IMPROVEMENT OF URBAN TRANSPORT ACCESSIBILITY FOR THE PASSENGERS WITH REDUCED MOBILITY BY APPLYING INTELLIGENT TRANSPORT SYSTEMS AND SERVICES

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Deployment of Intelligent Transport Systems and Services (ITS) has been strongly considered as crucial element of improved accessibility for passengers with reduced mobility. Intelligent transport systems in the light of improving an access to urban transport for passengers with reduced mobility are analysed in the article. The need of deployment of these systems in three areas – information, infrastructure and vehicles is emphasized and practical examples are provided. Only in the case if intelligent transport systems are deployed in all the three areas, a seamless transportation for the disabled people is ensured. The aim of the research is to evaluate solutions, encouraged by the EU transport policy and proved by a good practise that might be implemented in Lithuanian urban transport system. These solutions are also based on results of questionnaire, accomplished by the author.

Keywords: *mobility handicaps, reduced mobility, sustainability, Intelligent Transport Systems*

1. Introduction

Accessibility is the main element of a sustainable transport system. European Commission encourages forms of public transport accessible to all users, including people with reduced mobility (especially those with disabilities and the elderly ones) [1]. Nevertheless, there are too many obstacles for the people with reduced mobility as regards the transport accessibility: switching between modes, information services, pedestrian environment, traffic safety and others. Until these obstacles are not eliminated the vast majority of disabled people will continue to stay at a disadvantage and will be unable to travel as they would wish and consequently limited in the extent to which they can participate in society [2].

Mobility handicap is a broad term – it includes people who by some reason (it might be accident, certain disease, congenial condition or disability) have difficulties to move around [3]. Virtually everyone of us has or will have a certain degree of reduced mobility (due to temporary impairment, senescence, injury, etc.) therefore a good design of transport system leads to better quality of all passengers. The best example of this was introduction of low-floor buses – designed as an effective solution for passengers in wheelchair they brought significant benefits for all passengers due to faster, safer and easier boarding and disembarkation. The demand for mobility is the biggest in urban areas, this notwithstanding, whole transport chain should be adapted to seamless transportation, including aviation, trains, water transport and transport on demand. ITS might help to remove the most of the barriers in a very efficient way. Other perspective option is to facilitate accessibility to e-services, thus giving a possibility for people to use communication services (e-purchase, e-banking, etc.) instead of the need for physical transportation.

Development of intelligent transport systems to inform passengers with reduced mobility of transport conditions should eventually help reduce the time lost on transferring between modes or access to the stops and stations. There are about 30,000 persons in Lithuania who cannot receive and process information in the usual ways, because of their disabilities [4]. In the past decade no efforts have been made to adapt the information environment to the needs of such persons. Because of their low levels of income, disabled persons have limited opportunities to acquire the equipment necessary for the use of the internet and to cover user costs.

Public transport needs to achieve levels of comfort, quality and speed that come up to people's expectations. This quality option has been the choice of many European cities which have decided to innovate by bringing into service new metro or light railway lines or new buses with easier access for people with reduced mobility.

According to outcomes of studies, Lithuanian transport system is not well adapted for people with special needs. Moreover, only 55 per cent of population can use the present transport system in an absolutely seamless and accessible way [4]. This means that much has to be done to achieve better level of sustainability in transport, especially in urbanised areas.

The aim of the research is to evaluate solutions, encouraged by the EU transport policy and proved by a good practise that might be implemented in Lithuanian urban transport system. These solutions are also based on results of questionnaire, accomplished by the author in April 2007. The respondents (the disabled passengers) were asked to evaluate the level of quality of information provision services, the adaptation of transport infrastructure and vehicles, pedestrian and living environment. These results allowed indicating the most problematic obstacles for transport accessibility and find the most suitable ways of ITS application for removing of those obstacles.

2. Results of the Research

The results of the research allowed indicating the most problematic obstacles for transport accessibility in Vilnius and find the most suitable ways of ITS application for removing of those obstacles.

Group of respondents – wheelchair users – were asked to provide answers to questions related with Vilnius public transport system. In total, 52 respondents gave their answers and comments.

Results of the questionnaire showed that the vast majority of wheelchair users – over 50 % – never travels by public buses or trolleybuses (see Figure 1) in Vilnius. This is the main problem needed to be solved – how to improve their accessibility to public transport.

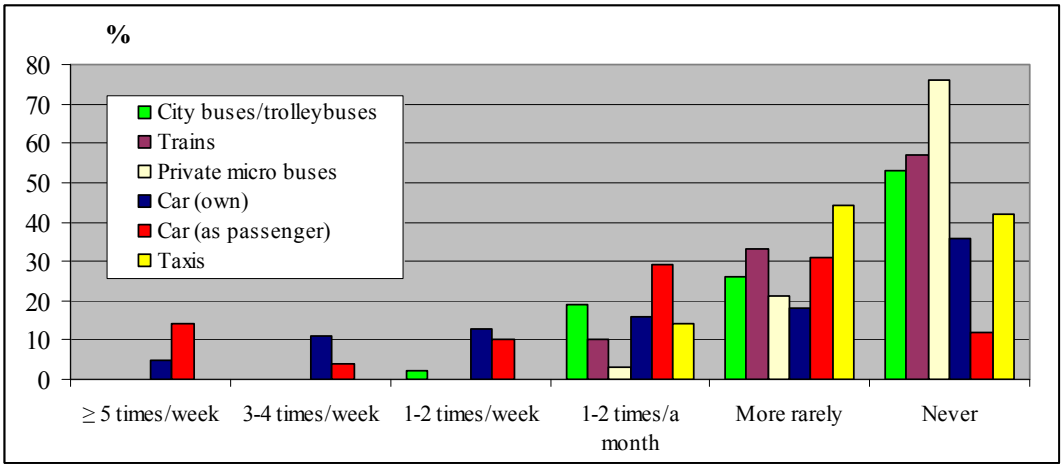

Figure 1. Frequency of trips performed by wheelchair users in Vilnius

Improvement of accessibility for people with reduced mobility is a very complex question. The authorities have to deal with adaptation of transport infrastructure, dwellings (lifts, elevators), pedestrian infrastructure and other related issues. As concerns the main reasons for not choosing the public transport, the respondents indicated physical restrictions (36 %) and a need of accompanying person (30 %). See green column, Figure 2:

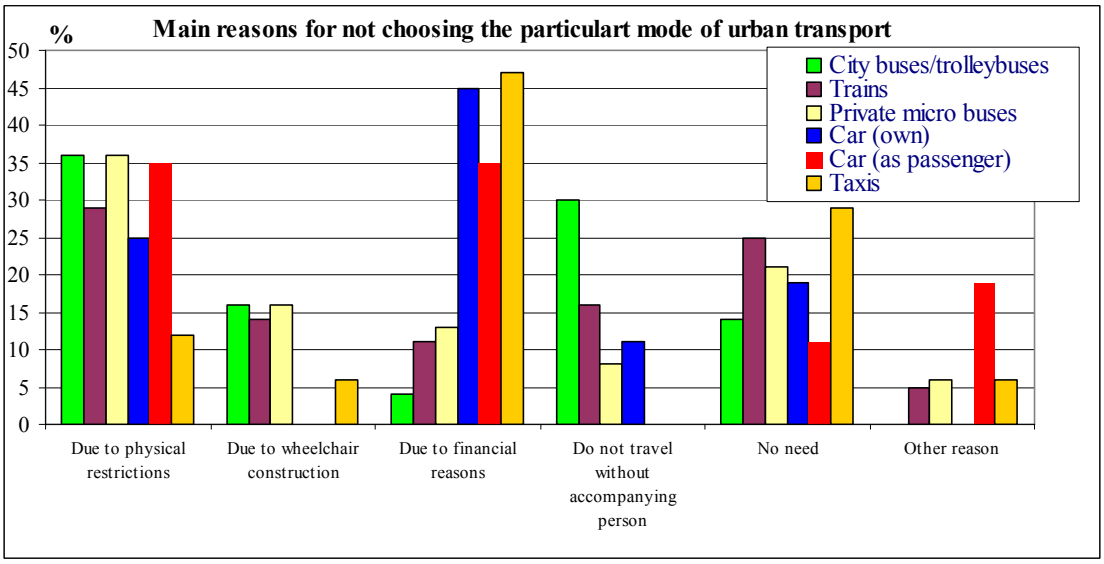

Figure 2. Answers of wheelchair users on the main reasons for not choosing the particular mode

To summarise the percentage of those who never travels without accompanying person and those who do not have a need for travelling by public transport, circa 45 % of wheelchair users are not potential public transport users in a nearest future. Nevertheless, the efforts must be done for those who cannot travel at all, or travel with heavy difficulties, due to physical restrictions, wheelchair construction or financial reasons (in total 55 %).

Railway transport is not an integrated part of public transport in Vilnius. Therefore, the answers should be treated as intercity trips.

Wheelchair users are, of course, only a small part of people with reduced mobility, in terms of percentage. But the results showed that these people still does not have accessible transport. The same is true for people with

other disabilities – blind people, people with reduced coordination, strength, partially sighted and others. There is a lot of room for improvement, and ITS is a solution to facilitate the travelling for people with reduced mobility.

The next chapter analyses possibilities for improving the transport system for the people with reduced mobility (including wheelchair users)

3. Nature and Degree of the Problems Concerning Passengers with Reduced Mobility

Intelligent transport systems, when implemented within transport system, play a crucial role for passengers with special needs. Vast majority of impaired persons need a special equipment to be able to travel by public transport, especially in the light of underground transport. They also need specific provision of information (visual or audio) and easier access to transport terminals. Although the special equipment is a must, the facilitation of travel is a complex process: in order to ensure a seamless transportation for the disabled persons ITS should be used leastwise in these three main areas:

1. Information;
2. Infrastructure and pedestrian environment;
3. Vehicles.

The first area – information – is described as a bunch of different methods of provision of information both on-board and outside the vehicles. The information is needed for evaluating the possible choices and then making decisions about the journey. The second one – infrastructure and pedestrian environment – encompasses the measures targeted for accessing stops and stations, for changing between modes, for moving in the terminals, reaching the information desks and other necessary places. And the last one – the vehicles area – encompasses systems that aims at facilitating a circulation within the vehicle, seating and sleeping accommodation, boarding the train, access to the facilities and services on the train (catering, lavatories, etc.).

The planned journeys might involve the use of multimodal transport, i.e. more than one mode of transport. But for the disabled persons, it seems not rationale journey, as it is difficult to interchange from one mode to another. Even information system is not adapted to multimodal journey. Therefore in developing comprehensive transport information system, it is of great importance to include information on intermodal as well as within one mode accessibility (would it be leaflet, brochure, internet web page, SMS inquiry, trip-planner programme, phone info-centre, or whatever else).

The White Paper on European Transport Policy suggests taking account of the difficulties encountered by people with reduced mobility that use public transport and for whom changing from one mode to another can sometimes be a real obstacle. It is worth to be mentioned that many problems might be caused by ineffective interaction of the three above-mentioned areas. Seamless transportation for the disabled persons is only achieved if intelligent transport systems and services are implemented and applied in all three areas and all the modes of urban transport system. Accessibility is about the usability of the public transport system as a whole. Thus it includes issues as the accessibility of the destination by public transport, the safety of travel, the services provided by the staff and the information available to passengers. The objective of improving the accessibility of public transport is to realise equal travel and mobility opportunities for everybody.

The people with reduced mobility represent roughly up to 30 per cent of the population in the European Union. People with reduced mobility include older people, people with reduced strength and temporary impairment, pregnant women, etc. People with physical impairment represent about 12 per cent of the EU population.

The table below indicates the percentage of impaired persons and respective intelligent solutions aimed at facilitating an access to rail transport:

Table 1. The number of impaired persons and respective ITS aimed at facilitating an access to urban transport

Nr	Nature of impairments	Percentage of impaired persons in the EU-27	ITS aimed at facilitating a use of rail transport
1	Wheelchair users	0,4 %	Autonomous systems for bridging the gap (bridging plates, special ramps), lifts for boarding and circulating in the terminals, automated systems instead of manual ones, wheelchair-lifts. Adapted ticket vending machines and information retrieval desks (parameters should allow convenient use of latter's).
2	Cannot walk without aid	5,6 %	
3	Cannot use fingers	0,1 %	
4	Cannot use one arm	0,1 %	
5	Reduced coordination	1,4 %	
6	Reduced strength	2,8 %	
7	Language impaired	0,6 %	Info-lines, signs, many other systems that are used for people with different impairments.
8	Without speech	0,3 %	
9	Dyslectics	3,1 %	Voice announcing systems, acoustic information instead of text-based ones.
10	Intellectually impaired	3,8 %	Assisting systems that are easy to understand and follow instruction, trained personnel.

Nr	Nature of impairments	Percentage of impaired persons in the EU-27	ITS aimed at facilitating a use of rail transport
11	Hearing disability	0,1 %	Different kinds of information provision based on visual perception and other equipment like the mobile phone, text phone, videophone, monitors or electronic signs. Advanced visual systems.
12	Hard of hearing	10,0 %	
13	Blind people	0,1 %	Special assisting systems for visual disabled persons helping to access to rail terminals and trains, equipment with Braille features, voice announcement systems, tactile surfaces and guide paths. Special ticketing systems (ticket vending machines with the Braille features).
14	Partially sighted	1,4 %	

The number shall not be summarized, bearing in mind that many people have more that one impairment (multi-disability). This makes the access to transport yet more complicated. The table helps us to understand to what extent the problem of accession the public transport, including underground urban transport and rail, is serious. State-of-the-art equipment and well-chosen interaction of intelligent transport systems and services in all three applied areas strive to solve the problem by introducing in practice lots of successful solutions. In the next chapters the authors scrutinized only the solutions that have already been successfully introduced.

In order not to overlap with the systems analysed in other two areas, the information provision here is understood both as advance information and information provision on-board and along the guiding route to the vehicle. At the first glance it seems that information provision is not a serious obstacle, but just imagine in what extent the information (esp. real-time) for railway passengers is important: usually the information for rail passengers with reduced mobility is needed on places to buy tickets, lavatories, steps, lifts, elevators, nursing rooms, luggage storage, information service, guidance assistance, waiting halls, where/what will be announced audibly, guide paths for the blind, signs, train timetables, other train station facilities and etc [5]. This is essential information for these travellers; hence the rail transport operator should ensure that advance information can be ordered to theirs home or workplace by mobile phone or SMS or via the Internet in advance, before the journey, making it possible to anticipate the whole travel chain.

The main difficulties in highly urbanised areas are associated with visually impaired passengers that have to deal with very problematic tasks that may not seem difficult to other passengers, but usually is an obvious obstacle for them to travel. They need to get on time the specific information due to their inability to go/move faster. This information not necessary is possible to provide in advance over the portable devices or provide in the Internet. If it is not possible, when it is recommended to introduce signs, audible and visual information screens, on-board displays, loudspeakers in the train stations, their vicinities and vehicles themselves. This would comprise the information on:

- finding a station, stop or terminal;
- navigation inside the terminals and vehicles;
- perceiving the arrival of the correct vehicle at the platform, terminal, stop;
- finding the door of the vehicle and finding one's way into it;
- paying for services;
- finding a seat, berth;
- obtaining information during the journey;
- disembarking at the right stop or station;
- navigation inside the station;
- finding the exit,
- finding the destination .

In terms of information provision, any group of the disabled persons shall not be neglected. The only one solution is to use multiple channels of information (audible, visual, information desk equipped with the Braille). The picture below indicates some practical suggestions on information desks where concrete information on the aforementioned questions might be obtained (it is true for ticket vending machines as well):

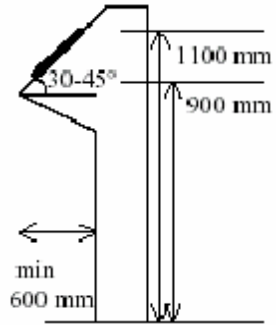

Figure 3. Recommended parameters of information desks

These information desks should be equipped with touch screens, integrated audio systems and the Braille option, besides have special parameters in order to provide the information for as many people as possible. Accessible with a wheelchair, equipped with a modern touch – screens, ordinary keyboards or ball mouse, convenient both for tall and short people, adapted for people with mobility, hearing or visual disabilities these information desks allow reducing costs of personnel:

Not importantly in whatever form the information is possible to be retrieved; it always must meet four criteria to ensure the seamless transportation: 1) Clear; 2) Accurate; 3) Timely and 4) Concise.

The infrastructure and pedestrian environment should be conveniently designed infrastructure that allows quickly finding the right information and using the right transport services. Where are the lifts, ramps and escalators? The plan of terminal should be planned taking into account the disabled passengers, for whom a circulation in it may pose many questions.

The biggest problems of circulating within the transport chain concern the blind. Intelligent transport systems like the system used in Utrecht Central Station (the Netherlands), or the system at Leeds City Station in the United Kingdom, enable visually impaired people to navigate around a station complex on their own. These systems are triggered by smart cards and provide the visually impaired person with spoken information either to a headset, or aloud. They are most useful when combined with a tactile surfaced guide path as in Utrecht. The safe circulation inside the terminal and safe boarding and disembarkment are seen as the crucial issues. The last but not the least is an issue of guidance in alarm-situations. Therefore, all the exits, space available, guide paths shall be very precisely projected for the disabled passengers.

Boarding and alighting the vehicle usually means that passengers have to get through the door and negotiate a few steps. Steps and gaps are usually a real barrier to people in wheelchairs and even to people with severe walking difficulties. The functional capabilities for passing over the gap between the platform (or pavement) and the vehicle floor have been intensively investigated in laboratories in France, Germany and Great Britain by mobility impaired people and wheelchair users who were used to moving around in the city and reaching the train station. These tests helped to design the requirements that were determined as follows [5]:

- The horizontal and vertical gaps shall be not greater than 100 mm (*50 mm is preferred*) and 50 mm respectively for people in wheelchairs;
- The horizontal gaps shall be not greater than 300 mm for people with severe walking difficulties;

Where level access cannot be achieved, technical and operational solutions for boarding/alighting should be used in order to overcome the steps and gaps. These lifts are adapted to different platform heights, so it is applicable in differently projected stations. Simple and inexpensive option for lifting the disabled passengers is access ramps (see the illustration below of the ramp used in Norwegian State Railways Company) that have an advantage against the lifts in the light of self-boarding:

Figure 4. Access ramp

This is usually limited option because of the height issue – the greater difference of height between coach floor and platform, the harder boarding into the train or other vehicle for the disabled passenger. If the difference is too great (too low angle), the assistance is necessary. Usually only one coach modified for wheelchair users, with access ramp to board and alight the train. The ramp is delivered as a compact cassette, integrated in the floor of the entrance area, containing frame, telescopic arms and the ramp. Some main characteristics of this ramp are given in the table below [1]:

Table 2. Some main characteristics of access ramp

Characteristic	**Dimension**
Dimension of the access ramp	80 cm x 333,6 cm
Dimension of the cassette	100 cm x 175 cm x 11.2 cm
Activation of the ramp	Electronically in driver's cabin while in use
Capacity	Up to 450 kg
Operation time	Max. 45 s
Work conditions	Snow, ice, water, sand.

If electronic ramp is too expensive to introduce, manual ramps are also used. There are two types of manual ramps:

1. Manual demountable, which is carried on the carriage and put in position when required;
2. Manual fixed which is folded out by the staff when needed.

Both of these two manual ramps have their own advantages and drawbacks: The manual demountable ramp is not fast to mount in the entrance. Nevertheless it is cheaper than the second one and might be mounted to any entrance of the vehicle.

The ramps and lifts are used if only vertical gap between platform and floor of the vehicle exists. Otherwise, the bridging plates (manual or electronic) are enough. As practice shows, the substantial improvement of accessibility is achieved if platforms of the stations and floors of carriages are at the same level and the horizontal gap (if greater than 5 cm) then is filled by a bridging plate.

Very important part of urban transport is demand-responsive services. Taxis can be accessible, and be used by the disabled persons, but it seems not that viable option, as most of the disabled persons consider this option to be too expensive (see Figure 2). The fares are usually more than they could afford. Nevertheless this problem might be solved by subsidising limited number of trips per given time. For a while, taxi services are not subsidised in Lithuania, besides, there are only few accessible taxi vehicles. The concept of shared transport on demand ("dial-a-bus") might be option as well. There are many transport companies of Vilnius, Kaunas and other Lithuania's cities rendering passenger transport services. The most suitable for this type of service would be mini/micro bus. Those buses might be booked by phone, mobile phone services, internet and companies should be able to organise services for the requests of trips in such a way that more than one or two people are carried at the same time. This shared ride concept could reduce the cost to less than the cost of the same taxi trip. But still, it seems more like a future option rather than real intention of Lithuanian city transport companies.

Accessible information, vehicles, infrastructure and pedestrian environment are crucial towards accessible transport system. And there are lots of possibilities to develop those domains with help of ITS. Nevertheless, there are some more essential parts of accessible transport, which can be improved without ITS. As the most practical example, training of transport staff might be mentioned. The staff must be trained to better understand the needs of the disabled persons according to his/her type of disability. Other issue is role of authorities. The local, regional and national authorities have to better co-operate during the decision making processes to achieve better accessible transport system within all the levels that leads to seamless multimodal travel.

Conclusions

1. Based on survey results, wheelchair users in Vilnius still does not have accessible transport. The same is true for people with other disabilities – blind people, people with reduced coordination, strength, partially sighted and others. There is a lot for improvement, and ITS is a solution to facilitate the travelling for people with reduced mobility.
2. It is quite obvious that the use of various electronic boarding aid devices is a financial burden both for the passengers and for the transport operators. Therefore, it is important that the right choice is made after considering all the factors that may affect the safe and effective operation of the system.
3. The specific intelligent systems would promote the use of urban transport if an effective interaction amongst information area, in-vehicle and outside-the vehicle areas is ensured. Otherwise the transport will not provide a seamless process.
4. An independent boarding and alighting for the disabled persons should be the aim wherever possible. Initially it should be aimed at urban transport for which passengers do not usually reserve their seat in advance. Good accessibility usually benefits the disabled passengers because it is safer and easier to board the vehicle and benefits the operators (companies) because it can reduce the stopping-time at the stations,
5. New transport services based on demand-responsive concept could be introduced as effective way to travel for the disabled people.
6. Every passenger travelling by public transport needs information, skills and abilities to travel safely, comfortably and independently. The same is true for passengers with reduced mobility, therefore the intelligent transport systems are so beneficial, because they enable as much as possible independent, safe and comfortable travel to the disabled persons and passengers with reduced mobility.

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