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Beata Stasiak-Cieślak*, and Iwona Grabarek

The method of selecting adaptive devices for the needs of drivers with disabilities

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Abstract: This article presents the research which resulted in the creation of the method of automatic selection of adaptive devices for the needs of drivers with motor disabilities – ASA System. An expert system was used to build the method, which used databases from various fields of knowledge in the inference process. The databases were created on the basis of an analysis of the literature on the mobility of people with disabilities, a review of the operation of companies specializing in adaptations, verification of adaptive devices in terms of their functions, as well as various categories of disability. The knowledge of the individual selection of adaptive devices and expertize in this area made for specific recipients were used. Based on the accumulated knowledge, a simplified division of adaptive devices and classification of disabilities were implemented. The conclusions from analyses made it possible to formulate the rules necessary for the application process. A comparative analysis of the degree of consistency between the selection of devices generated by the ASA System (automatically) and the selection made by three experts (individually) for 44 people with various motor disabilities, was carried out. The results obtained confirmed usefulness of the expert system in building the method of automatic selection of adaptive devices, as well as the rightness of automating this process, due to the objectivity of the proposed method in comparison with individual, subjective selection carried out by experts.

Keywords: adaptive devices, adaptation, expert system, disabled driver, disability

*** Corresponding author: Beata Stasiak-Cieślak,** Department of Diagnostic and Maintenance Processes, Automative Services Center for People with Disabilities, Motor Transport Institute, Warsaw, Poland, e-mail: beata.stasiak@its.waw.pl
Iwona Grabarek: Department of Information and Mechatronic Systems in Transport, Faculty of Transport, Warsaw University of Technology, Warsaw, Poland, e-mail: iwona.grabarek@pw.edu.pl

1 Introduction

Mobility is one of the most important needs of every human being, influencing social and professional mobilization, enabling the implementation of tasks resulting from social functioning. Without it, it is difficult to imagine that a person with a disability will be able to fulfil his or her basic existential needs, allowing for self-fulfilment in society. Mobility is also dealt with in a synthetic way in the Convention on the Rights of Persons with Disabilities, adopted by the United Nations General Assembly in the form of an international human rights agreement to protect the rights and dignity of people with disabilities. This document states that people with disabilities have the right to unrestricted movement through:

- facilitating the mobility;
- facilitating access to high-quality mobility aids, devices, and assistive technologies;
- encouraging entities that produce mobility aids, devices, and assistive technology to take into account all aspects of the mobility of people with disabilities.

The Convention on the Rights of Persons with Disabilities was adopted by the United Nations General Assembly in 2006, and became effective in 2008. In total 156 states are parties to the Convention (June 2015). The party to the convention is the European Union. Poland ratified the convention only in 2012.

Referring to the above provisions on mobility, it is impossible not to take into account the details of adaptive devices (products facilitating mobility), because in the case of people with disabilities, functional deficits are substituted precisely, thanks to these products necessary for professional mobility, on the same terms as non-disabled people. It is therefore worth providing the following technical driving aids:

- device for manual operation of acceleration, brake and clutch, assisted use of steering and braking system;
- relocating braking to the right side of the steering wheel;
- device for manual acceleration control – rim, brake;

– device for central vehicle control;
– moving the gas pedal to the left side;
– holder mounted on the steering wheel of the vehicle;
– accelerator pedal lock, pedals cover;
– extension of the pedals, lifting of the floor;
– swivel seat, seat modification;
– elevator, ramps, rails;
– four-point belts, individually modified belts;
– other devices on individual order (signalling control in an alternative way).

The basis for considerations in the field of the described mobility method was the idea of developing a new system for the selection of adaptive devices using expert systems as one of the elements of artificial intelligence [1]. The analysis of the issues showed the complexity of the process of selecting adaptive devices in vehicles for people with disabilities. There are no comprehensive solutions that would include the automation of this process and would take into account the provisions regulating the use of solutions that interfere with the technical aspects of vehicles. Automating this process is a new proposal to standardize this procedure, leaving individual selection for later.

2 The state of knowledge in the field of mobility

Adapting the vehicle to driver's needs requires correct selection of adaptive devices. A large variety of motor limitations do not facilitate this process, therefore research is carried out in this field to gain knowledge about the usability and effectiveness of the solutions used.

The aim of the study by Björn [2] was to determine the burden related to the work of drivers with disabilities. The comparison of driving by the drivers with a spinal cord injury (26 people with quadriplegia) with driving of able-bodied people was made in a driving simulator. Quadriplegic drivers used two types of hand controls for acceleration and braking, while fit drivers used standard pedals. Drivers with disabilities performed the task of driving equally well as the control group, but they had a longer reaction time. Research has shown that the task required more effort for disabled drivers than for physically fit drivers. They also felt more fatigue related to the performing braking and acceleration activities. The observed differences were interpreted as a result and, at the same time, an indicator of the level of maladjustment of the adaptive devices.

The aim of the Engkasan et al. study [3] conducted in Malaysia was to test the ability of patients to return to driving a car after lower limb amputation and to examine the factors that significantly affect this ability. The criteria for selecting the research sample were age of the participant (over 18 years of age), unilateral or bilateral lower limb amputation, and driving at least 6 months before amputation. Data were collected through a structured questionnaire which showed that 45.6% of respondents returned to driving within 1–72 months after amputation. The main reasons for returning to driving were: extracurricular activities (65.8%), return to work (19.5%) and hospital visits (12.1%). Of the 32 participants, 15 had a right-sided amputation, 14 had a left-sided amputation, and three had a bilateral amputation. The main reasons for giving up driving were: family members' fears, other diseases and the lack of information about the availability of adaptive devices.

Henriksson and Peters [1] carried out studies commissioned by the Swedish National Road Administration on drivers with disabilities, vehicle adaptation, safety, and accident involvement. The questionnaire used focused on the following aspects: driver disability, adaptive equipment, car use, safety, and accident participation. It was sent to a random sample of people with disabilities driving adapted cars. Research showed that drivers felt safe and had a high level of confidence in a car that was tailored to their needs. Statistically, one in ten drivers has been involved in an accident in the last three and a half years, with most causing only material damage. The risk of accidents in the target group did not differ from the risk in the group of able-bodied drivers. A small number of accidents were attributed to problems with special equipment in the car. The reasons could be unfamiliarity with the controls, adaptive devices that did not fully met the needs of the person, or damaged equipment.

Koppa [4] described a tool for assessing the ability to drive a vehicle, which supported the selection of adaptive devices. This device made it possible to measure the muscle strength of the upper limbs, based on which adaptation devices appropriate for the tested person were selected.

Reger et al. [5] developed an alike, but slightly more sophisticated, approach to assess and train driving abilities in individuals with spinal cord injury (SCI). In this protocol, only the device-related measures were collected, and training sessions were performed during a 4 week period. A series of training and assessment meetings were used to propose the readiness of the topic for an on-road test based on specific mechanical recommendations, such as the force needed for brake application.

Prasad et al. [6] observed, however, that adapting the driving technique to the adaptive equipment or prosthetic device used may be more difficult than the use of known controls. A study conducted on a group of drivers with various disabilities showed a large number of accidents among people who used manual steering. These facts indicated the need to retrain people who continue to drive with the use of unconventional adaptive devices. The researchers also found that the prosthetic devices used should be carefully assessed as amputation leads to the loss of sensation necessary to operate car pedals.

Wolak [7] conducted tests of two types of special devices intended for driving a car by people with disabilities, which represented the equipment of two cars of a given make. The assessment of the functionality of the devices was carried out with the participation of able-bodied drivers performing selected manoeuvres and road tests. The subjective evaluation of the properties of the cars was carried out using the questionnaire method. The results were statistically processed using the non-parametric rank test.

Zabłocki and Torzyński [8], in turn, described the procedures for selecting and purchasing a passenger car for the needs of people with motor disabilities. According to the authors, the preliminary determination of the ability of a person with disabilities to drive a vehicle relies on estimating his/hers financial capacity; conducting medical examinations for driver candidates and drivers; and determining the ability to drive a vehicle or use alternative ways of moving – leading an active, independent life. According to them, the process of using a car can be divided into the activities of driving, getting in/out, and loading/unloading the wheelchair. The focus was on many important factors in selecting a vehicle, but unfortunately the information on individual devices for controlling acceleration and braking processes was insufficiently collected. The problem analysis was concluded with the statement that the process requires the participation of many specialists from various fields of science.

Pauley and Devlin [9] found that transtibial amputees proved higher reaction time (RT) and movement time than controls when exposed to a dual task, and this result is in accordance with previous studies in no amputee populaces. However, the most interesting conclusion was that the complete limb had a similar dual task effect to the prosthetic leg. The authors suggested that this result might be due to the reorganization of central motor pathways after amputation.

Dols et al. [10] described a fact acquisition system planned and developed for obtaining data from experimental tests on the execution of habitual driving manoeuvrs. The data gathered will allow for definition of the thresholds of biomechanical values and ergonomic values necessary for driving motor vehicles. The results have shown that application in real driving tests of the data acquisition system designed provides valid and suitable results for the case studied. Therefore, it will contribute to substantially improving the assessment procedure for drivers in general and for disabled people in particular when obtaining or renewing their driving licenses.

Caber et al. [11] presented an exploratory survey on this topic and apply an inclusive design approach in order to accommodate the whole range of diversity in our population. The results indicate a low usage rate of driver assistance features as well as their possible adaptations. However, results suggest a high appreciation for a potential smart adaptation of driver assistance features.

Di Stefano and Stuckey [12] outlined the goals of ergonomic evaluation and adjustment: optimization of seating and posture to maximize fitness, comfort, and safety. Correctly tuned body to ensure safe and reliable use of auxiliary vehicle controls and displays, and to counteract poor posture and alignment to increase physical endurance and avoid fatigue. Case study topics included adapting the vehicle cabin and managing the storage of mobility aids to optimize the vehicle configuration for a person with a mobility disability.

Suliano et al. [13] presented a research carried out on a group of 30 drivers with limb disabilities. The main aim of this study was to discover the real need of disabled limbs in relation to all activities related to driving a car while getting in, driving, and getting out of a car. Five aspects of ergonomics were assessed, namely safety, ease of use, comfort, productivity, and efficiency, and aesthetics. A Likert scale (from 1 to 5) was used as a score to be scored for each question within the components. The survey shows that interior components such as handling, upholstery, and steering require an ergonomic redesign.

To sum up, it should be stated that the conducted analysis of the state of knowledge in various fields allows to formulate a final conclusion that there is no comprehensive research on the methods of selecting adaptive devices and their automation.

3 Method

Taking up the work aimed at facilitating the process of selecting adaptive devices was associated with the analysis of many issues closely related to this problem, including the methods of selection, the scale of disability and IT tools useful in this process. In Poland, the selection of adaptive devices for adapting the vehicle to the needs of a driver with disabilities is carried out individually, both by specialists and by people who do not have appropriate knowledge in this area. People who deal with the adaptation of the devices are driving instructors and occupational medicine doctors with licenses to examine drivers. Each of these professional groups pays attention to different selection criteria. Adaptation companies are guided by knowledge and experience in selecting devices to which they have access. Driving instructors are guided by quite limited knowledge of the spectrum of types of adaptive devices available on the market and usually duplicate and advise the selection of devices that DTC vehicle has (...). This type of approach limits the correct matching the device to a given dysfunction. Occupational medicine doctors only take into account the codes and sub-codes of restrictions, without knowing the subject of the existing devices.

The imperfections of the method of individual selection of the devices have become one of the key issues influencing the commencement of works aimed at developing an objective and comprehensive method of automatic selection of adaptive devices. The individual selection method is a simple procedure, the key element of which is an expert. The level of selection in this case will depend only on the person, who is not always responsible for the expertise issued. This may be due to a lack of medical or legal knowledge necessary to make a proper decision. It is also worth mentioning that there are no diagnostic centres with sample devices in Poland. Usually, the customers buy the devices they sees in the photo and is not able to test whether a given technical solution will meet his needs. The time-consuming nature of such a procedure will extend in direct proportion to the problems encountered, for example, those related to communication with the client or his expectations regarding the device [14,15].

Designing new technical tools using expert systems is aimed to improve the process of adapting a vehicle to a driver with special needs, improve its quality, systematize knowledge about devices and disabilities, as well as standardize and improve the accuracy of the formulated expertize in the selection of devices. Defining the scope of operation, describing the types of disability and available devices, the use of IT tools and many other factors, constitute the method of automatic selection of adaptive devices called System – ASA (Automatic Adaptation Selection System), also referred to as "System." It is based on an expert system using databases and inference procedures [14].

Figure 1 presents the algorithm for building the method of automatic adaptive devices selection, ASA System in a vehicle for the needs of drivers with disabilities, along with the stages of its verification and inference. According to the diagram, the algorithm includes a series of steps. The knowledge gathering stage concerned several data sources, i.e. companies offering adaptation service and adaptation devices; disability classification; driving instructors, people dealing with the adaptation process, and occupational medicine doctors.

The first analysis covered information on the activities of adaptation companies, adaptation devices of various makes and various mechanisms (electronic, mechanical, complex joystick devices), and preferences in the use of these devices by companies dealing with vehicle adaptation. Another analysis concerned the classification of disability used by various institutions in Poland and the ICF International Classification of Disability. Then, the knowledge obtained from people dealing with the selection of adaptive devices and from expert opinions made for a specific recipient was analysed. On the basis of the collected resources, the final version of the classification of adaptive devices and disability classification, which formed the basis of the system's database, was prepared.

Conclusions from the above analyses as well as knowledge and experience in this field allowed to formulate the rules necessary for the application process. The next stage was the design of the user/operator interface of the system developed.

Transferring a human experience into a computer program is a complex task. The information collected is in numerical, text, or more complex structures. The knowledge bases usually store information in the form of rules. These rules have a form similar to a logical theorem, they can be divided into an assumption and a thesis. An assumption is a condition that must be met in order for a thesis to be true. All the expert's knowledge has to be reduced to a set of rules. Individual rules are not directly related to each other. The theses contained in the rules should present all conclusions that may arise from the operation of the system. In addition to the set of rules stored in the database, one needs a program that takes the input information and runs through all the rules one by one, choosing the right ones. The set of so selected rules constitute the final proposal of the system. It is the simplest structure of an expert system.

Based on the input data, the system first analyses only the first set of rules. Each subsequent set of rules is analysed not only based on the input data, but also on the basis of conclusions drawn from the analysis of the previous sets. In the case of using the feedback loop, the

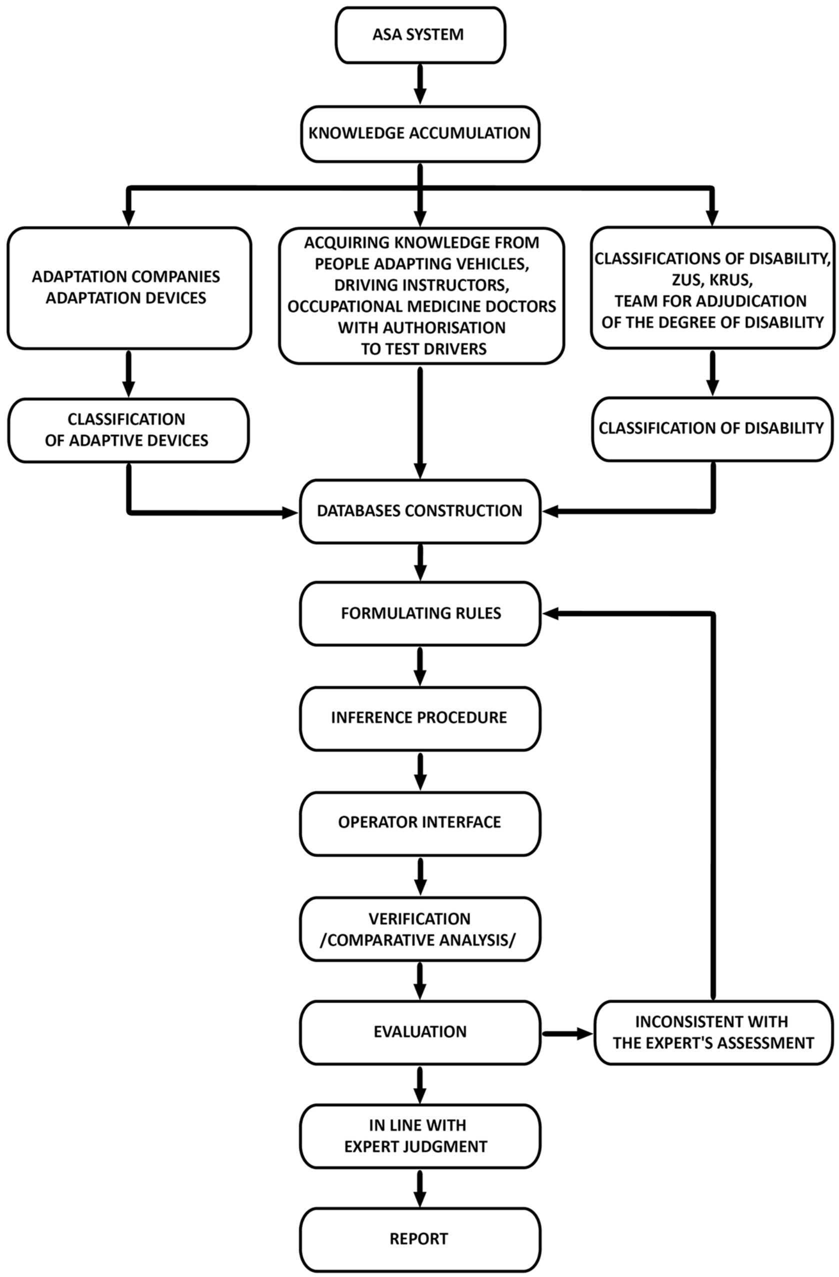

Figure 1: The algorithm for building a method of automatic adaptive devices selection, ASA System.

sum of all conclusions may constitute the input data for the reanalysis of the entire knowledge base [14–16].

The method presented was built on the basis of PHP (Hipertext Preprocessor), functionally associated with the generated code of websites using databases that are linked by commands that are an integral part of PHP. It turned websites into dynamic pages with a simple programming language based on typical web application tasks, i.e. submitting forms' data and building databases or websites. The code written in PHP could be easily embedded on a website, in HTML code (www.systemasa.edu.pl). In addition, it is executed on the server side, which means that it is invisible to the users. It is a safe solution due to the anti-virus protection. PHP is an Open Source project. Anyone can download designs, modify them and share them with other users. Thanks to this, on the Internet one can find ready-made solutions that greatly facilitate the work of people working in PHP. Open Source guarantees that every user can download, install and use PHP for free. As a result, the language is constantly and dynamically developing, and a huge number of shared solutions can be found on the Internet. Below is a fragment of the code used in the method of selecting adaptive devices, ASA System for generating two variants of devices:

1st variant looks as follows: < h2 > RESULTS </ h2 >< divclass = ”backgroundsection2” >< divid = ”variant1” >< divclass = ”valid” >< h6 > Configuration1 < /h6 > steeringwheel :< bid = ”steeringwheelv ar1” > −− < /b >< br > brake :< bid = ”brakev ar1” > − − −− < /b >< br > throttle :< bid = ”throttlev ar1” > − − −− < /b >< br > other :< bid = ”othervar1” > − − −− < /b >< /div >< divid = ”errors1”class = ”errors” > Errormessage :< bid = ”errorv ar1” > error < /b >< /div >< /div >

2 while the variant looks as follows: < divid = ”variant2” >< divclass = ”valid” >< h6 > Configuration2 < /h6 > steeringwheel :< bid = ”steeringv ar2” > − − −− < /b >< br > brake :< bid = ”brakev ar2” > − − −− < /b >< br > throttle :< bid = ”throttlev ar2” > − − −− < /b >< br > other :< bid = ”otherw ar2” > − − −− < /b >< /div >< divid = ”errors2”class = ”errors” > Errormessage :< bid = ”errorv ar2” > error < /b >< /div >

ASA System interface is clear and simple. Using the System does not require IT or expert knowledge. Access to the System (www.systemasa.edu.pl) is possible at the Motor Transport Institute by registering the user in the register of subscribers.

The last stage, necessary in the construction of the method, concerned the verification of the degree of consistency between the selection of devices carried out by the System and the selection made by experts for real cases. In the event of discrepancies, the descriptions of the disability and possibly the rules in the system were detailed.

4 Results

Three experts and a group of 44 drivers with disabilities participated in the process of verifying the correct operation of the developed method of adaptive devices automatic selection.

The study assumes that

- actual applications from drivers for whom expert evaluation has already been carried out over the past few years will be used;
- data verification will be based on a comparative analysis of opinions issued as a result of the application of an individual method by three experts with data obtained according to the developed “System – ASA” method in two device configurations;
- if two out of three experts do not agree with the proposal presented by the System, the given case will be re-assessed by experts in order to determine whether the solutions proposed by the System are acceptable;
- in the event of a negative evaluation issued by an expert, it will be necessary to modify the rules entered into the System database.

The purpose of the comparative analysis of the results generated by the ASA System and proposed by the experts was to prove the validity of the implementation of the method that automates the process of selecting adaptive devices.

The selection of the research sample in the form of the described categories of dysfunction was prepared in a nonrepresentative manner. It resulted from the availability of knowledge derived from the database of the Motor Transport Institute. The paper uses the non-random technique, i.e. the selection of a sample according to the subjective evaluation of the researcher, which does not require the determination of the error level or the determination of the accuracy of the estimates. The details of the trial were selected based on the predetermined criteria for disability and the typology of the adaptive devices used.

The selection of experts was based on recommendations and knowledge in the field of methods of selecting adaptive devices. The participation of three independent experts was due to several reasons. First – from the availability of experts in the field of equipment selection. Second, it resulted from the willingness to compile extreme opinions regarding the selection of adaptive devices, represented by experts. The number of three experts is the minimum number and sufficient to evaluate the validity of the comparative method used. In the process of selecting experts, requirements were formulated that had to be met by the chosen ones. The E1 expert represented knowledge and experience in the field of vehicle adaptation and had 20 years of professional experience in adapting vehicles for people with mobility impairments. The E2 expert represented the knowledge and experience related to the training and examination for driving licenses of people with motor disabilities, and as the only one in Poland has the qualifications of a trainer to improve driving techniques for people with disabilities. The E3 expert represented knowledge and experience in coordinating the transport of people with disabilities.

As part of the verification of the correctness of the method developed, the selection of adaptive devices was carried out using the ASA System for 44 people with various dysfunctions and this selection was also conducted by three experts (E1, E2, E3). If the type of dysfunction allowed it, both the ASA System and experts proposed two variants of sets of adaptive devices. In each variant, the configuration of sets of adaptive devices resulted from the analysis of devices available on the market and entered into the database.

The analysis of the results allowed for the formulation of the following conclusions:

- the total number of analysed cases was 44, descriptions of individual dysfunctions were presented along with the selection of adaptation devices made by experts and by the ASA System;
- the number of cases in which all three experts were in agreement with each other in both sets of adaptation devices was 21;
- the number of cases in which all three experts were in agreement with the system in both sets of adaptation devices was 21;
- the number of cases in which all three experts were in agreement with the System in at least one set of devices was 38;
- the number of cases in which one expert disagreed with the other two experts in at least one variant of adaptation devices was 17 (including E2 expert who disagreed 13 times);
- the number of cases in which one expert disagreed with the other two experts on both variants of the devices was 5;
- the number of cases in which all three experts selected different sets of devices was 0;
- the number of cases where one expert selected one set consistent with the system and another one another, was 18;
- the number of cases in which one expert provided both sets of devices other than the System was 5;
- the number of cases in which two experts provided different sets (in at least one variant) than the System, was 1;
- the number of cases in which all three experts provided other sets (in at least one variant) than the System, was 0.

The results regarding the degree of consistency between the configurations of adaptive devices proposed by experts and ASA System, are as follows:

- the number of cases in which at least one expert was in agreement with the System in the selection of both sets of adaptation devices, was 44;
- the number of cases in which at least two experts were in agreement with the System in the selection of both sets of adaptation devices, was is 43;
- the number of cases where three experts were in agreement with the System in selecting both sets of adaptation devices, was 21.

The comparative analysis conducted allowed for the formulation of the following conclusions:

- individual method of selecting adaptive devices is burdened with subjective opinion of experts;
- E2 expert did not agree with the System in the selection of devices in 19 cases;
- E2 expert, regardless of the disability, chose mainly adaptive devices such as the lever under the steering wheel and the lever in the floor;
- E2 expert selected different devices despite the same disability;
- E1 expert did not agree with the System in the selection of devices in 5 cases;
- experts make subjective choices in the individual method, while the choice of the System is objective;
- the selection of adaptive devices by experts is made "on paper," and customers are deprived of the opportunity to "try it on" – unfortunately, this type of approach may generate errors;
- selection of devices can be automatic.

When comparing the two methods of selecting adaptive devices, it should be stated that the incompatibilities revealed during the tests resulted from the fact that:

- the automatic ASA System method developed proposes two device configurations, which results from its assumptions, therefore the probability of incompatibility between the methods (individual and automatic) is greater than in the case of one configuration;
- each expert claims that his individual method of selecting adaptive devices is the best and it is difficult to convince;
- them of other possible solutions.

It is worth noting that the study of the publication only provides for studies on the activity of persons with disabilities in their functional capacity in the professional, recruitment, social, and basic living needs [17–20]. According to Jach, a huge number of controllable physiological traits are an important problem in the design of systems for functional capabilities, and it describes very widely the different diagnostic systems for occupational activity, taking into account ergonomic diagnostics, but only for workstations. It does not refer to the narrow area of choice of adaptive equipment.

Horberry and Inwood [21] describe the tasks that define limits for cognitive, perceptual, and physical tests on the Static Evaluation Platform (SAR). These devices are used to measure the handling characteristics as part of the assessment. However, the decision-making criteria for the functional ability to drive vehicles have not been explicitly specified or confirmed for SAR. Other studies identify different elements of assistance to experts, but do not relate to the use of expert systems for this purpose [11,22–24].

The matching module MDA and the "ASA" by Stasiak-Cieślak and the algorithm proposed in the Koźma's publication are the only adaptive device methods developed in Poland. The algorithm comparison with the system is as follows: Analysing the sequence of events – algorithm → is it moving on the cart? → NO → does it have paresis of the limbs? → YES → 2; the algorithm selects only the automatic transmission. This algorithm does not include the selection of devices for, for example, a person moving on a ball and not having the ability to drive with his feet. This was probably not the intention of the authors to create a comprehensive algorithm, but only to include research assumptions. The "System-ASA" approach takes into account the different types of disability and has a broad range of physical dysfunctions variables, as well as many adaptive equipment variables. It also uses, and perhaps above all, artificial intelligence, which is extremely valuable, for example, in creating rules that have proved to be very important and have contributed to the system's attitude. The article focuses on the use of expert systems in this type of research, experimental results in the form of extensive tables, thus constituting the content of research in the doctoral work of Stasiak-Cieślak [15]. It seems from the study that the only problem can be the expert in the study alone, who has just been burdened with his subjective assessment of the choice of the device. However, this situation may be eliminated if individuals who take care of individual selection and their seniority in this regard are invited to do so. Gathering knowledge on the choice of adaptation devices is key to building solutions in scientific projects, defining guidelines for legislative changes, but above all to defining criteria that will properly and professionally support the diagnostic process. The knowledge built into one system, as new solutions become available, will provide a comprehensive view of the problem. "System-ASA" is by design generating evidence-based expertize, not subjective expert assessments. The future development of the method should take the following into account: updating data covering new devices, restriction codes, and device manufacturers; to detail the scale of disability by implementing an extended database; surveys among driver training centres undertaking training courses for persons with disabilities; establish an interdisciplinary group to develop a universal model, enhanced by current legislation.

In the future research aimed at developing and improving the method there should participate professionals with interdisciplinary knowledge. Also, their view of the available devices should be subject to critical analysis and thorough evaluation.

5 Conclusion

The knowledge of the methods used in the selection of adaptive devices was based primarily on the method of individual selection of these devices, made by experts representing various fields of knowledge. At present, it is possible to elaborate in detail databases on disability categories and adaptive devices. The created databases and specialist knowledge allowed to use the structure of the expert system in the construction of an automatic method of selecting adaptive devices. On the other hand, a comparative analysis of data collected as a result of the application of the automatic device selection method and data obtained from individual device selection made by experts provided a reliable verification of the correctness of the System-ASA method developed.

The methods of selecting adaptive devices for people with various disabilities require specialists to have extensive knowledge in the field of technical sciences, medicine, psychology, ergonomics, sociology and psychology. The methods used and the consequences of incorrect selection may hinder driving, e.g. by uncomfortable locating the device or focusing too much attention on the devices. The use of an expert's subjective opinion in the selection of adaptive devices, unsupported by knowledge and experience, and sometimes even common sense, may have a negative impact on both the comfort of driving a vehicle and on the safety of road users.

The ASA System takes into account individual needs, offering more than one device proposal. The user, depending on his preferences, chooses the one that suits him best. Facilitating the selection process will significantly improve the work of people who need research-confirmed knowledge in the field of devices supporting driving vehicles for people with motor disabilities. Combining knowledge from various fields of science in the System gives it an interdisciplinary character. In addition, it allows to develop a tool devoid of subjective expert judgement. Gathering knowledge on the selection of adaptive devices was the key to shaping solutions as part of scientific projects, determining guidelines for legislative changes, but most of all – to determining criteria that will properly and professionally support the diagnostic process.

It is also worth expanding the databases in the method used with descriptions of adaptive devices, specifying manufacturers and the location of representative offices. Such extensive knowledge gathered in one System, supplemented with the emergence of new solutions, will allow for a holistic view of the problem. It constitutes a significant added value to the knowledge possessed by the adapters, whose opinion – resulting from his qualifications and experience, as well as from market conditions – is usually, as already mentioned, subjective. The ASA System generates expertize based on facts, not on individual preferences of experts. Preparing algorithms and introducing them to the program was a complex and time-consuming process, but its effect is important, i.e. easy and quick access to the necessary information needed to identify the problem and select adaptive devices. The automatic selection process is definitely shorter than the individual one, carried out by an expert.

Currently, there is a shortage of people with the status of a specialist/expert, taking into account the perception of humans in a holistic way, i.e. experts dealing with the selection of adaptive devices based primarily on the knowledge of the needs of people with disabilities as far as the moving about is concerned.

The future expansion of the method should take into account:
– updating data on new adaptive devices by the manufacturers of these devices;
– detailed disability scales through the implementation of an extended database;
– survey research among the Drivers Training Centres undertaking driving license training for people with disabilities;
– establishing an interdisciplinary group to develop a universal model.

The method of automatic selection of adaptive devices developed, using an expert system and PHP software to build the interface, ensured an objective selection of devices as well as the availability of the method itself, for everyone who needs such expertize, at www.systemasa.edu.pl. Logging into the system is possible through user registration at the Motor Transport Institute (cum@its.waw.pl).

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