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Evaluation of systems and devices used in cars by the drivers and passengers with disabilities – results of pilot research¹

Układy i urządzenia stosowane w samochodach w ocenie kierowców i pasażerów z niepełnosprawnościami – wyniki badań pilotażowych

Abstract

Since 2015, the Automotive Services Centre has been operating at the Motor Transport Institute for Disabled People (CUM) and since 2021, as part of the project entitled Knowledge Centre on Accessibility to transport and mobility for people with special needs (CWoD), there has been an information and consultation point active in which road users with disabilities, and in particular users of individual transport – drivers and passengers of passenger cars – can obtain information that will facilitate their functioning in road traffic. Part of customer service for people with disabilities is collecting information, also for scientific and research works. From November 2022 to June 2023, as a pilot research, interviews were conducted with beneficiaries of the above-mentioned entities, in order to learn their opinions on the systems and adaptive devices they use in cars. The results of this study, presented in this article, allowed for the development of general recommendations regarding advising people with special needs (PSN) – users of individual transport, the implementation of which would improve the quality of services in this area.

Keywords:

people with special needs; users of individual transport; advising people with disabilities; systems and devices in passenger cars dedicated to people with disabilities

Streszczenie

Od 2015 r. przy Instytucie Transportu Samochodowego działa Centrum Usług Motoryzacyjnych (CUM), a od 2021 r. w ramach projektu Centrum Wiedzy o Dostępności do transportu i mobilności dla osób ze specjalnymi potrzebami (CWoD), również punkt informacyjno-konsultacyjny, w którym niepełnosprawni użytkownicy dróg, a w szczególności użytkownicy transportu indywidualnego – kierowcy i pasażerowie samochodów osobowych – mogą uzyskać informacje, które ułatwią im funkcjonowanie w ruchu drogowym. Częścią obsługi klienta osób niepełnosprawnych jest zbieranie informacji – także do prac naukowo-badawczych. Od listopada 2022 r. do czerwca 2023 r. przeprowadzono badania pilotażowe – wywiady z beneficjentami ww. podmiotów, mające na celu poznanie ich opinii na temat systemów i urządzeń adaptacyjnych stosowanych przez nich w samochodach. Wyniki tego badania, zaprezentowane w artykule, pozwoliły na opracowanie ogólnych rekomendacji dotyczących doradztwa dla osób ze specjalnymi potrzebami (OSP) – użytkowników transportu indywidualnego, których wdrożenie pozwoliłoby na poprawę jakości usług w tym zakresie.

Słowa kluczowe:

osoby ze specjalnymi potrzebami; użytkownicy transportu indywidualnego; doradztwo dla osób z niepełnosprawnościami; systemy i urządzenia w samochodach osobowych dedykowane osobom z niepełnosprawnościami

JEL: L62, L99, J14, R49

Introduction

In the European Union people with disabilities account for approximately 15% of the population; 25% of European adults struggle with some form of disability². Using the criterion of biological disability, the population of people with disabilities in Poland can amount to between 5.3 million people and 9 million people, i.e. from 14% to as much as 25% of citizens (Biuro Pełnomocnika Rządu do spraw Osób Niepełnosprawnych, n.d.; GUS, 2012; 2021). The most common causes of disability are diseases of the musculoskeletal system, circulatory system and neurological ones (WHO, 2020).

Every year, over 300,000 persons obtain driving licenses in Poland and only 0.1% of them are people with disabilities³. According to data from the CWOD, verified on an ongoing basis since 2021, 40 driving schools in Poland declare the possibility of training candidates for drivers with disabilities. 18 entities sell adaptive devices or adapt vehicles to the needs of drivers with disabilities (driving schools and adaptation companies locations in voivodeships are shown in Figure 1). At the same time, there are approximately 7,000 entities in the country conducting training activities for driver candidates⁴.

This stands as an evidence that there are still:

- insufficient access to training and adaptation services and their variants dedicated to this diverse group of people;

- excessive costs related to participation in the process of obtaining driving licenses for people with disabilities and adapting car to their needs;
- inadequate awareness of the possibilities of using individual transport, available technical solutions and obtaining support in this area.

A part of customer service for persons with disabilities at CUM/CWOD is collecting and contributing information not only to develop/provide respondents with professional answers/help/support, but also to provide data supplementing scientific and research work, aimed, among the others, at understanding the profile of people with disabilities who need support and assessing the systems and devices they use in cars. These elements are the subject of this study.

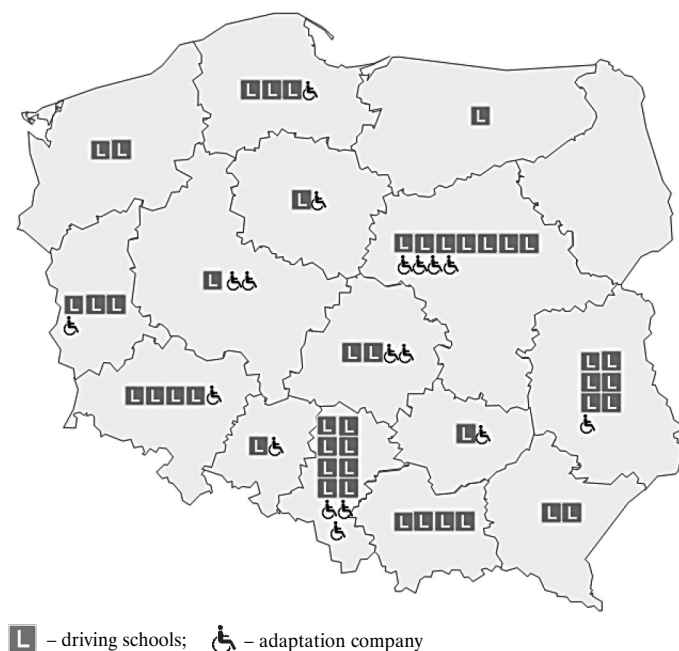
Concept of pilot research

Interviews with beneficiaries of the information and consultation point

In order to characterize people with special needs – beneficiaries with disabilities (drivers and passengers) who need support in the field of individual transport – and to get to know their opinions on the devices and systems they use in

Figure 1

Distribution of driving schools and adaptation companies in individual voivodeships of Poland



Source: author's own elaboration on the basis of: Górska & Błaszczak, n.d.

cars, between November 2022 and June 2023 interviews were conducted with beneficiaries of CWOD and CUM who used the services of both entities at that time. A questionnaire was used to collect information (Cohen et al., 2007). Respondents completed it anonymously – in person or electronically. The activity was preceded by a discussion of the purpose of collecting information and an explanation of the content of the tool. The questionnaire consisted of several chapters, and each chapter consisted of several parts including both open and closed questions regarding the respondents themselves, their health condition, also in relation with travelling as a driver/passenger; experiences as drivers/passengers, including as people with special needs. Respondents were also asked to make general assessment of devices/systems, as well as their individual elements/features using a scale of 1–5, where 1 means very low and 5 means very high. A total of 23 interviews were collected, of which 14 with drivers and 9 with passengers.

The small number of participants may result from:

- insufficient knowledge about the functioning of information points and the possibility of using this type of counselling,
- meeting the needs of drivers and passengers with disabilities in the field of counselling in the region resulting from a larger number of similar facilities and access to them (e.g. Office of the Government Plenipotentiary for Disabled Persons, municipal offices, State Fund for Rehabilitation of Disabled Persons – PFRON), and within it information and advisory Centres for people with disabilities and a Support service system; Provincial Road Traffic Centres; foundations; associations; adaptation companies; driver training centres, etc.),
- low interest of beneficiaries in participating in scientific research.

The findings presented and the resulting conclusions are mainly of an illustrative nature, showing an exemplary approach to the analysis of survey data. It should be noted, however, that 14 drivers account for as much as 4% of the total annual population of people with disabilities obtaining qualifications to drive a passenger car (B category) in Poland. In this context, the result no longer seems as low (Stasiak-Cieślak et al., 2023). Rankings of systems/devices for people with disabilities are available in international sources⁵. Some scientists investigate selected aspects related to, for example, the functioning of the disabled driver's body (Ucińska & Stasiak-Cieślak, 2016) and the operation of adaptive devices (Stasiak-Cieślak, 2022). The issue is niche in nature. In Poland, it has a pioneering character.

Data regarding respondents

Data describing the respondents include their age, gender, driving experience and experience in using devices that adapt the car to the needs of people with motor dysfunctions.

The persons surveyed were between 20 and 60 years of age, with no specific age prevailing within the study group. Men were in slight majority (7) compared to women (5). Most respondents use a car in a big city.

In most cases, a driver's practice ranged from 11 to 25 years. This indicates sufficient time to gain experience behind the wheel. Only two persons had had a driving license for 6 to 10 years, nobody had shorter driving experience. One person interviewed had had a driving license for over 30 years. The effects of driving experience as a disabled person are very similar. Only one person's dysfunctions appeared after having obtained the driving license. This means that those surveyed had substantial experience in using adaptive devices.

Only the last adaptive device in use was evaluated in the survey. Its period of use was relatively short, from 0 to 2 years. When asked in the survey whether the assessed device was the first one a given person had ever encountered, most people answered negatively.

Summing up, drivers with disabilities using systems and devices dedicated to them are:

- using the vehicle mainly for private purposes;
- unspecified in terms of their age (but younger than 55) or gender;
- mostly having higher education;
- coming from the large city and region where the consultation point is located;
- being drivers with several or even dozens of years of experience, including as persons with disabilities;
- to an equal extent with retained and not retained other body functions affecting driving, such as, for example, paresis of lower limbs, paraplegia, spina bifida, paresis of lower and upper limbs, lack of lower limbs with the ability of upper limbs;
- divided into those who are using and those who are yet to use various solutions for PSN drivers, such as, for example, another rim under the steering wheel; another rim above the steering wheel; other pull-push devices; a stick with a shifter under the steering wheel.

Data on devices

Data describing adaptive devices refer to their type and manufacturer, both in relation to adapting the braking system and controlling the vehicle's acceleration. Most people (10) use an adaptation of the braking system in the form of a hand brake lever. Two people did not answer this question.

To control the car's acceleration, half of the surveyed use a pull/push stick, i.e. a device combined with the brake lever. The remaining ones use: the rim located both under and above the steering wheel, and two people use the shifter located on the brake lever.

Regarding the brands of devices (both those adapting the braking system and the acceleration system), most respondents did not provide any information. In the few surveys that contained such information the following manufacturers were mentioned:

- brake operating devices: Veigel (2 persons), Cebzon (2 persons) (Figure 2 and Figure 3);
- acceleration control devices: Veigel (2 persons), Ghost (2 persons) (Figure 2 and Figure 4).

Figure 2

Veigel pull/push device



Source: Motor Transport Institute.

Figure 3

Cebzon pull/push device



Source: Cebzon.

Figure 4

GHOST hoop device/rod under the steering wheel (brake) by Guidosimplex



Source: own work.

These devices were mostly new (used for a few months) or several years old.

Sources of financing for the purchase of a device used by drivers with disabilities included own funds; PFRON funds; own funds with funding from PFRON and NGOs; own and NGOs. The devices/systems used and assessed were purchased in Warsaw.

Usage ratings

The evaluation of usage included questions about many elements of each solution regarding their level of ergonomics, precision of operation and physical strength required from the driver. Unfortunately, most of the questions in this part of the survey were omitted. Based on sparse data in this area, the following information can be provided.

When assessing the precision of devices' operation, the highest rating prevailed – 5 (8 persons). Only two persons rated their precision highly – 4. The ease of operation ratings were slightly more spread out. The highest rating also prevailed, but there were also 3 and 4 rates. No one rated the ease of operation low or very low. The level of ergonomics assessment was very similar to the ease of use. It is possible that the respondents failed to fully understand the difference between overall ergonomics and ease of use of the device.

Respondents highly rated the features of devices that meet the criteria of universal design, such as:

flexibility of use, error tolerance, and minimizing physical effort. Vast majority of users had no difficulties in using the systems and devices dedicated to them. Also, vast majority of the latter never required repair.

The overall rating of the devices was dominated by two ratings: high and very high. Only one person rated their device average. Despite high ratings, two persons would not recommend the reviewed devices to other drivers. Selected elements of devices/systems assessed by drivers and their results are presented in Table 1.

Correlations

As part of the analysis of the survey results, the overall assessment of the devices was compared with the data about persons. The following conclusions were drawn:

- Comparison of the average rating with the age of the respondents shows a slight negative correlation. The rating drops slightly as the driver ages.
- Comparison of average grade with gender shows no correlation.

Table 1
Selected elements of devices/systems as rated by drivers

Assessment of functionality/usability of the system/device by drivers with disabilities	Average rating	Other features according to users	Average rating
Manipulation (rotating/turning) – precision of movement	Very high	The material from which the system/device was made	Very high
Manipulation (turning/rotating) – twisting of the wrist	Very high	Form (arrangement of elements)	Very high
Manipulation – transfer of force from the hand through the handle onto the device	High	Construction (ergonomics)	Very high
Manipulation (handle, knob) – hand strength required	High	Construction (proportions)	Very high
Pressure force of the upper limb (bar, lever)	High	Safety of use	High
Pressure force of the hand on the handle (downward movement)	High	Ease of use	Very high
Hand/finger pressure force on the rim	Very high	Satisfaction from use	Very high
Force of hand (fingers) pulling up the rim to the steering wheel	High	Accuracy of passive movement of the device(when the vehicle is stationary)	High
Pressure force of the upper limbs on the bar, brake lever	High	Accuracy of active movement of the device (while the vehicle is moving)	Very high
Pulling force of the upper limbs (bar, lever)	High	Degree of stress during use – lack of confidence, fear of improper use	Low
Ergonomics of the grip (maintaining the anatomical shape of the hand) on the bar, lever, handle	High	Aesthetics of the system/device – workmanship of the entire system/device	Very high
Range of maximum movement (if applicable)	High	Aesthetics of the system/device – workmanship of individual elements	High
Minimal movement range (if applicable)	Very high		
Functionality compliance with a rule, specification, policy, standard or law	Very high		

Source: own elaboration.

- Comparison of the rating with the number of years of use of the device does not show any significant correlation.
- Similarly, no significant correlation was observed comparing the grade with the respondent's driving experience.

In the further part of the analysis, the evaluation of the devices was compared with the data on the devices themselves. The following conclusions were drawn:

- Comparison of the overall rating of the operator's type acceleration device showed that the rim mounted under the steering wheel was most favourably seen.
- A similar comparison was not made for the brake due to the lack of diversity in the devices used.
- The overall rating was also compared to the acceleration operator's brand. The brand with the best results was: GHOST (better than the average rating). The Veigel brand performed less favourably (below the average) (Stasiak-Cieślak et al., 2023).

Solutions for passengers with disabilities

Nine persons took part in the survey. As with the previous survey, this is a small number to analyse. Therefore, the high uncertainty of the conclusions must be taken into account. Data describing the surveyed persons with motor dysfunctions concern age, gender and experience in using devices that adapt the car to their needs. Due to the fact that the passengers are people with various types of disabilities, some surveys were completed together with the driver or by the driver – a person indirectly using the device, e.g. operating it in the car.

Data regarding respondents

The respondents were aged between 9 and 90, most of them between 40 and 80. This is quite a wide range of age, considering how small group was. Of them, 6 were men and 3 were women.

The devices were used mainly in urban conditions (only one person lives in a rural area). Half of the respondents live in a large city, another half in a smaller town.

While the age of the device assessed ranged from 0 to 8 years, in most cases it was less than one year. This means that the respondents had not used the device for long.

In half of the cases, the device being assessed was the first one the surveyed person had.

Therefore, passengers with disabilities using systems and devices dedicated to them are:

- unspecified in terms of their age or gender, including children;
- with various levels of education;
- coming from towns of various sizes and regions of Poland;
- suffering or not from other body functions that affect travel as passengers, such as, paresis of lower limbs and upper limbs, amputation of lower limbs, paraplegia;
- with little experience in using similar solutions for passengers with disabilities.

Data concerning the devices

Data describing adaptive devices include their type and manufacturer, although most people did not mention the brand. Among the devices used, the most common is an elevator (6 persons), followed by additional seat belts (4 persons), then a ramp (3 persons) and a swivel chair (3 persons), while the least common is docking a wheelchair (1 person).

Regarding device brands, most persons provided no information. The only two persons who provided such information mentioned the Cebtron company. This concerned devices: run-on platform (ramp) by FEAL and additional seat belts (Figure 5 and Figure 6).

These devices were mostly new (used for several months). Sources of financing for the purchase of a device used by passengers with disabilities included their own funds or own funds and PFRON. Some respondents took advantage of an option to rent a device. The devices/systems used and evaluated were purchased in Warsaw.

Usage ratings

The usage evaluation included questions about many elements that contribute to ease of use and safety. Unfortunately, many questions in this part of the survey were omitted. Based on incomplete data in this regard, the following information can be provided. In the assessment of the ease of use of the device, the highest rate prevailed (7 persons). One person rated the device high – 4, and one person rated it average – 3. In the context of user safety, all respondents rated the devices very highly – 5. Similarly to the drivers' survey, passengers or their assistants were also asked about the level of ergonomics. It is possible that the surveyed people did not fully appreciate the difference between ergonomics in general and the ease of using the device.

Figure 5
FEAL overrun platform, assembled by Cebzon



Source: Cebzon.

Figure 6
UNWIN overrun platform, assembled by Cebzon



Source: Cebzon.

Table 2
Selected elements of devices/systems as rated by passengers or assistants

Assessment of the functionality/usability of the system/device by passengers or assistants	Average rating	Other features according to users	Average rating
Easy guiding the wheelchair	Very high	Material from which the system/device is made	Very high
Securing the wheelchair	Very high	Form (arrangement of elements)	Very high
Passenger protection (e.g. Backrests, headrests)	High	Construction (ergonomics maintained)	Very high
Wheelchair docking	Average	Safety of use	Very high
Wheelchair securing rails	High	Safety of use	Very high
Straps securing the wheelchair	Very high	Ease of use	Very high
Swivel chair functions	Very high	Reliability of electronic functions	Very high
Functionality compliance with a rule, specification, policy, standard or law	Very high	Satisfaction of operation	Very high
Aesthetics of the system/device according to users – workmanship of the entire system/device	Very high	Degree of stress during use – lack of confidence, fear of misuse	Average
Aesthetics of the system/device according to users – workmanship of individual elements	High		

Source: own elaboration.

Respondents rated very highly the features of devices that meet the criteria of universal design, such as: flexibility of use, clear information/instructions for use; error tolerance. Minimizing physical effort was rated average. The level of stress associated with

the use of the solution by the transported passenger and the caretaker who installs the device is noteworthy – these issues certainly require improvement. Vast majority of users had no difficulties in using the systems and devices

dedicated to them. The devices/systems did not require repairs during use. The overall rating was dominated by very high rates (6 persons), with three respondents giving high rating – 4. Despite this, two persons would not recommend using evaluated devices to other passengers. Selected elements of devices/systems assessed by passengers and their results are presented in Table 2.

Correlations

As part of the analysis of the survey results, the overall assessment of the devices was compared with the data about the respondents. The following conclusions were drawn:

- The comparison of the average rating with the age of the respondents shows no correlation.
- Comparing the average grade with gender also shows no correlation.
- The comparison of the assessment with the period of use of the device shows a statistically insignificant correlation.
- The average rating is the same for residents of large and small cities.

In the further part of the analysis, the assessment of the devices was compared with data on the devices themselves. The following conclusions were drawn:

- Devices such as: elevator, swivel chair and wheelchair docking received the highest average rating.
- An overrun platform received a slightly lower average rating.
- The additional seat belt device received the lowest average rating (although still above the high rating).
- The only manufacturer (Cebtron) indicated by the respondents received a lower rating than the most common one (it was usually rated high, but not the highest) (Stasiak-Cieślak et al., 2023).

Summary

It should be emphasized that the number of surveys was not sufficient to clearly evaluate the devices. The results should therefore be treated as examples, showing the methodology of activities and analysis of results, but also, to some extent, should indicate directions for future activities and current areas for improvement.

As for drivers with disabilities-users of devices, demographic data such as age, gender, and driving experience were only slightly correlated with the evaluations regarding the adaptive devices used.

However, an interesting impact of the devices themselves upon the respondents' assessment was observed, although this may have been accidental, resulting from a small number of surveys. The respondents deserve special attention – they are drivers with disabilities who, despite an imperfect system of providing assistance to PSN in Poland, are independent road users, thanks to, inter alia, greater access to adaptation services (originating from central Poland), own determination, and financial resources – own as well as obtained.

As for passengers, demographic data such as age, gender and driving experience did not correlate with the ratings regarding the devices used. However, also in this group there was a noticeable influence of the devices on their evaluation by the respondents, although this influence could have been accidental, resulting from the small number of surveys.

Noteworthy in both surveyed groups is the number of PSN for whom the device was the first adaptation used: 5/14 in the group of drivers and 5/9 in the group of passengers. It is therefore difficult to form an opinion on the various features and correct functioning of such a device if one have not yet had an opportunity to compare it with other ones available on the market.

If more extensive research is carried out using this method, obtaining an overall assessment of individual devices and their manufacturers by the users will be possible.

Taking the above information into account, the following is recommended:

- monitoring the number of beneficiaries and their needs in order to better understand the population of the PSN – drivers and passengers of individual and public transport who should be supported;
- educating employees of entities whose activities are related to individual transport and public of PSN in terms of learning about the needs of these groups and enabling them to function freely and safely use the transportation services;
- consolidation of advice on transport availability for the PSN, including road transport – individual and public one;
- conducting educational activities aimed at making the PSN familiar with the sources of knowledge on their rights and support options, including easy travel;
- creation of regional/provincial support points for the PSN regarding travel;
- supporting the community of designers and adapters in order to design, produce and promote solutions at an increasingly higher level;
- providing potential users with access to modern solutions and the possibility of free testing and selecting them (i.e. not the one that is cheaper,

- available, "almost fits", but the one that is really most suitable for the user);
- creating conditions for certification of individual transport devices dedicated to drivers and passengers with disabilities;
- supporting the training environment regarding the expansion of activities dedicated to candidates for drivers with disabilities;
- creating a comprehensive support system covering all groups of road traffic participants, including drivers and passengers among the PSN, enabling them to freely and safe travel.

Notes/Przypisy

¹ The study was prepared on the basis of the material entitled: *Monitoring the effectiveness of systems and devices introduced in cars in the context of the needs of their users with disabilities*, Internal report of the Team of the Motor Transport Institute on subtask of task 1 of the Knowledge Center project on accessibility to transport and mobility of people with special needs (POWR.03.05.00-00-CW07/20). Source of financing: subsidy from the Ministry of Education and Science.

² *Niepełnosprawność w UE w liczbach*, www.consilium.europa.eu/pl/infographics/disability-eu-facts-figures/ (access: 15.09.2023).

³ *Statistics from SI CEPiK*, www.cepik.gov.pl/statystyki (access: 18.09.2023) and data received from Polska Wytwórnia Papierów Wartościowych, 2023.

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