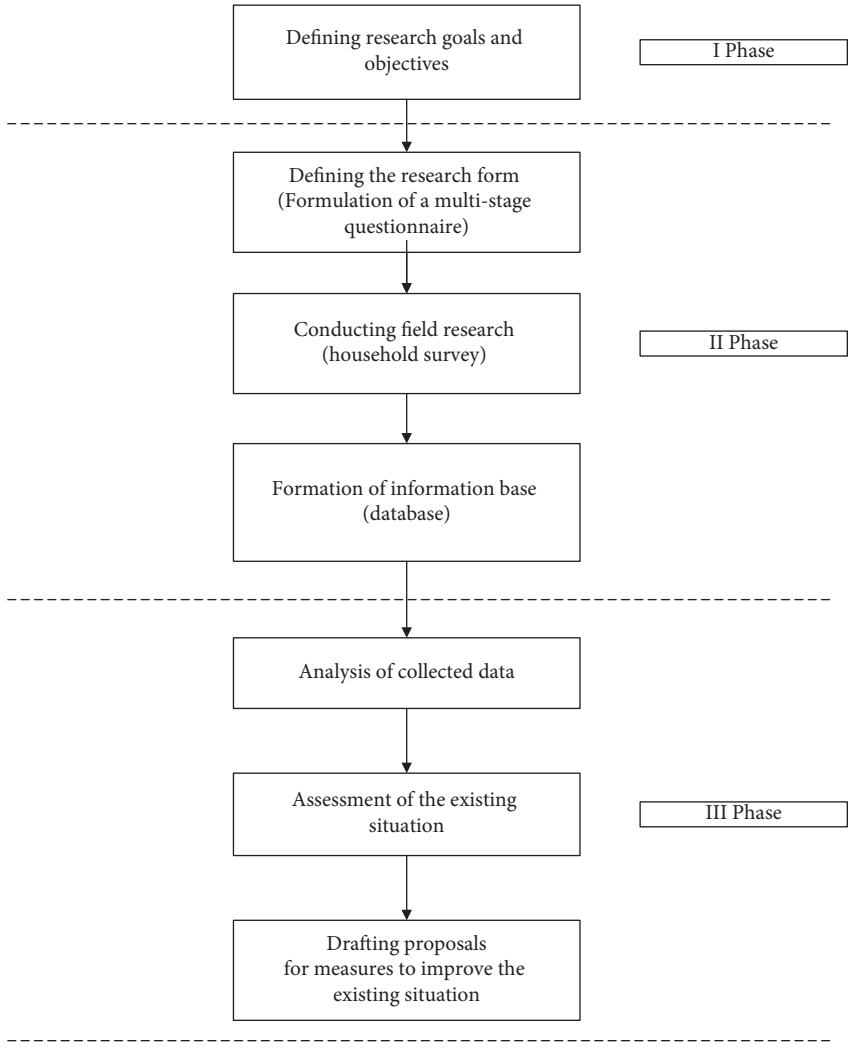


Figure 2: Research process flowchart.

distributed across all age strata except the respondents aged 15, 16, and 17. Their presence in the sample is significantly lower, due to the fact that this age group spans only three years, while other strata span 7 to 10 years.

Regarding the educational status of the respondents, the results show that 16.4% of them are without primary school education, 7.8% have primary school education, and more than half of the respondents have completed high school or have some sort of trade occupation—55.5%, 7.8% have a two-year college, and a bachelor/master's degree was completed by 12.5% of respondents. Among the respondents in the completed sample, there were no persons with a Magister degree or a PhD.

The employment status analysis shows that only 7% of respondents are employed, while as many as 93% of respondents are unemployed, i.e., with different current statuses such as preschoolers, pupils, students, or other unemployed/unskilled persons or pensioners. There is a significantly higher representation of pensioners than the participation of pensioners in the adult population of Novi Sad and the surrounding settlements. These data are not surprising, given that this is the population of PWDs and it is expected that there will be a significantly higher representation of pensioners among them, given that disability is often associated with age.

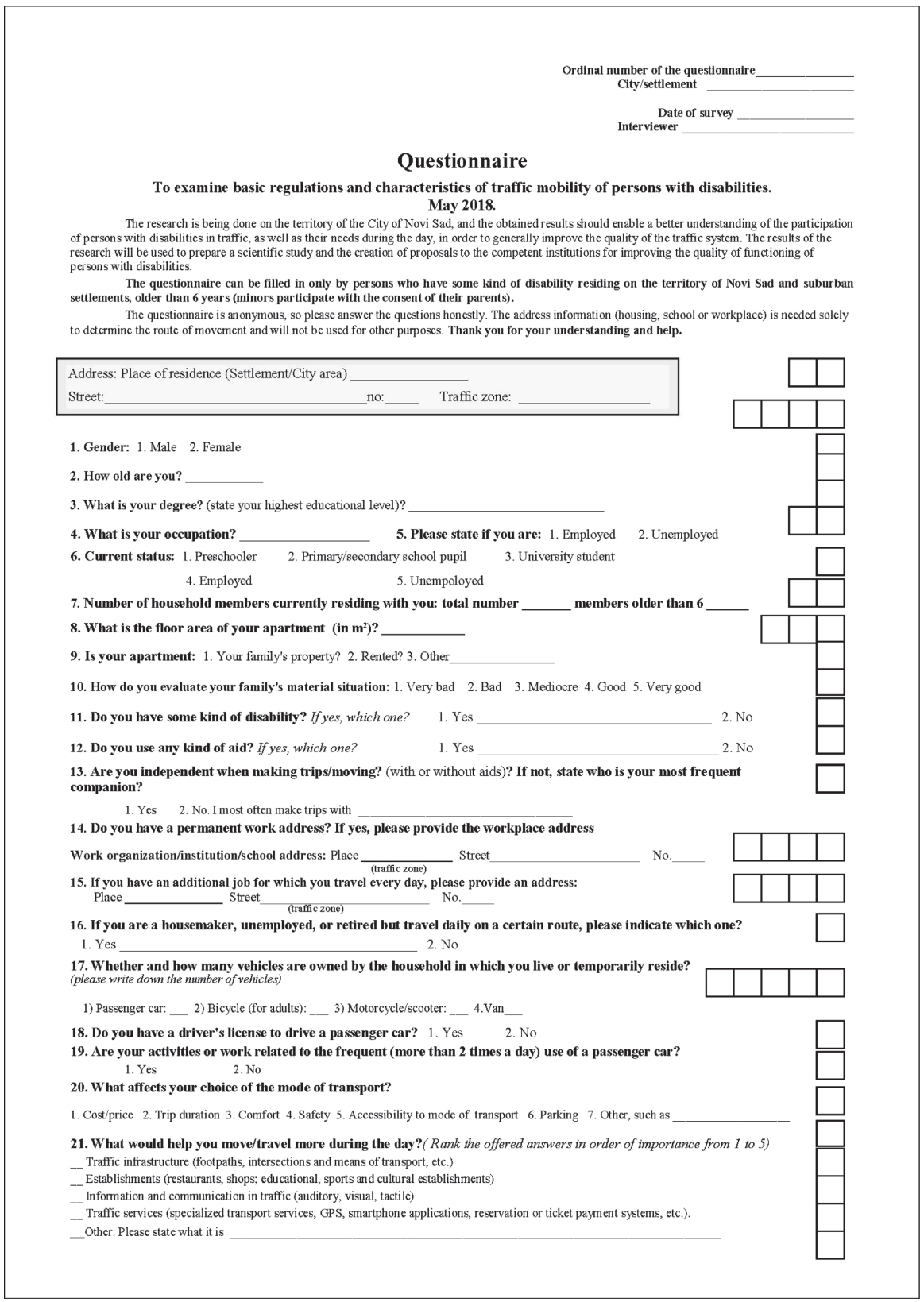
The most of respondents rated their financial situation as a mediocre or bad (Figure 7).

Of a total of 128 respondents, only 18% of respondents have a driver's license.

In terms of independence, 43% of respondents are independent when travelling (with or without the use of aids), while the remaining 57% of respondents are not independent regardless of the use of aids.

4.2. General Travel Characteristics. When it comes to the volume of travel, according to the data from the travel diaries, during one working day (24 hours) in the covered territory, the respondents made a total of 414 trips, of which 14 passengers (11%) did not make any trips that day.

Based on the thus determined volume of movement, mobility, i.e., the average daily number of PWD trips in the observed area, is 3.23 trips per capita per day (Table 1). Of these groups, the least mobility is possessed by the persons



Ordinal number of the questionnaire_____
City/settlement _____

Date of survey _____
Interviewer _____

Questionnaire

To examine basic regulations and characteristics of traffic mobility of persons with disabilities.
May 2018.

The research is being done on the territory of the City of Novi Sad, and the obtained results should enable a better understanding of the participation of persons with disabilities in traffic, as well as their needs during the day, in order to generally improve the quality of the traffic system. The results of the research will be used to prepare a scientific study and the creation of proposals to the competent institutions for improving the quality of functioning of persons with disabilities.

The questionnaire can be filled in only by persons who have some kind of disability residing on the territory of Novi Sad and suburban settlements, older than 6 years (minors participate with the consent of their parents).

The questionnaire is anonymous, so please answer the questions honestly. The address information (housing, school or workplace) is needed solely to determine the route of movement and will not be used for other purposes. **Thank you for your understanding and help.**

Address: Place of residence (Settlement/City area) _____
Street:_____no:_____ Traffic zone: _____

1. Gender: 1. Male 2. Female

2. How old are you? _____

3. What is your degree? (state your highest educational level)? _____

4. What is your occupation? _____ **5. Please state if you are:** 1. Employed 2. Unemployed

6. Current status: 1. Preschooler 2. Primary/secondary school pupil 3. University student
4. Employed 5. Unempoloyed

7. Number of household members currently residing with you: total number _____ members older than 6 _____

8. What is the floor area of your apartment (in m²)? _____

9. Is your apartment: 1. Your family's property? 2. Rented? 3. Other_____

10. How do you evaluate your family's material situation: 1. Very bad 2. Bad 3. Mediocre 4. Good 5. Very good

11. Do you have some kind of disability? *If yes, which one?* 1. Yes _____ 2. No

12. Do you use any kind of aid? *If yes, which one?* 1. Yes _____ 2. No

13. Are you independent when making trips/moving? (with or without aids)**? If not, state who is your most frequent companion?**

1. Yes 2. No. I most often make trips with _____

14. Do you have a permanent work address? If yes, please provide the workplace address

Work organization/institution/school address: Place _____ (traffic zone) Street_____ No._____

15. If you have an additional job for which you travel every day, please provide an address:
Place _____ Street_____ (traffic zone) No._____

16. If you are a housemaker, unemployed, or retired but travel daily on a certain route, please indicate which one?
1. Yes _____ 2. No

17. Whether and how many vehicles are owned by the household in which you live or temporarily reside?
(please write down the number of vehicles)

1) Passenger car: ___ 2) Bicycle (for adults): ___ 3) Motorcycle/scooter: ___ 4.Van___

18. Do you have a driver's license to drive a passenger car? 1. Yes 2. No

19. Are your activities or work related to the frequent (more than 2 times a day) use of a passenger car?
1. Yes 2. No

20. What affects your choice of the mode of transport?

1. Cost/price 2. Trip duration 3. Comfort 4. Safety 5. Accessibility to mode of transport 6. Parking 7. Other, such as _____

21. What would help you move/travel more during the day?*(Rank the offered answers in order of importance from 1 to 5)*

__ Traffic infrastructure (footpaths, intersections and means of transport, etc.)
__ Establishments (restaurants, shops; educational, sports and cultural establishments)
__ Information and communication in traffic (auditory, visual, tactile)
__ Traffic services (specialized transport services, GPS, smartphone applications, reservation or ticket payment systems, etc.).
__Other. Please state what it is _____

Figure 3: First part of the conducted questionnaire (Form 1).

Note: Movement means any change of place of residence (change of address) by a person older than 6 years, with a specific purpose (e.g. school, work, shopping, etc.), which is performed by any type of transport, including walking/on foot. For example: going home from work is one movement, while returning home from work is another movement. If you make one purchase when you return home, then three movements have actually been made (1. home-work, 2. work-shopping, 3. shopping-home.

FORM 2: Trips during working days (Tuesday, Wednesday or Thursday) from 00-24 hours!

22. No. of trip	23. Departure address?	24. Destination address?	25. Departure time?		26. Arrival time?		27. Type of establishment		28. Purpose of trip/mobility	29. Mode of transport	30. Why did you choose that mode of transport?	31. Was the trip made independently or with a companion?	32. Suggestion for improvement of transport
	Place and municipality (if outside Novi Sad), For Novi Sad (as precise address as possible: Settlement, street and number) * For professional drivers, private trips only	Place and municipality (if outside Novi Sad), For Novi Sad (as precise address as possible: Settlement, street and number) * For professional drivers, private trips only	Hour	Minute	Hour	Minute	1. House/apartment 2.Apartment/house of another person 3. Preschool/school/university 4. Industrial facility 5. Business establishment 6. Bank 7. City administration 8. Health/social institution 9. Retail business 10. Agricultural establishment 11. Cultural establishments 12. Catering facilities 13.Sports and recreation facilities 14. Stop stations (bus, train) 15.Other establishments		1. Regular job 2. School/University 3. House/apartment 4. Official visit 5. Shopping 6. Use of services 7. Going out/entertainment 8. Recreation/leisure 9. Transportation of another person 10. Private visit 11. Other	1. On foot (all the way) 2. Bicycle 3. Scooter/Motorcycle 4. Passenger car (driver) 5. Passenger car (passenger) 6. JGSP (specify lines by order) 7. Taxi 8. Bus, minibus 9. Train 10. Special transportation for people with disabilities 11. Mechanical wheelchair 12. Motorized wheelchair 13. Other	1. Short distance 2. Speed 3.Transportation provided 4. Price 5. Parking 6. Close to a stop 7. Solely available 8. Health 9. Attitudes/beliefs (e.g. ecology) 10. Comfort 11. Flexibility 12. Quality 13. Security 14.Punctuality of transportation 15. Something else	1. Independently 2.With a companion	
							Departure point	Arrival point					
1.													
2.													
3.													
4..													
5.													
6.													
7.													
8.													
9.													

FORM 3: Data on the respondent's movements during the non-working day?

33. No. of trip	34. What was your departure address?	35. What was your destination address?	36. When did you depart?		37. When did you arrive?		38. Type of establishment		39. Purpose of mobility/trip	40. Mode of transport	41. Reason for choosing that mode of transport	42. Was the trip made independently or with a companion?	43. Suggestion for improvement of transport
			Hour	Minute	Sat	Minute	Departure point	Arrival point					
1.													
2.													
3.													
4..													
5.													
6.													
7.													
8.													
9.													

THANK YOU FOR YOUR COOPERATION !

Figure 4: Second and third parts of the conducted questionnaire, travel diary during working (Form 2) and nonworking days (Form 3).

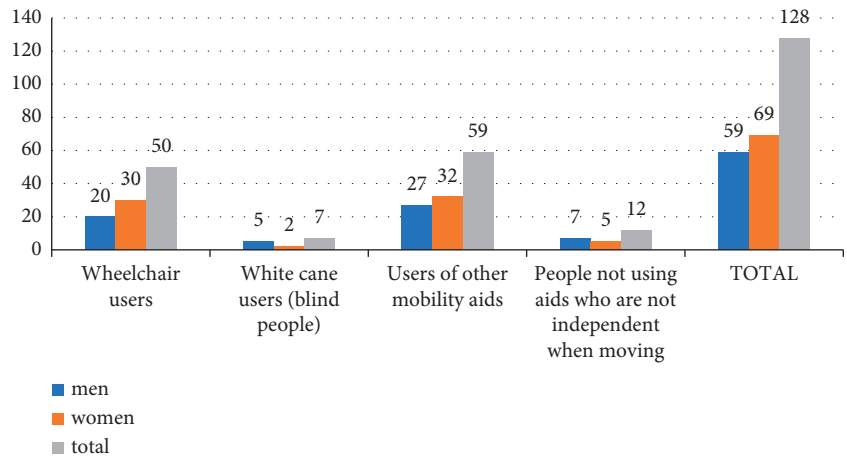


Figure 5: Respondents' structure in relation to their mode of traffic participation and gender.

who are wheelchair users (2.54), followed by the persons who use a white cane (2.85), then the persons who do not use aids and are not independent (3.41), and the persons who use another aid (3.83).

Bearing in mind that as many as 57% of the above-mentioned respondents are not independent in their movements, mobility was additionally examined only for those respondents who are not independent in their movements, i.e., whose mobility is conditionally dependent.

The mentioned group of respondents made a total of 73 trips, of which 12 persons (16.4%) did not make any trips on that day. The white cane users, i.e., visually impaired persons

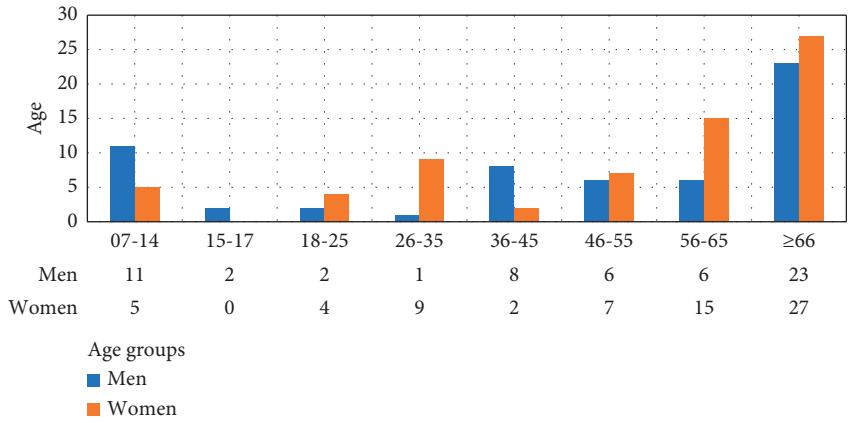


Figure 6: Respondents' structure by age and gender.

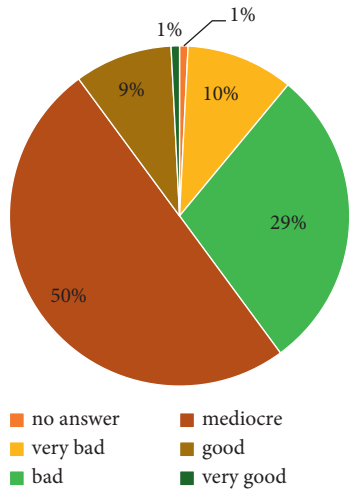


Figure 7: The respondents' personal financial situation.

Table 1: Overview of the total number of achieved trips of characteristic groups of PWDs, by gender and mobility.

	Characteristic PWD group	Men	Women	Total	Number of trips	Mobility (trip/day)
1	Wheelchair users	20	30	50	127	**2.54**
	White cane users	5	2	7	20	**2.85**
2	Users of other mobility aids	27	32	59	226	**3.83**
3	Persons who do not use aids but are not independent when moving	7	5	12	41	**3.41**
	Total	**59**	**69**	**128**	**414**	**3.23**

Table 2: Presentation of the total number of accomplished trips by gender and mobility for PWDs who are not independent during the trip.

	Characteristic PWD groups	Men	Women	Total	Number of trips	Mobility (trip/day)
1	Wheelchair users	18	26	44	111	**2.52**
	White cane users	3	2	5	12	**2.40**
2	Users of other mobility aids	6	6	12	32	**2.66**
3	Persons who do not use aids but are not independent when moving	7	5	12	41	**3.41**
	Total	**34**	**39**	**73**	**196**	**2.68**

(2.40), have the lowest mobility, followed by the wheelchair users (2.52) and the users of other mobility aids (2.66), while the persons who do not use aids have the highest mobility (3.41).

The mobility achieved by the characteristic groups of PWDs indicates the fact that persons who use or do not use aids, and who are not independent in their movement, make

a significantly lower number of trips during the day, compared with the persons who are independent (Table 2).

These groups of respondents, with less mobility, also have the greatest dependence in terms of travel, whether on the one hand they need a companion, or face greater obstacles regarding the transport system (urban transport infrastructure or means of transport). On the other hand, the persons who do not need escorts during the trip, i.e., who are more independent, make a higher average number of trips during the day.

When it comes to the PWDs' mobility, in relation to age, the results show the expected decline in mobility for the oldest age group (≥66 years of age).

The highest mobility is shown by age groups from 15 to 17 years (4.5 trips/day), from 7 to 14 years (3.81 trips/day), and then from 26 to 35 years (3.33 trips/day). The result for the age group of 15 to 17 years shows a significantly high mobility, which can be explained by a slightly smaller number of respondents from this group in the total sample. The lowest average number of trips during the day is made by age groups from 66 and older, with 1.73 trips/day (Figure 8).

The distribution of trips by mode of transport (Table 3) shows that walking has the absolute primacy, with as much as 32.4% share in the total travel distribution by modes of transport and in relation to the passenger car (PC) (passenger) (24.6%), mechanical wheelchair (15.9%), motorized wheelchair (7%), special transport (7%), public transport (5.8%), or PC (driver) (5.1%).

When it comes to the respondents who are not independent when participating in traffic, the distribution of trips by modes of transport shows slightly different results compared with the distribution for respondents who are more independent in movement. The respondents in this group use passenger cars most often (as passengers) (31.6%), and mechanical wheelchairs, followed by mechanical wheelchairs (29.6%), walking (15.3%), special transport (13.8%), and motorized wheelchairs (9.7%). It is interesting that JGSP (public transport), as a means of transportation, is not represented at all in this distribution of trips by modes of transport (Table 4).

The relations of different types of transport used by the respondents reveal not only the characteristics of their trips, but also the existing conditions in terms of traffic infrastructure. The large share of passenger cars in the travel distribution, in relation to public transport (which is represented only in the segment of special transport, as one type of public transport), indicates the unavailability or inadequate accessibility of the public transport subsystem and urban transport infrastructure (making trips to/from and the ability to reach the destination). On the other hand, the large share of pedestrian travel, including motor and mechanical wheelchair travel, for which the existing pedestrian infrastructure is otherwise used, indicates a favourable terrain configuration and relatively good accessibility of urban pedestrian communication lines (Figure 9).

Comparing the obtained results with the modal split for the whole city (Table 5), a similar distribution of the modes of transport was observed for the more independent users, while for the users who are not independent, the primary type of transport is a passenger car with complete absence of public transport.

Based on the obtained data, it is clear that there is a certain connection between the type of disability, the way of participation in traffic (the aids they use), and the age on the one hand, and the choice of modes of transport on the other hand. This is supported by the results regarding the importance of factors that influence the choice of modes of transport the most by respondents, among which the dominant is safety (30%), followed by comfort (23%), speed (23%), time (9%), price/cost (9%), parking (5%), and access (1%).

Observing the trip purposes during the day (Tables 6 and 7), the respondents made most trips for the purpose of using various services, shopping, or leisure. Having in mind the level of unemployment and the current status, a smaller number of trips are made with the purposes such as work or school/university. The smallest number of trips is made for the purpose of recreation or official visit, which is logical with regard to the degree of independence and employment.

Comparing the obtained results with the already existing results on the territory of the City of Novi Sad [1], it can be concluded that the basic characteristics of travel in terms of achieved mobility are identical and amount to 2.6 trips/day.

In terms of the purpose of travel, PWDs make a significantly smaller number of trips for the purpose of work or school/university compared to persons without disabilities. Table 8 presents the results of travel demand research for all citizens.

Compared with the data from other countries, the obtained mobility of PWDs is somewhat higher, which could be explained by the large percentage of unemployed respondents, i.e., the small number of completed work-related trips, making it possible for those persons to have more time during the day which they use to make other kinds of trips. On the other hand, the socioeconomic characteristics of PWDs indicate that, in terms of functioning, they are on their own. At the same time, in more developed countries there are appropriate systems and support services for PWDs such as working from home, attending "online" classes, and various services that are provided at a home address, thus reducing their number of trips during the day. In terms of the distribution of trips by modes of transport, the results are identical in the sense that persons with disabilities mostly use a passenger car (as passengers) with a high percentage of pedestrian and wheelchair movements that use the pedestrian infrastructure. The only exception is regular public transport, which is not represented at all in the distribution of trips by modes of transport, except when it comes to a special type of transport for PWDs, as a type of specialized service within public transport. The results related to the purpose of making trips are also very similar to the results of other research, in the sense that PWDs most often make their trips for the purpose of using various services, shopping, or leisure, with a smaller number of trips for work or school/university.

At the beginning of the study, the assumption was that PWDs move less during the day than people without

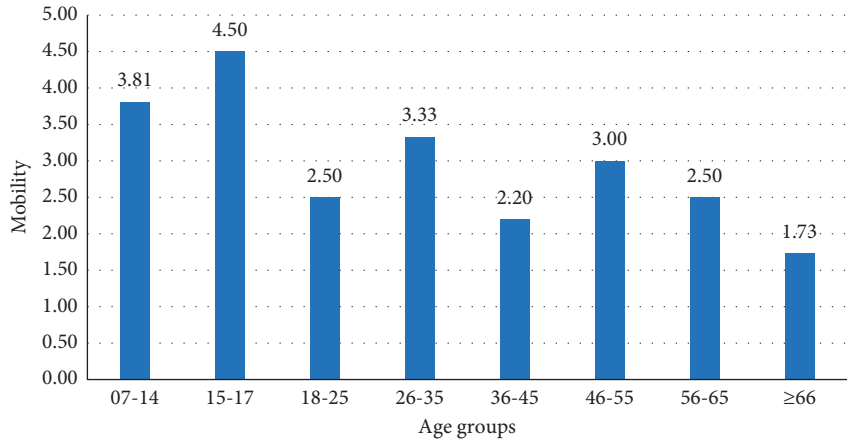


Figure 8: Achieved PWDs' mobility by age groups (trips per person/day).

Table 3: Distribution of modes of transport by order of travel (for the total observed group of respondents).

	Mode of transport	Trips accomplished by order								Σ	%
		1	2	3	4	5	6	7	8		
1	Walking	31	35	25	25	11	5	2	0	134	32.4
2	Bicycle	1	1	2	1	0	0	0	0	**5**	**1.2**
3	Scooter/motorbike	1	1	0	0	0	0	0	0	**2**	**0.5**
4	PC (driver)	2	2	4	5	5	3	0	0	**21**	**5.1**
5	PC (passenger)	26	25	25	14	9	3	0	0	**102**	**24.6**
6	Public transport	10	7	3	2	1	1	0	0	**24**	**5.8**
7	Taxi	1	0	0	0	0	0	0	1	**2**	**0.5**
8	Bus	0	0	0	0	0	0	0	0	**0**	**0.0**
9	Railway	0	0	0	0	0	0	0	0	**0**	**0.0**
10	Special transport	10	9	4	4	1	1	0	0	**29**	**7.0**
11	Mech. wheelchair	23	23	12	5	3	0	0	0	**66**	**15.9**
12	Mot. wheelchair	9	10	5	4	1	0	0	0	**29**	**7.0**
	Total	**114**	**113**	**80**	**60**	**31**	**13**	**2**	**1**	**414**	**100.0**

Table 4: Distribution of trips by modes of transport according to the order of travel (for respondents who are not independent during the trip).

	Mode of transport	Trips accomplished by order								Σ	%
		1	2	3	4	5	6	7	8		
1	Walking	10	10	4	4	2	0	0	0	30	15.3
2	Bicycle	0	0	0	0	0	0	0	0	**0**	**0.0**
3	Scooter/motorbike	0	0	0	0	0	0	0	0	**0**	**0.0**
4	PC (driver)	0	0	0	0	0	0	0	0	**0**	**0.0**
5	PC (passenger)	17	17	15	8	4	1	0	0	**62**	**31.6**
6	Public transport	0	0	0	0	0	0	0	0	**0**	**0.0**
7	Taxi	0	0	0	0	0	0	0	0	**0**	**0.0**
8	Bus	0	0	0	0	0	0	0	0	**0**	**0.0**
9	Railway	0	0	0	0	0	0	0	0	**0**	**0.0**
10	Special transport	9	8	4	4	1	1	0	0	**27**	**13.8**
11	Mech. wheelchair	19	19	12	5	3	0	0	0	**58**	**29.6**
12	Mot. wheelchair	6	7	3	2	1	0	0	0	**19**	**9.7**
	Total	**61**	**61**	**38**	**23**	**11**	**2**	**0**	**0**	**196**	**100.0**

disabilities, for the simple reason that the imposed, innate, and/or acquired restrictions narrow down their opportunities for making more trips during the day. Looking at the number of average trips made by persons without disabilities on the one hand and PWDs on the other hand, it is noticed that the PWDs participating in the research made on average more trips during the working day than persons without disabilities. However, when the structure of accomplished trips is analysed and the purposes and some other elements of trips are considered in more detail and placed in the context of socioeconomic characteristics of both populations, the need for more detailed analyses arises. This is

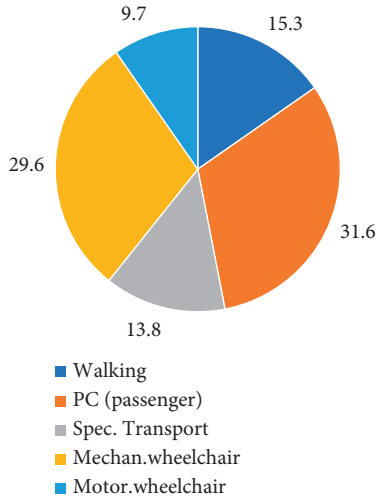


Figure 9: Travel distribution by mode of transport for users who are not independent in traffic (in %).

Table 5: Distribution of trips by mode of transport (all citizens) [1].

	Total number of trips	Percentage of all trips (%)
Walking	306581	39.98
Bicycle	67752	8.84
Scooter/ motorbike	5772	0.75
PC (driver)	173241	22.59
PC (passenger)	80740	10.53
Public transport	114869	14.98
Taxi	14431	1.88
Other	3391	0.44
Total	766777	100

Table 6: Distribution of trips per purpose (total).

Purpose of the trip		Trips accomplished by order								Σ
		1	2	3	4	5	6	7	8	
1	Work	5	2	1	1	0	0	0	0	9
2	School/university	7	0	0	0	0	0	0	0	**7**
3	Home/apartment	0	66	33	36	18	11	0	1	**165**
4	Official visit	1	0	1	1	0	0	0	0	**3**
5	Shopping	23	17	7	5	2	0	0	0	**54**
6	Using services	44	19	12	3	1	0	0	0	**79**
7	Entertainment	9	3	12	6	2	0	0	0	**32**
8	Recreation	3	1	3	1	2	0	0	0	**10**
9	Transport of other persons	1	1	1	0	2	2	2	0	**9**
10	Private visit	12	1	8	4	3	0	0	0	**28**
11	Other	9	3	2	3	1	0	0	0	**18**
	Total	**114**	**113**	**80**	**60**	**31**	**13**	**2**	**1**	**414**

supported by the fact that among the respondents, there is a significant representation of persons who are out of the work-related process (93%, including pupils, students, and pensioners), a higher representation of pensioners due to the nature of disability, more elderly, more uneducated, or with lower education. Among them, there is a higher

Table 7: Distribution of trips by purpose (for users who are not independent during trips).

Purpose of the trip		Trips accomplished by order								Σ
		1	2	3	4	5	6	7	8	
1	Work	0	1	0	0	0	0	0	0	1
2	School/university	5	0	0	0	0	0	0	0	**5**
3	Home/apartment	0	34	21	12	8	2	0	0	**77**
4	Official visit	0	0	0	0	0	0	0	0	**0**
5	Shopping	8	9	3	1	0	0	0	0	**21**
6	Using services	28	11	4	3	0	0	0	0	**46**
7	Entertainment	6	2	4	3	1	0	0	0	**16**
8	Recreation	1	1	2	1	1	0	0	0	**6**
9	Transport of other persons	0	0	0	0	0	0	0	0	**0**
10	Private visit	8	0	4	2	1	0	0	0	**15**
11	Other	5	3	0	1	0	0	0	0	**9**
	Total	**61**	**61**	**38**	**23**	**11**	**2**	**0**	**0**	**196**

Table 8: Distribution of trips by purpose (all citizens) [1].

		Total number of trips	%
1	Work	92573	12.07
2	School/university	47982	6.26
3	Home/apartment	324547	42.33
4	Official visit	7720	1.01
5	Shopping	81678	10.65
6	Using services	45673	5.96
7	Entertainment	37520	4.89
8	Recreation	22151	2.89
9	Transport of other persons	15224	1.99
10	Private visit	51951	6.78
11	Other	39757	5.18
	Total	766776	100.00

unemployment rate, but also the impossibility of independent movement. The PWDs that participated in the research, for example, go out less to make large purchases of household supplies, but they go out to make small purchases several times a day. The possibilities of choosing transport are conditioned and limited, first of all due to the real insecurity or to the simple feeling of it, and inadequate safety (hence the high frequency of safety factors featuring as a reason for choosing the means of transport), and lack of independence but also real impossibility to use certain types of transport.

Having in mind all this knowledge and obstacles faced by this part of the population, in the instrument used for the field data collection (Form 1), there was also a question through which an attempt was made to find out what it would have to be that would make possible for the PWDs to move more during the day along with their attitudes regarding the improvement of the city's traffic system.

With this in mind, the research participants were offered four groups of answers that referred to traffic infrastructure, facilities, information and communications, and traffic services, whose solutions or improvements would help them move more. As expected, the highest ranked was the traffic infrastructure, i.e., the need to improve the traffic system through general improvement of the traffic infrastructure, in

the form of accessible paths, intersections, and means of transport. The following are the answers related to the development of traffic services, facilities, and, finally, information and communication in traffic.

In addition to the offered groups of answers, the possibility was left for them to add something they thought was important and assign a rank of significance, which belongs to that answer in their opinion. Most of the added answers, unfortunately, were not related to the improvement of the transport system, but referred to socioeconomic characteristics such as better financial situation (for the purchase of adequate aids, wheelchairs, cars, transport, or fuel tickets), "better health," bad experience with regard to other people and prejudices towards PWDs. These answers only confirm the gravity of the situation and the fact that PWDs are left to fend for themselves without adequate social support.

When filling out the travel diary (forms 2 and 3), the respondents also had the opportunity to suggest various improvements that would increase the quality, their safety, and mobility in general on the routes they were using that day.

The obtained results show that persons with disabilities are prevented from moving safely by numerous obstacles that stand in their way. Among these obstacles, the following stand out in particular: unadapted pedestrian footpaths and streets, inaccessible road crossings, curbs, potholes, atmospheric drains or canals, improperly parked cars on movement trajectories, etc. The smaller number of proposals referred to the need not only for the introduction of more bus lines, their better connection, and more low-floor public transport buses, but also for organised, specialized transport only for PWDs. The smallest number of proposals referred to the prices and transportation costs.

5. Conclusion

An informational database of main travel demands for persons with disabilities was formed, based on comprehensive research initiatives conducted in the Novi Sad area. As a result, for the first time, there was a realistic potential for creating a sustainable urban transport plan, which recognizes and includes travel demand for all users and their specific attitudes.

In general, the basic socioeconomic characteristics of PWDs, obtained by this research, can be assessed as unfavourable. In that sense, a large number of respondents live in relatively unfavourable conditions, excluded from the economic system and general social trends. However, such unfavourable socioeconomic characteristics do not significantly affect their daily mobility. Since most of them are not in the money-earning process (unemployed or retired), they have more free time that they use to make more short trips, several times a day, with the same purpose, such as services and shopping.

By analysing the general characteristics of trips and noticing the links between different types of disabilities and ways of participating in traffic, the modes of transport [19], and the purpose of making trips, it is clear that PWDs have specific requirements regarding the transport system. In that sense, people living with more severe forms of disability have less mobility compared with some other types of disabilities, which is logical. For such user groups, increasing the accessibility to the transport system can be a key factor that will increase their degree of autonomy and independence. For example, the possibility of greater use of public transport will increase the degree of independence and involvement for those user groups who, apart from a passenger car (as passengers) and walking (or using a wheelchair), have no other alternative.

The implementation of this research also showed certain difficulties and shortcomings, in terms of finding PWDs in as many urban traffic zones as possible, by random sampling and personal interviewing. This resulted in a slightly lower total number of respondents, with very diverse types of disabilities and specific travel requirements. Having in mind the experience gained, it is recommended that the standard household survey, which is conducted periodically to determine the travel characteristics of the population, should be updated. The questionnaire should contain questions that would determine possible specific requirements of respondents, their traffic participation, use of certain travel aids, specific modes of transport, and the like, with mandatory representation of PWDs in the total sample. Of course, this study should be continued with creating other important demand models for persons with disabilities. A model for the criteria selection regarding the quality of passenger service can be used as a benchmark, from the perspective of persons with disabilities as the main passenger category. Đorđević et al. (2019) have created such model in rail transport [19], while similar models can be created in road transport using different methodologies such as fuzzy FUCOM and neutrosophic fuzzy MARCOS [20], TRUST approach [21, 22], CoCoSo in integration with fuzzy power Heronian function [22], and fuzzy PIPRECIA [23].

Further studies should also focus on verifying the effects of the applied measures for increased accessibility in real conditions, which would imply the application of the proposed changes and improvements. Subsequent correction of the measures would allow validation of the used methodology and create conditions for testing and application of the same process in other cities.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This research received no external funding.

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