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EVALUATION OF PUBLIC TRANSPORT IN POLAND FORM THE PERSPECTIVE OF THE DEAF AND HARD OF HEARING PEOPLE TOWARDS THE IMPROVEMENT OF MOBILITY

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Abstract:

The article presents findings of a survey research carried out on a group of the deaf and the hard of hearing. The objective of the research was to evaluate the quality of public transport in urbanized areas in Poland, identify problems that the deaf and the hard of hearing face while using public transport, and to review a selection of solutions facilitating mobility of this group of people. The survey was conducted on a group of 71 persons, of whom 65% were women and 35% were men. The group surveyed was active professionally and socially, thus they used public transport daily or several times a week, which they confirmed in surveys. Most of them (65%) were persons with profound hearing loss (above 90 dB), 17% with severe hearing loss (71-90 dB), and 11% with moderate hearing loss (41-70 dB). Public transport and its accessibility for the given group in the urban area where they live was assessed as very good by 8% - 17% of the surveyed, good: 23% - 46%, sufficient: 13% - 25%, bad: 13% - 25%, very bad: 3% - 28%. The results presented on the assessment of public transport by the deaf and the hard of hearing indicate that accessibility of public transport in Poland for this group of passengers is on a sufficient level. The assessment of public transport in Poland, performed in the survey, allowed the identification of vital problems the deaf and the hard of hearing face when they use the infrastructure and means of public transport. The article presented a selection of technical solutions used in public transport vehicles in Germany, Austria, Great Britain, France, Poland and Czechia. The following aspects were in the focus of this paper: information displayed at stations and train platforms; the passenger information system in vehicles; spots at railway stations where the deaf may obtain help connected with their journey; applications that enable planning a journey. These solutions aim at facilitating travel for the deaf and the hard of hearing.

Keywords: *the deaf, the hard of hearing, public transport, survey research, technical measures, improving mobility of the deaf and the hard of hearing*

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1. Introduction

More than 4.7 million people in Poland have some kind of disability, which makes more than 12% of the society. Among them, nearly 3 million people use wheelchairs, 1.5 million are blind and visually impaired and 0.5 million are deaf [Zając, 2015]. Widely understood accessibility is the basic condition for those people to participate in social and economic life. It ensures safe and easy access to the destination, whether in their own vehicles or public transport. It also ensures equal access to the physical environment, transport, technology and information-transport systems, as well as to other buildings and services [Kamruzzaman et al., 2016, Thorslund et al., 2013]. Different meanings of the word 'disability' or 'person with a disability' can be found in various publications, documents or acts of law, depending on the science, especially in medicine, psychology or philosophy [Xiaoming et al., 2023]. The World Health Organization introduced three definitions of disability, regarding the health status of a person [Webpage United Nations Information Center]:

- impairment – any loss or abnormality of psychological, physiological or anatomical structure or function,
- disability – any restriction or lack of ability to perform an activity in the manner or within the range considered normal for a human being,
- handicap – the result when an individual with an impairment or disability cannot fulfill a normal life role, limiting or preventing full realization of a social role adequate for the age, gender and social and cultural circumstances.

The notion 'disabled person' or 'person with reduced mobility', in accordance with Regulation (EU) no. 181/2011 of the European Parliament and of the Council of 16 February 2011 concerning the rights of passengers in bus and coach transport means any person whose mobility when using transport is reduced as a result of any physical disability (sensory or locomotory, permanent or temporary), intellectual disability or impairment, or any other cause of disability, or as a result of age, and whose situation needs appropriate attention and adaptation to his particular needs of the services made available to all passengers [EU Regulation, 2011]. Due to the type and cause of limitations, disability may be divided into [Majewski et al., 2007]:

- locomotory disability (physical) – persons with an injury to the locomotor organ and persons with chronic internal diseases,
- sensory disability (dysfunction of the vision and hearing) – the blind and visually impaired, the deaf and hard of hearing,
- mental disability – persons with a mental disease, persons with intellectual disability.

When we examine the share of individual senses in the general amount of information that reaches a human being, it can be stated that eyesight provides 87% of messages, with hearing responsible for only 7% of total information. The sense of smell provides only 3.5%, and the senses of touch and taste – 1.5% and 1% respectively. When one sense is eliminated, the human attempts at replacing it with another one. However, that proves very difficult. The eyesight is irreplaceable when traveling and extremely difficult to substitute with another sense [Zając 2015, Goldstein E. B 2010].

A study of the literature on this subject indicates that until recently persons with disabilities were mainly associated with persons in wheelchairs, and a vast majority of scientific publications regards this group of people [Gabryelski et al., 2021, Seriani et al. 2022, Schneider et al., 2010, Bęczkowska and Zysk 2021].

International and domestic regulations related to ensuring equal access to public transport for persons with disabilities and the healthy ones are numerous: [EU Regulation, 2011, EU Regulation, 2014, EU Regulation, 2007, Resolution 1.08.1997, Act of 16 December 2010]. The main objective of the regulations is to indicate proper solutions of problems and to enforce those regulations in practice. However, fulfilling legal obligations is not always an easy task. Various factors are responsible for that, but also the fact that individual groups of people with reduced mobility need different information regarding barriers and accessibility. Therefore, town planners, architects and constructors need to be aware of problems concerning each of those groups of the disabled [Park and Chowdhury., 2022, Leonardi et al., 2020]. Most people who can hear do not understand the impact of hearing impairment on daily functioning. Thus, the needs of the deaf and the hard of hearing are frequently overlooked when technical buildings are designed or modernized. These issues are rarely discussed in scientific papers.

The hard of hearing experience difficulties perceiving, locating and identifying sounds. Hence, major problems encountered by this group of public transport passengers are related to: limited access to current and up-to-date information displayed on information boards at stations and in vehicles, incomprehensible voice announcements, illegible signposts and problems communicating with other people [Orczyk and Młodystach, 2022, Zając 2015, Saby et al., 2005, Fürst et al., 2021, Fürst 2010, Paire-Ficout et al., 2013, Thorslund et al., 2013].

Another issue related to the accessibility of public transport is the possibility to plan a journey. A public transport user, especially in a large urban area, expects to plan a short journey, using as few means of transport and as cheap as is possible, while maintaining the standards of safety, convenience and comfort. In case of persons with reduced mobility, the criterion of avoiding barriers is of particular significance. Those barriers might hinder or prevent the use of a given means of transport, or require changing it. Removal of such barriers is called 'barrier-free travel' [Pędziwiatr et al., 2017, Załuska et al., 2022]. There are numerous initiatives enabling barrier-free travel, among them: BAIM/BAIM PLUS [Pędziwiatr et al., 2017], aim4it [Starzyńska et al., 2015], MoViH [Fürst 2010] – Webpages created by transport operators, dedicated to given groups of users. German railways [Webpage of Deutsche Ban 2] and Czech railways [Webpage of České Dráhy] may be models of websites for the deaf and the hard of hearing. Information found on Webpages and in mobile applications dedicated to persons with disabilities should always be up-to-date and easy to find, as it impacts accessibility and is an important aspect of sustainable development [Ferreira et al., 2020].

The main aim pursued by the authors is to identify gaps in the adaptation of public transport to the deaf, and to indicate ways in which these gaps can be effectively addressed. The following functionalities of public transport at stations and in vehicles were analyzed: information displayed, spots where the deaf can obtain help traveling and Internet and mobile applications. Additionally, a survey was carried out, which examined the opinions of the deaf and the hard of hearing on the functioning of public transport in Poland.

2. Survey related to the assessment of public transport in Poland by persons with hearing impairment

The survey was directed only at persons with hearing impairment, it was carried out across the country (Warsaw, Poznan, Wroclaw, Cracow), and it was conducted using a specially prepared form on the Internet. The main objective of the survey was to assess the quality of public transport in urbanized areas in Poland, to identify problems of the deaf and the hard of hearing when using public transport, and to review chosen solutions improving the quality of public transport, directed at that group of the disabled. The survey included 71 persons, of whom 65% were women and 35% were men. The surveyed were mostly inhabitants of big cities (54%), who use public transport daily or several times a week (62%), with average travel time of 30 minutes. 59% of the respondents were 20-40 years old, active professionally and socially (persons working or studying) – 86%. Further questions in the survey regarded the level of hearing loss, the type of hearing aid and the ways of communicating with the surrounding.

According to the survey, the largest group consisted of persons with profound hearing loss above 90 dB – making up 65% of the total number. 17% of the respondents suffer from severe hearing loss (71-90 dB), and 11% from moderate hearing loss (41-70 dB). The smallest group were persons with mild hearing loss (21-40 dB) – 7% of the surveyed.

The respondents could indicate whether they use one or two hearing aids, or if they do not use it at all. 17% of them do not use a hearing aid. The largest group – 31% said they use two hearing aids. The second largest group use one cochlear implant – 22%, with 13% of the surveyed who use one cochlear implant and one hearing aid. Persons with two implants constituted 10% and with one hearing aid – 7%.

Methods of communicating with other people used by the respondents were as follows: 44% speak to communicate, but 42% use varied techniques – speech and sign language. Only 14% communicate with sign language exclusively. Figure 1 presents answers to the question: How important are the following aspects of public transport to you?

The surveyed indicated the following aspects of public transport were essential to them: travel safety (59%), adaptation to the needs of the deaf (54%), passenger information system and technical condition of the vehicles (52%), as well as adaptation to

the needs of the disabled (49%). Punctuality and frequency of departures were indicated by 47% of the surveyed. Travel comfort, travel time, synchronized connections and cleanliness in vehicles were important aspects for the respondents. Answers 'does not matter' and 'I do not have an opinion' did not exceed 10% of total answers.

Figure 2 shows answers to the question: How do you assess the following aspects of public transport in your city or urban area?

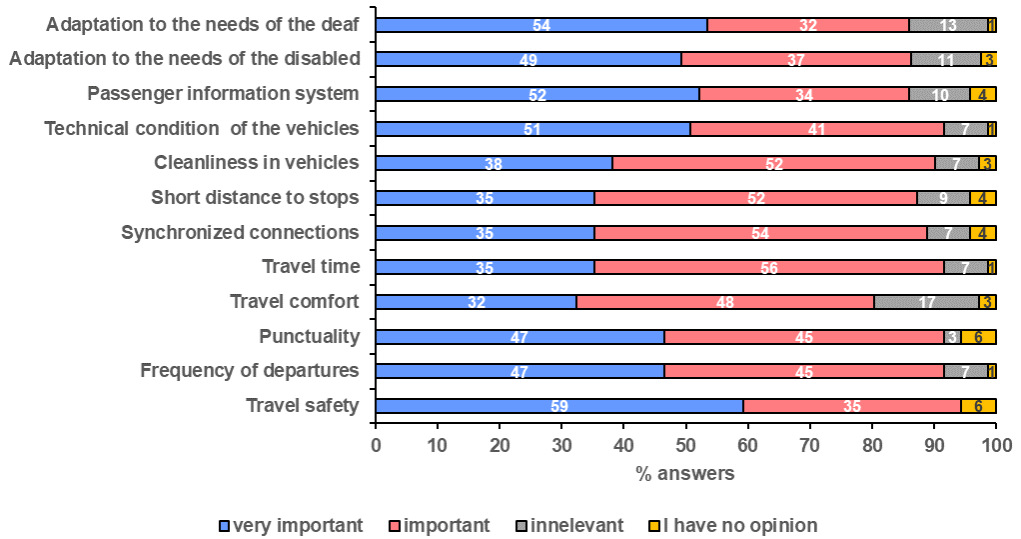

Fig. 1 Answers to the question: How important are the following aspects of public transport to you?

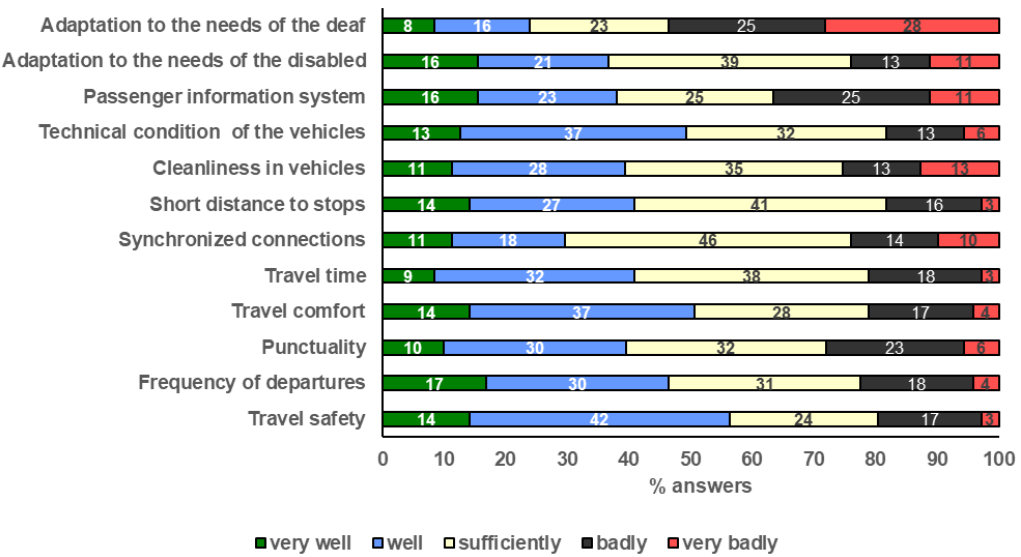

Fig. 2 Answers to the question: How do you evaluate the following qualities of public transport in your city or urban area?

The respondents assessed public transport as follows: very good – between 8 – 17%, good – 23 – 46%, sufficient – 13 – 25%, bad – 13 – 25%, very bad – 3 – 28%. The aspect assessed as bad and very bad was adaptation to the needs of the deaf. The passenger information system was rated by 25% as good, sufficient and bad.

Adaptation to the needs of the disabled was assessed as 'sufficient' – 39% of replies. 'Good' and 'very good' answers were given by 21% and 16% of the respondents respectively. Assessment of 'bad' and 'very bad' was in the brackets between 11% and 13%.

The aspect rated as very good and good – 42% and 14% respectively – was travel safety, the next was travel comfort – 37% and 14%, and technical condition of vehicles – 37% and 13% of the replies Next two questions of the survey regarded the functioning and adaptation of the passenger information system to the needs of the deaf, in vehicles, at stops, platforms and stations in Poland. Figure 3 shows answers to these questions.

The surveyed assessed the passenger information system in public transport vehicles and at stops, platforms and stations as sufficiently adapted to the needs of the deaf. This answer was given by 32% of the respondents for stops, platforms and stations, and 34% for vehicles. Respondents also gave assessment of 'badly' and 'very badly' – 18-25% of the answers. Only 10% of the surveyed gave the assessment of 'well' and 'very well'. Passenger information system in vehicles was assessed as very good by 17% of the respondents [Orczyk and Młodystach, 2022].

The results of the survey concerning assessment of public transport indicate that it is sufficiently adapted to the needs of the deaf.

3. Review of chosen technical measures facilitating the use of public transport for the deaf and the hard of hearing

3.1. Information displayed on boards at railway stations and platforms

The concept of universal design, in accordance with the UN Convention on the Rights of Persons with Disabilities, means the design of products, environments, programs and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed. Implementation of universal design solutions enables all people to have independent and free access to the public and digital space. [PKP, Zając 2015, Branowski, et al., 2022, Convention 2006].

The Technical Specifications for Interoperability obliges every member state of the European Union to eliminate identified barriers in accessibility of the rail system for persons with disabilities and persons with reduced mobility [EU Regulation, 2014]. The organizer of public transport is obliged to ensure adequate conditions of its functioning, in particular of standards pertaining to transport stops, stations and passenger information system [Act of 16 December 2010]. Several countries use the following examples to facilitate the use of public transport by the hearing impaired.

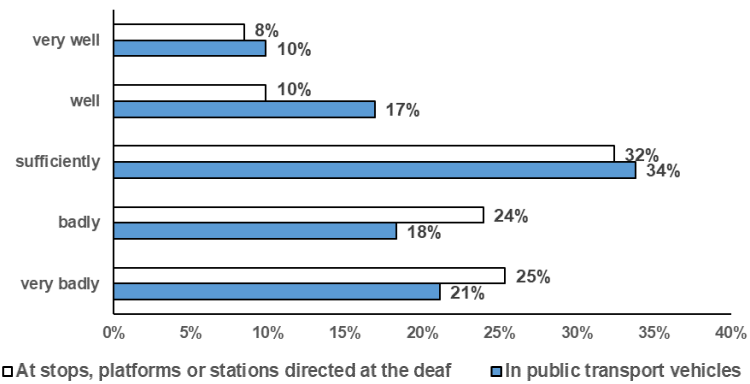

Fig. 3. Answers to the question regarding assessment of the passenger information system in vehicles and at stops, directed at the needs of the deaf and the hard of hearing [Source: Orczyk and Młodystach., 2022]

From the perspective of accessibility, visual information is of key importance for all passengers who have good eyesight, and especially for the deaf. This group of passengers, and in particular people with residual hearing, are unable to receive some if not all acoustic signals. Visual information encompasses any type of sign roads, pictograms and dynamic visual information systems.

The respondents were asked about the usefulness of a solution where an additional display is located next to the standard loudspeaker system. The display would give information on train delays or disruptions. An example of such a display found in Germany is show in figure 4. Another question regarded the justifiability of simultaneous visual and acoustic announcement.

Fig. 4. An example of a dynamic text messenger in Germany [Source: Webpage Archive]

The surveyed were positive that this type of solution would be useful – 92% of answers, 6% gave a negative reply, and 2% of the surveyed did not have an opinion on this subject.

Another question of the survey concerned the issue whether in order to improve the level of safety at railway stations it is important to inform passengers about the transit of a train without stopping. Examples of such solutions are show in figures 5 and 6. Figure 5 shows a display found at a train station in Germany, and figure 6 – a display at Salzburg Hbf train station in Austria.

90% of the surveyed confirmed the importance of a message informing about the train passing without stopping, with 7% of the opposite view and 2% of the respondents with no opinion on the subject.

Rail stations and stops give acoustic information about train delays, changes of platforms or impediments systematically, compared to visual messages, given less frequently. In order to make rail and city transport accessible to everyone, and in particular to the deaf and the hard of hearing, such information must also be conveyed visually. The British manager of rail infrastructure, Network Rail, uses a certain solution at a London train station – Euston, with 71 million passengers every year. Trains leave from this station in different directions, to Liverpool, Manchester, Birmingham, Edinburgh or Glasgow. It was the first station in the UK to give messages in writing and to display them translated to the British Sign Language (BSL) on screens next to departures and arrivals boards [Webpage Network Rail 1, Webpage Network Rail 2]. The view of the railway station with information about departures and arrivals presented simultaneously with information for the deaf is shown in figure 7.

Fig. 5. A display in Germany, informing of a train passing without stopping [Source: Młodystach 2021]

Fig. 6.a. Displays warning about the train transit in Austria: Achtung ZugFhrt! (Watch out! Train passing!) [Source: Młodystach 2021]

Fig. 6.b. Displays warning about the train transit in Austria: Bitte Vorsicht! (Watch out!) [Source: Młodystach 2021]

In addition, there are 10 information touch screens placed around Euston station, as shown in figure 8. Those screens display information written by rail staff during rail traffic disruption. The messages are translated into British Sign Language within an hour and sent directly to the screens through 4G network [Webpage Network Rail 2].

Messages concerning disruptions not related to the timetable are usually given only through loudspeakers, causing difficulties for persons with hearing impairment. They do not hear those messages and in addition, they have problems communicating with other passengers or transport staff. In such cases information based on symbols or pictures or simple text messages on information boards are useful. Moreover, this kind of information should be strengthened by a light signal, which would attract attention to messages regarding re-routing, disruption or danger. This led to another question in the survey: would a light signal be useful along with voice and visual announcements at stops and in vehicles. It was answered 'yes' by 92% of the surveyed, with 4% answering 'no' and 'no opinion'. Figures 9 and 10 show examples of strengthening the information system with light signals.

Figure 9 shows the doors of a Berlin metro train. Red lights are mounted on the doors, they turn on when the doors close and the train leaves. Prior to the light signal, a voice message asking to move away is played.

A person with hearing impairment may not hear the approaching tramway when crossing the street that is not equipped with traffic lights. An interesting example is found in Szczecin, Poland, with a LED display board warning pedestrians of an approaching tramway. Figure 10 shows the board with the picture of a tramway lit up to signal the tramway approaching to the pedestrian crossing.

Fig. 7. The view of a departures board with information screen for the deaf in Great Britain [Source: Webpage Network Rail 2]

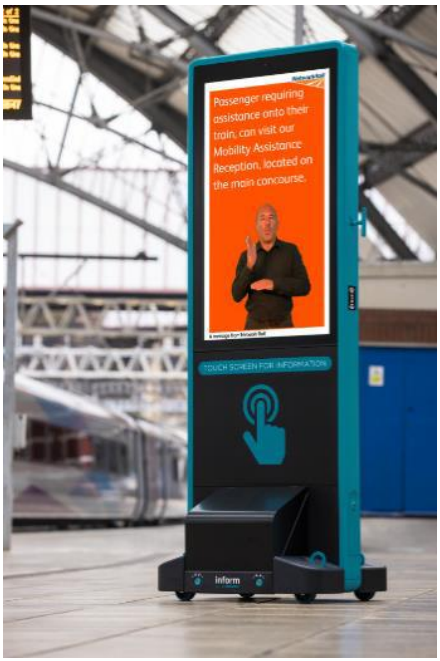

Fig. 8 An information touch screen for passengers in Great Britain [Source: Webpage Network Rail 2]

Fig. 9. Red lights on the doors of Berlin metro train [Source: Młodystach 2021]

Research carried out in France shows that animated graphic messages displayed on information boards at railway stations may be an effective tool to better inform the deaf. It is especially useful when voice announcements are given in a disrupted environment, or when unexpected traffic disruption occurs. Research proves that displayed information is less often misinterpreted, it is better understood; it is also preferred by most passengers, compared to other, more static formats of information. In addition, the ability to quickly process visual information by the brain, as well as the ability to quickly analyze picture have a positive influence on graphic animations. Young age, frequent use of public transport and a good knowledge of multimedia favor better understanding of such messages. Implementing animated messages at railway stations next to information displayed on boards and voice messages would also be helpful for other passengers, for example foreign tourists or people with intellectual disabilities [Paire-Ficout et al., 2013].

Fig. 10. A warning board with the picture of a tramway that lights up as the tram approaches – 3 Maja street in Szczecin, Poland – 'Beware of tramway' [Source: Młodystach 2021]

3.2. Passenger information systems

Passenger information is a key element of public transport. Passenger information system enables obtaining information about departures and displaying special messages (traffic disruption, re-routing, etc.). Such messages are presented on electronic information boards, or given as voice announcements

in vehicles and at stops, stations and platforms. The system is a great convenience for each passenger who has access to the latest information regarding given vehicle or line [Webpage PIXEL].

A well designed and used passenger information system found at terminuses and stops, as well as inside public transport vehicles, facilitates traveling and increases the comfort of everyday commute. It also gives information regarding the route, intermediate stations and the location of the vehicle at platforms. The system, connected to a mobile application, facilitates information search and quick transit of passengers. Railjet trains of an Austrian operator ÖBB are a good example. These trains are equipped with a passenger information system that gives information related to traveling on a particular train. Displays are located in every vestibule of the train carriage and below the ceiling. The screen shows the number and the list of stops of given train, so that the passenger knows they are in the right vehicle, and the platform number at the current station.

Moreover, the displays show the train direction with arrival times at stations. If there is a delay, the system automatically crosses out the planned arrival time and above it shows the updated arrival time, in orange. An example of how the system works is given in figure 11.

German ICE trains, similarly to Railjet trains, also have a system of passenger information. The boards show information about connections, delays and the possibility to change trains, along with the railway track number. The list of stations is shown in figure 12a, whereas the list of trains to change to – in figure 12b. Messages on the boards are clear and intuitive, with adequate font. Thanks to this, a passenger is fully informed about the journey.

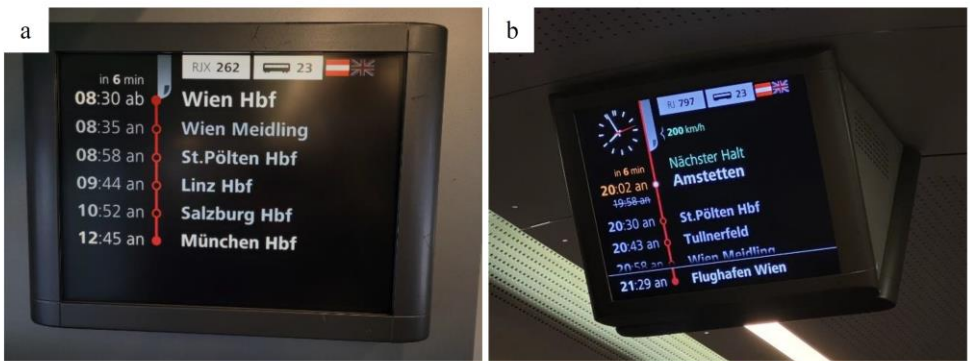

Fig. 11. Screens in trains with the route, arrival and departure times and stations in a Railjet train in Austria [Source: Młodystach 2021]

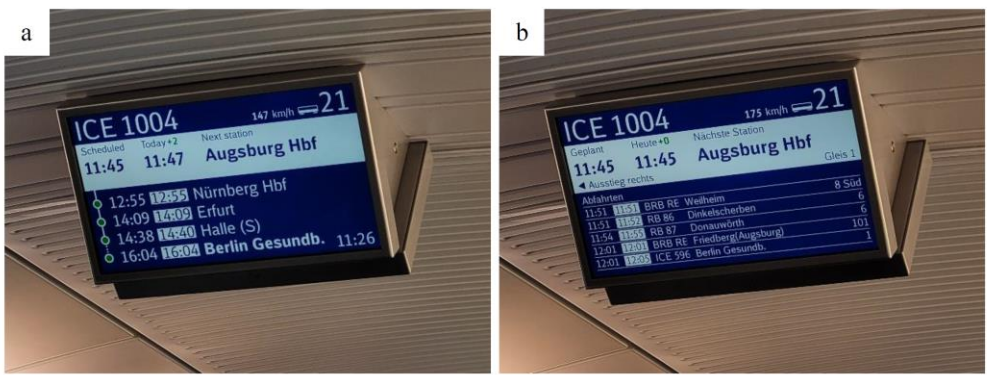

Fig. 12 Screens of passenger information system in a German ICE train [Source: Młodystach 2021]

Łódzka Kolej Aglomeracyjna (Lodz Urban Railway) is another example of how passenger information systems can work. Newag Impuls II is a vehicle equipped with an induction loop that facilitates hearing for persons wearing compatible hearing aids. Thanks to the induction loop, voice messages about arrivals and departures are better understood. Train guards working for Lodz Urban Railway carry tablets with an online sign language translator [Młodystach 2021]. New Stadler trains in Koleje Mazowiecke (Mazovia Railway) are also equipped with an induction loop for the hard of hearing [Webpage of the Magazine Rynek Kolejowy].

The solutions presented above help the hearing impaired better find themselves in an unusual situation. Information obtained about delays or disruptions at stations and platforms, enables planning an alternative journey or cancelling it. Full knowledge about disruptions gives certain comfort to persons with disabilities and eliminates the necessity to ask for help or a quick update on the journey planned.

Deutche Bahn dependent company – responsible for managing about 5,400 railway stations in the German railway network – carried out an accessibility analysis of approximately 9,300 platforms. On 30 November 2021 the company declared that 98% of stations it manages have screens of dynamic passenger information or Dynamischer Schriftanzeiger (DSA) on platforms. 99% of stations have DSA with an acoustic module on platforms. 93% of platforms have equipment accessible for the deaf or the hearing impaired [Webpage of Deutsche Bahn 1]. In the Polish railway network only 4.7% of passenger stations managed by PKP PLK have systems of visual information, and 116 of this group have systems with LCD screens [PKP Polskie Linie Kolejowe S.A.].

3.3. Areas where a deaf or hard of hearing passenger may obtain help during journey

Another question of the survey regarded the signage of areas where the hearing impaired may obtain necessary help during their journey. Did the respondents see the sign of a sign language translator or a spot with an induction loop at stations or ticket offices? Analysis of the replies confirms that 41% of the surveyed saw such signs, compared to 59% who did not. If respondents gave an affirmative answer, they were then asked to indicate where such signs were most often seen. The following were given most frequently: East Warsaw and Central Warsaw railway stations, Warsaw Public Transport Authority office at Central Warsaw railway station and at railway stations in bigger cities, i.e. Wroclaw, Katowice or Lodz. Figure 13 shows answers to questions related to places where a deaf or a hard of hearing person may obtain help connected with their journey.

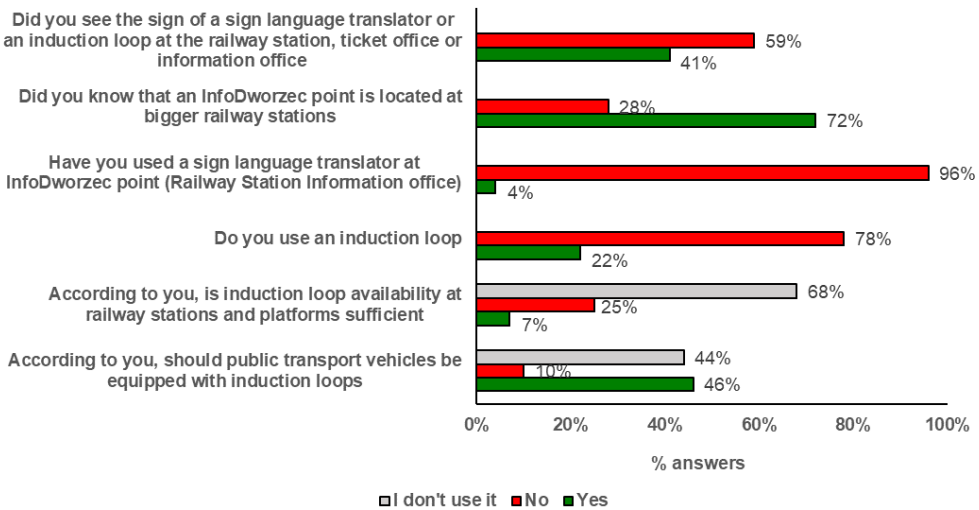

Fig. 13. Answers to questions related to places at a railway station where an induction loop or a sign language translator is available

A large part of the surveyed – 72% – saw the place called InfoDworzec at the biggest railway stations in Poland. InfoDworzec is a place where all travelers, including the disabled, may obtain help with their journey, including: city topography, public transport, tourist attractions, finding lost luggage. In addition, the deaf may use the help of a sign language translator or an induction loop. InfoDworzec points are found only at the biggest railway stations in Poland (Central Bydgoszcz, Central Gdansk, Central Gdynia, Katowice, Central Cracow, Central Poznan, Central Warsaw, East Warsaw, West Warsaw, Central Wroclaw) and they are open from 7 a.m. to 9 p.m. [Polskie Koleje Państwowe]. Outside these hours, travelers will not obtain necessary information regarding their journey. A good solution was implemented in the southern region of Great Britain in 2021 – SignLive service. It is a 24-hour sign language translation service, thanks to which passengers may get access to the station announcements or information connected with safety [Webpage Network Rail 2, Webpage Singlive].

Answers to the question whether the respondents use the service of sign language interpreting at InfoDworzec point show that they do not – 96% negative answers, with 78% of respondents who do not use the induction loop. A similar set of answers was given to the question 'According to you, is availability of induction loops at railway stations and platforms sufficient?': 68% of the surveyed replied they do not use induction loops, 25% said their availability is insufficient, and only 7% gave an affirmative answer. As far as induction loops in vehicles are concerned, 46% of respondents said it is justifiable, 10% replied 'no', and 44% of the surveyed do not use induction loops.

A similar situation can be observed connected with marking places where the deaf may obtain help: 59% of the respondents did not see the sign of an induction loop or a sign language interpreter at the railway station, ticket office window, with 41% of the surveyed who did see such signs.

3.4. Applications connected with accessibility of public transport accessibility to the disabled

Currently, a big facilitation for persons using the internet is information found on carriers' website. It is important for the information to be up-to-date, and if possible, given in real time. It is vital especially for connections, punctuality or disruptions.

One publication [Ferreira et al., 2020] gave an evaluation of websites of public transport carriers based on information regarding accessibility to the disabled. The main objective of the research was to verify whether the disabled could conclude a journey to a city abroad using only information included on the website of the public transport carrier. Several factors were taken into account for the analysis:

- whether the carrier's website can be found online using a free internet browser,
- translation of the content into English (or another foreign language),
- how easy it is to translate the content of the carrier's website with the help of a free translator tool,
- information regarding accessibility to people with disabilities on the main site and subsites of the carrier,
- the use of graphical symbols that signal accessibility in an intuitive way,
- giving information about accessibility to people with disabilities at individual stations,
- marking entrance and exit of the station,
- ensuring accessibility of the surrounding or transfers.

The research was conducted in 59 countries worldwide (Europe, Asia, Africa, Australia, North and South America), examining 212 systems. The results of the research indicated that no system is complete or detailed. None of the websites of carriers may be deemed a point of reference. The main conclusions of the research are as follows: 44% of the websites examined do not have English sites – thus they were unavailable to foreigners; information about accessibility to the disabled was difficult to find in 77% of the websites – each country researched has a different way of referring to accessibility to the disabled. The research showed that placing information about accessibility for the disabled on the main site is advantageous and increases the willingness to choose a particular city as the travel destination. Moreover, carriers' websites would be more accessible if they included graphical symbols. Conveying information with symbols facilitates access to information,

Dedicated applications or websites should also enable purchasing tickets or re-booking them, which is of vital importance for persons with mobile disabilities or those whose verbal communication is impeded. The possibility to use facilities related to

functionalities or internet information often enables performing necessary activities in spite of architectural and technical barriers.

An example of how important communication and access to information are for the deaf is the next question of the authors'survey: Do you use mobile apps connected with public transport, e.g. Jakdojadę, mobileMPK, Portal Pasażera? The surveyed were also asked to assess the mobile apps they use in Poland. 38% of respondents gave assessment 'very good', 31% - good, 18% - sufficient. Only 13% gave assessment of 'bad' and 'very bad'. An example of a functional mobile app dedicated to the disabled is BAIM/BAIM plus. This project is one of advanced information systems for persons with reduced mobility. It is a system of planning a journey that was created in cooperation of Verkehrsverbund Berlin-Bradenburg (VBB) with other public transport organizers [Pędziwiatr et al., 2017]. In this system, it is possible to find connections, taking into account the needs of a person with a disability, especially mobile disability, with the possibility to change trains/buses where a lift, ramp or escalator is available. Additionally, when changing, the system may also indicate the route from one station to the other. A mobile VBB app with the same functionality is also available.

Accessible and inclusive mobility for all with individual travel assistance – aim4it in short – an international project, may also appear helpful. The aim of the project was to create a mobile app for a smart phone that would facilitate access to a virtual journey assistant on public transport for passengers with locomotor, visual or auditory dysfunctions. This app can help plan the journey, taking into account the special needs and requirements of a person with a disability, as well as change the journey plan due to a lift failure, delay of a line, or traffic disruption. Functionalities such as a demand to be assisted by the driver, translation of announcements regarding dangers into sign language or a demand to adapt connections when changing trains/ buses by the disabled are also available in the app. At the beginning of 2016 this app was demonstrated and positively evaluated in Vienna by participants of the app test [Statistics Poland 2013, Starzyńska et al., 2015].

Another aspect of proper communication are carriers' websites dedicated to the deaf. Currently in Poland there is no website run by carriers dedicated to the deaf. On the website of PKP S.A. there is a directory of railway stations with information if and how a given station is accessible to people with disabilities. It is however recommended to ensure this information while searching for a connection or buying a ticket on the website of a carrier. Finding facilities should be easy and intuitive, as opposed to a time-consuming search for information of interest [Polskie Koleje Państwowe].

The website of a German carrier Deutsche Bahn (DB – Germain Railway), created specially for people with hearing impairment, gives most important information regarding own journey. Passengers can find information about current traffic situation, punctuality, report lost property or a failure by sending a text message to the mobility centre (Mobilitätsservice-Zentrale). Additionally, Deutche Bahn has its own YouTube channel, where it places films in German sign language, subtitled, giving information on reserving seats, IT and mobile services, as well as passengers' rights, with a functionality of praising or criticizing the railway staff [Webpage of Deutsche Ban 2].

The website of České Dráhy (ČD – Czech Railway) also gives information about services for the hearing impaired. This website has plans of railway stations along with the existing infrastructure around them, a passenger information system at stations and in trains, and it encourages passengers to download the app 'Můj vlak'. The app facilitates searching railway connections, buying a ticket, obtaining information about services and accessibility and current information – delays or disruptions on the route of a chosen train [Webpage of České Dráhy].

Understanding regulations, agreements and similar documents poses another problem for the deaf. The complex language of such documents is incomprehensible for people using sing language. 45% of the surveyed gave an affirmative answer to the question: Do you find it difficult to understand regulations and information regarding means of public transport. 41% of the respondents did not find it difficult, and 14% did not have an opinion. Moreover, 75% of the respondents claimed regulations and information should be given in a shortened version, specially prepared for the deaf. 20% of the surveyed did not have an opinion, and 5% claimed it was not necessary [Młodystach 2021].

4. Summary and conclusions

The paper presents results of survey research in a group of the deaf and the hard of hearing. The objective of the research was to evaluate the level of adaptation of means of public transport and the related infrastructure in Poland to this group of people. The analysis carried out led to several significant conclusions for the improvement of mobility of the deaf and the hard of hearing.

According to this group of people, crucial elements of public transport are:

– travel safety,
– technical condition of vehicles,
– accessibility to persons with hearing loss and other disabilities,
– passenger information system.

As regards the functioning of public transport, the quality assessed the worst was adaptation of public transport to people with hearing impairment and other disabilities – 25% gave assessment of 'bad' and 28% - 'very bad'. Assessment of 'good' and 'very good' was given to: travel safety and travel comfort. The passenger information system in vehicles and at stations is 'sufficiently' adapted to the needs of the deaf and the hard of hearing. The system in vehicles was assessed as 'very good' by 17% of the surveyed.

Solutions presented in this article, in particular concise written messages and easy-to-read information are extremely useful for the deaf and the hard of hearing – they facilitate understanding announcements. As the survey shows, 55% of the respondents have problems when communicating with the ticket office staff. Ticket machines with a wide range of tickets could be a solution. Technology available today can help eliminate the discomfort experienced by the hearing impaired in direct contact with another person when obtaining passenger information or buying tickets.

Staff training in the area of appropriate behavior towards not only the hearing impaired, but also towards people with other disabilities, does not always bring expected results. Some behaviors often depend on the character, individual approach or the ability to feel empathy. Technological development, increased access to information on the internet, as well as the development of mobile apps, enables a wider and easier use of existing tools. Thus, people with disabilities have wider access to the expected and required solutions.

The role of architects, urban planners or constructors, who are often unaware of the influence of their solutions on the mobility of the deaf, cannot be overstated. It is recommended that they cooperate with a given group of the disabled in order to create the best solutions.

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