# Advanced Assistive Technologies and Digital Inclusion – the case studies of the MATUROLIFE and DIGITAL ACCESSIBILITY projects

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**Abstract:** This paper describes a preliminary study into the impact of assistive technologies (ATs) and particularly the impact which Information and Communication Technologies (ICT) may have on social inclusion. The basic research problem of the study is the question of whether and to what extent technology, in particular ICT, opens up new areas of activities in which elderly people and persons with disabilities can have better access. The case studies of two projects: "MATUROLIFE" and "DIGITAL ACCESSIBILITY" are presented in the article; and through the combination of primary and secondary research, several social, technical and economic trends are identified. These are used to compile three explorative scenarios about the future of AT and its impact on digital inclusion.
**Keywords:** assistive technologies, social inclusion, digital inclusion

## Introduction

In Europe over 73 million people have disabilities and globally the figure is over a billion (Eurostat, 2018). Individuals can experience different types of disabilities including visual, hearing, speech, mobility, cognitive, and psychosocial. Many individuals also experience the onset of disabilities as they age. The global population aged 60 years or over numbered 962 million in 2017 and it is expected to more than double by 2050, when it is projected to reach nearly 2.1 billion (United Nations, 2017). Physical inaccessibility has been one of the primary factors for the marginalization of persons with disabilities

and older people. Everything from being able to travel, enter a school or work site, perceive and understandwhat is written, hear and communicate with family, teachers, workmates, and peers, access recreation or socialization can become a barrier. However, in the economy that is based on digital computing technologies the main barrier is the lack of ability on the part individuals and groups to access and use information and communications technologies (ICT). In the digital age, when we see the digital revolution intensifying, governments, non-profits, and businesses worldwide are searching for ways to cope with digital inclusion as an element of social inclusion, taking into account the needs of persons with disabilities and the ageing population. Social inclusion is a multi-dimensional process aimed at creating conditions which enable the full and active participation of every member of society in all aspects of life, including civic, social, economic, and political activities and the process aims at improving the ability, opportunity, and dignity of those disadvantaged on the basis of their identity to take part in society (Das, 2016).

Nowadays, the world is at a critical juncture when it comes to digital transformation. Information and communication technologies continue to develop rapidly and are combining in novel and innovative ways, pushing digital transformation in new unpredictable directions. Therefore, there is an urgent need for governments and stakeholders to shape a common digital future that makes the most of the immense opportunities that digital transformation holds to improve people's lives. They all view extending access to ICT with greater urgency to create a more enabling and competitive society.

The United Nations in 2016 declared Internet access a basic human right, that should be extended to all citizens of the world. In particular, the agency has declared "online freedom" as a basic right that must be nurtured by all nation states (United Nations, 2016). Despite the fact that the UN's resolution is not binding, it is meant as a guideline to nations to properly protect and secure people's right to internet access and expression online. It also serves to put pressure on countries that actively suppress internet access and freedom of speech, and gives credence to activist groups. The potential contribution of Assistive Technologies (ATs) to increase social inclusion and the independence of older people is the subject of continuously exploration.

This paper describes a preliminary study into the impact of Assistive Technologies and particularly the impact which Information and Communication Technologies may have on social inclusion. Therefore the basic research problem is the question of whether and to what extent

technology, in particular ICT, opens up new areas of tasks in which elderly people and persons with disability can have better access. The case studies of two projects: "MATUROLIFE" and "DIGITAL ACCESSIBILITY" are presented here and through the combination of primary and secondary research, several social, technical and economic trends are identified. Such findings are used to compile three explorative scenarios about the future of AT and its impact on digital inclusion of persons with disabilities and elderly people.

## The importance of digital transformation

Most countries in the world will move towards digital transformation. Almost half of the world's population is now connected to the Internet, up from only 4% in 1995. In 2016, 83% of adults in the OECD area accessed the Internet and 95% of firms in OECD countries had a high-speed Internet connection (OECD, 2018). Therefore, digital transformation affects all aspects of the economy and society in complex and interrelated ways. But the digital transformation may have both positive and negative impacts; and various groups of population experience these impacts. Particularly vulnerablegroups are persons with disabilities and older people.

One of the issues with important implications for the assessment of disability is the distinction between legal and biological disability. These two categories are not identical. The first of these categories refers to a judgment system regarding disability. This is the situation when a person who has a disability certificate issued by a competent authority may not feel limited in their ability to perform their daily activities. This situation can be interpreted as either an error in the legal judgement system or the success of a support system that has eliminated the barriers. The second category refers to biological disability, which is a subjective assessment of the person pertaining to limitations in their everyday functioning. A much greater and more frequent problem will be a situation in which a person does not have a legal decision about disability but experiences different barriers in ordinary, basic, life activities. This particularly applies to older people with retirement benefits who do not need a disability certificate (Antczak, Grabowska, Polańska, 2018, pp. 21-43) From the digital inclusion perspective, the assessment of biological disability is much more important than the assessment of legal disability. Information and communication technologies can help people experiencing

limitations in their daily functioning, and thus it is crucial to ensure the availability of ICT and the ability to use them by all possible social groups. Digital inclusion should be therefore promoted in all possible ways. Institutions such as schools and libraries play a key role in this process. They usually can provide free access to digital technologies including hardware, software and the Internet. Moreover they can also provide digital content to their respective communities, as well as improve digital literacy skills through practical training programs and workshops.

In the next part of the article the focus is placed on ATs for two specific disabilities. The first is blindness and visual impairments, which ranges from mild disorders to severely limited visual perception and blindness; the second is deafness and hearing impairments, which ranges from minor disorders and range limitations to more severe impairment and deafness. The occurrence of vision loss and blindness in Europe is estimated at 2.9% and 0.3% respectively. The occurrence of hearing impairments which is correlated to the ageing population, is around 10% of all adults suffering some form of hearing impairment but the figure rises to 50% for people in their 80s. However, loss of vision, like hearing impairment, correlates with ageing, and around 81% of those with severe impairments or blindness are over 50 years old (Boucher, 2018, p. 5). Both of those disabilities can present barriers to an individual's participation in society, including access to education and employment, and these barriers extend to the digital economy. Despite the fact that we can observe an increase in the supply of Assistive Technologies, many of them remain unused.. However, some of the mainstream technologies, such as smartphones, through a special configuration may be used to assist people with disabilities, and may help them to overcome some of the barriers to their participation in the digital economy. The detailed classification of existing ATs for blindness and visual impairment which include 1) haptic aids, 2) travelling aids, 3) AT for accessible information and communication, 4) AT for daily living 5) phone and tablet applications for the blind and visually impaired people; and also the classification of AT for deaf and hearing impaired people which include three broad classes of devices: 1) hearing technology, 2) alerting devices and 3) communication technology; was developed by the Scientific Foresight Unit of European Parliament (Nierling et al., 2018, pp. 26-39). Table 1 shows examples of barriers to participation by disability type and the relevant ICT solutions.

**Table 1.** Barriers to participation by disability type and relevant ICT solutions

| Disability category | Examples of barriers in social, economic, and community participation | Examples of accessible technology solutions |
|---|---|---|
| Visual Disability Includes total blindness Or low Visio | • Reading print (e.g., textbooks, instructions, documents) and writing (e.g., signing checks, legal documents<br>• Accessing visual information in print or audiovisual media (for example, warnings and information in text scrolls on television)<br>• Navigating new surroundings | • Text-to-speech rendition and speech/voice output<br>• Braille displays<br>• Screen and text magnification<br>• Voice recognition<br>• Audio description of graphic and visual media<br>• Electronic audio signage<br>• GPS-facilitated navigation<br>• Optical character or image recognition<br>• Changing screen brightness, colour contra |
| Hearing disability Total or partial hearing loss | • Hearing lessons, warnings, and other auditory information in person or over audio media such as the radio or television.<br>• Communicating with others including educators, peers and colleagues, clients, first responders, government personnel, and others. | • Closed and open captioning, subtitles for videos, TV programming<br>• SMS, text messaging<br>• Text Telephone or Telecommunication Device for the Deaf (TTY/TDD) which allow text messaging over the phone line<br>• Telecommunications Relay Services which allow text to speak conversions through an operator<br>• Use of vibrations/text alerts instead of audio alerts |

Source: D.S. Raja (2016), *Bridging the disability divide through digital technologies,* p. 8 http://www.worldbank.org/en/publication/wdr2016

Currently, the promotion of social inclusion through digital inclusion facilitates a more comprehensive participation of persons with disabilities in social life. As it was shown in the above table, there exist relevant information and communication technology solutions, and they are increasingly enabling persons with disabilities to level their chances in terms of accessing lifelong education, skills development, and employment (Broadband Commission, 2013). Moreover, the growing number of mainstream, everyday appliances of information and communication technologies, such as mobile devices and desktops, are increasingly offering features that facilitate communication and

access to information for people with disabilities. Functions, that in the past required special software or hardware, such as text-to-speech, voice recognition, the ability to change contrast and colour schemes, touch and gesture input, screen magnification, and many others, are now more often embedded in products for regular users. Thanks to information and communication technologies, people with disabilities have the opportunity to receive information and content in a format they can perceive and prefer. For example, a person with visual impairments can use speech or text functions to read a web page, people with hearing impairments can use text or other text messages to communicate, and a person with a movement disability may use voice recognition to operate and navigate the digital device.

In addition, the Internet and ICT are becoming more and more popular channels of socio-economic development; and by enabling direct interaction between producers and markets around the world, they facilitate new ways of providing personalized public and social services, creating new income channels, and of contributing to poverty reduction. However, the situation of persons with disabilities on the labour market has not seen any amelioration. Although, in recent decades there a significant change has been noted in the labour market, characterized by the increasing use of computer technology in the workplace; the first consequence of this change has been the replacement of human work with technology. From the research conducted in Germany over the course of many years pertaining to the influence of digitalization on the tasks of employees with disabilities, it has not been observed that the growing use of technological tools in the workplace has allowed disabled workers to perform more complex tasks in order to mean a given demand. Additional findings from this study indicate that technology deployment in the workplace is increasingly replacing simple tasks and creating newer and more complex requirements for employee qualifications. The research findings show that technology is becoming more and more complicated and difficult to use because the complexity of the application is continuously growing and thus the process of digitalization is giving rise to more complex work processes. This is related to an increase in skill requirements and the reduction or outsourcing of simple tasks. This has created worse opportunities on the labourmarket for people with disabilities. The implementation of technology in the workplace is basically related to the benefits for people with disabilities because burdensome tasks are increasingly performed by machines and robots. However, with regard to functional

limitations concerning mobility, sight and hearing impairments, the use of Assistive Technology devices may facilitate many tasks; but the effectiveness of those devices will only be high if they are compatible with other devices and programs used. In order to achieve high effectiveness, it is necessary to support people with disabilities in other aspects, such as reduced work and time pressure, and the optimization of work processes (Weller, 2019).

**Assistive technologies in digital economy**

Assistive technology (AT) is any item, piece of equipment, software program, or product system that is used to increase, maintain, or improve the functional capabilities in learning, working, and daily living of persons with disabilities (ATIA, 2019). Although there are few categories of ATs, such as low-tech (e.g. wheel chairs, walkers) or high tech (e.g. special-purpose computers) hardware devices, the stu dy investigate the role of Information and Communication Technology devices (e.g. special switches, keyboards, pointing devices, and software such as screen readers and communication programs) and other advanced products or materials such as smart textiles, that can be used as assistive technologies.

Assistive Technology may help people who have difficulty when speaking, typing, writing, remembering, pointing, seeing, hearing, learning, walking, and many other things; therefore different disabilities require different assistive technologies, however, due to the fact that the use of AT is symbolically, culturally and historically contextual, it may in some situations hinder social inclusion. Assistive Technology devices may therefore be more often questioned or rejected. As an example, cochlear implants mayprove informative. The devices are rejected by deaf people, because they perceive themselves as cultural and linguistic minorities and consider these implants as a symbol of the medicalized perception of deafness, forcing them to speak the language. Assistive Technologies are rejected mainly because people feel stigmatized due to the design and external appearance of these devices. Especially when an Assistive Technology device is a dual identity marker: on the one hand, it is an independence tool, and on the other hand it is also a symbol of a person's inability to work and their dependence on others. In addition, ATs are often rejected due to a lack of access to Assistive Technology; no information about devices, repairs and maintenance, changes in the user's functional abilities or activities, inflexibility or ineffective device performance;

minimal or no need for the device; negative family attitudes, and also a lack of motivation to use the device (Ravneberg, Soderstrom, 2017, p. 9).

In the Digital Economy, information and communication technologies (ICT) represent an opportunity for the social integration of a person with disability, and also for older persons. An increase in the importance of digital data also means that good (broadband) internet connections, that make it possible to access or deliver new content, applications and services, are essential for promoting social inclusion. Moreover, when citizens do not have access to broadband, it may have profound implications on their economic potential.

ICT enables the use of multiple means of communication: example voice, text, and gestures – in order to enable disabled people to access information and engage with others, and hence can help them to address long standing barriers of communication and interaction. ICT plays a crucial role in promoting the independence and full participation of persons with disabilities across life domains. It represents an important enabler of accessibility to systems and services, access information and uphold freedom of expression an opinion. This is confirmed in the United Nations Convention on the Rights of Persons with Disabilities (CRPD), a human rights treaty which specifically addresses the rights and needs of persons with disabilities; which came into force in 2007 (United Nations, 2007), and has been ratified by more than 150 countries. The Article 9 of the convention obliges Member States to take appropriate measures to ensure access for persons with disabilities, on an equal basis with others, to, inter alia, information and communication technologies, including the internet. Countries that have signed the Convention were expected to submit a report on progress toward its implementing within two years of its taking force. Moreover advocacy organisations had to publish their own shadow reports (Bratan et al., 2018).

Also, the European Parliament has approved a directive on making the websites and mobile apps of public sector bodies more accessible. This means that people with disabilities – especially persons with vision or hearing impairments – will have better access to the websites and mobile applications of public services (Directive (EU), 2016/2102). As part of its Europe 2020 strategy, in 2010 the European Union set three targets for broadband: by 2013, to bring basic broadband (up to 30 Megabits per second, Mbps) to all Europeans; by 2020, to provide all Europeans with fast broadband (over 30 Mbps); and by 2020, to ensure take-up by 50% or more of European

households to ultra-fast broadband (over 100 Mbps). To support these objectives, the EU implemented a series of policy and regulatory measures and made some 15 billion euro available to Member States for the period 2014--2020, through a variety of funding sources and types, including 5.6 billion euro in loans from the European Investment Bank (EIB). However, according to the report of European Court of Auditors published in 2018 Europe 2020 targets will not all be achieved. Broadband coverage has generally been improved across the EU, but rural areas remain less well connected than cities, and the take-up of ultra-fast broadband is significantly behind target. For example, only 15% of households had subscribed to ultra-fast broadband internet connections by mid-2017, against a target of 50% by 2020 (European Court of Auditors, 2018 p. 8).

**The case study 1: MATUROLIFE project**

*Metallisation of Textiles to make Urban living for Older people more Independent* & *Fashionable* – the MATUROLIFE project was founded under the European Research and Innovation Programme HORIZON 2020, the topic NMBP-05-2017 – *Advanced materials and innovative design for improved functionality and aesthetics in high added value consumer goods.* The project, which began in January 2018, looks to address the development of innovative advanced material solutions, among others, smart textile fabrics; all of which go toward making living significantly easier: more sustainable, more comfortable, more secure, and more functional.

The specific objective of advanced materials research and innovation is to develop materials with new functionalities and facilitate improved in-service performance, and also to ensure more competitive and safe products. The project builds on existing technological advances in materials which have produced a highly innovative selective metallisation process that utilises nanotechnology, electrochemistry and materials science in order to encapsulate fibres in textiles with metal, and thereby provide conductivity and electronic connectivity. In this way, better integration of electronics and sensors into fabrics and textiles will be possible. It is expected that this will give fashion designers and artists the tools to produce an AT for older people that is not only functional but is more desirable and appealing, as well as being lighter and more comfortable.

The expected results of the project include highly innovative, conductive, multi-functional textile products and intelligent fabrics, enabling the production of new assistive technology prototypes. The AT prototypes created in the project include shoes, furniture (e.g. sofas) and clothes. Such products with metallised textiles (smart textiles) can have many different applications in everyday life. The key functions of the prototypes are related mainly to protection and health. The function of protection includes: detecting conditions that prevent danger; preventing accidents by sending a signal when dangerous conditions are detected; providing instantaneous protectio; against thermal radiation; and for anti-static protection.

The functions of health include: warning on the evolution of a disease; diagnosing a disease and monitoring the physiological variables of a user; automatically alerting; and collecting data and sending it to telemedicine centres via a communication network.

The newly created products will respond to current and future social challenges related to the urban life of older people and people with disabilities. The project consortium actively cooperates with societal stakeholder groups representing end users of the products. Importantly, older people and persons with disabilities are heavily involved in the design process. They also feedback and direction on the development of AT prototypes, thus contributing significantly to end-user acceptance[1].

## The case study 2: DIGITAL ACCESSIBILITY project

The Certified Digital Accessibility Training (Digital Accessibility) project, begun in 2018, is funded under the Erasmus+ Programme, KA2 - *Cooperation for innovation and the exchange of good practices* KA202 - *Strategic Partnerships for vocational education and training.* The aim of this project is to develop vocational training modules focused on digital accessibility aimed at improve the knowledge, skills and the competencies of key stakeholders according to web accessibility standards. Thanks to this kind of training, the visual, auditory, physical or cognitive needs of persons with disabilities, to also include older people, low literacy website visitors and apps users, will be able to better access the information and benefit from the digital era.

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[1] More information can be found at the project website: www.maturolife.eu.

The training modules will improve the competences of Vocational Education and Trainings (VET) learners, students as future experts and existing professionals in the field of developing and designing websites, all so as to allow them to contribute to more inclusion and equity in education and lifelong learning. The project is based on the key assumption of increasing the importance of digital web resources in many aspects of life, such as: education, employment, government, commerce, health care, recreation, access to information and others. The project looks to contribute to improving the digital accessibility of web content and supporting equal access and equal opportunity to persons with disabilities, who can then more actively participate in society.

The results of the project include four training programs, of which two are dedicated as new job roles for persons with disabilities. They are: Digital Accessibility Manager and Digital Accessibility Tester. Two other programs are addressed to professionals as up-skilling trainings in order to help meet evolving market needs. They are: Web Developer with expertise in Digital Accessibility and Web Designer with expertise in Digital Accessibility. Designing the above trainings, testing them, and then international dissemination, will contribute to the increase of information and communication accessibility which is necessary for the social and digital integration of persons with disabilities in information society and digital era.

The project activities are fully in line with the European Disability Strategy 2010-2020, which among several proposed actions include web accessibility, with the objective "to ensure accessibility to goods and services including public services and assistive devices for people with disabilities"[2].

**Scenarios for Assistive Technologies**

Three exploratory scenarios about the future of AT and its impact on digital inclusion are presented here. Visions were used as targets and three scenarios were developed to showcase examples of how these visions could be achieved. Each scenario include five elements which describes the situations in the future in which persons with disability and elderly people can be found:

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[2] More information can be found at the project website: https://www.facebook.com/digitalaccessibilityproject/.

**Table 2.** Analysis of trends in the environment having an impact on the Assistive Technologies sector for digital inclusion of persons with disabilities and elderly people in Europe in 5 years' time

| Factors in the environment | Trend | Impact factor from -5 to +5 | Probability (0-1) |
|---|---|---|---|
| **Economic area** | | | |
| Economic situation in Europe (GDP per capita) | growth | +5 | 0,25 |
| | stabilization | +1 | 0,70 |
| | regress | -4 | 0,05 |
| Vocational integration of persons with disabilities (unemployment rate of PWD) | growth | +5 | 0,50 |
| | stabilization | +1 | 0,45 |
| | regress | -4 | 0,05 |
| Amount of public funds for social integration for persons with disabilities, including tax reduction due to expenses for rehabilitation (Euro) | growth | +5 | 0,50 |
| | stabilization | +1 | 0,45 |
| | regress | -5 | 0,05 |
| Mobility of persons with disabilities and their assistants or carers (number of European Mobility Cards) | growth | +5 | 0,60 |
| | stabilization | +2 | 0,35 |
| | regress | -3 | 0,05 |
| Sale of Assistive Technologies ICT devices | growth | +5 | 0,50 |
| | stabilization | +2 | 0,35 |
| | regress | -3 | 0,05 |
| **Technological area** | | | |
| Development of information and communication technologies for digital integration of persons with disability (number of AT ICT devices launched) | growth | +5 | 0,80 |
| | stabilization | +3 | 0,15 |
| | regress | -3 | 0,05 |
| New assistive technologies devices more attractive: lighter, safer, stronger, easier to use (number of new AT launched) | growth | +5 | 0,70 |
| | stabilization | +2 | 0,25 |
| | regress | -1 | 0,05 |
| Development of medical technologies compensating disabilities - health science | growth | -1 | 0,75 |
| | stabilization | +2 | 0,25 |
| | regress | +3 | 0,05 |
| Availability of ultra-fast broadband internet | growth | +5 | 0,80 |
| | stabilization | +1 | 0,15 |
| | regress | -3 | 0,05 |
| Innovative ways of transmitting and receiving digital information | growth | +5 | 0,70 |
| | stabilization | +2 | 0,25 |
| | regress | -4 | 0,05 |
| **Social area** | | | |
| Population of people with disabilities | growth | +3 | 0,65 |
| | stabilization | +2 | 0,25 |
| | regress | -1 | 0,10 |

| | | | |
|---|---|---|---|
| Population of elderly people: 65 plus | growth | +4 | 0,85 |
| | stabilization | +3 | 0,10 |
| | regress | -2 | 0,05 |
| Educational integration of persons with disabilities and elderly people in education, (e.g. third age universities) | growth | +4 | 0,60 |
| | stabilization | +1 | 0,35 |
| | regress | -4 | 0,05 |
| Persons with disabilities and elderly people enjoying recreational and tourist services | growth | +4 | 0,70 |
| | stabilization | +2 | 0,25 |
| | regress | -2 | 0,05 |
| Persons with disabilities participating in social and vocational rehabilitation (participants in occupational therapy) | growth | +3 | 0,50 |
| | stabilization | +1 | 0,45 |
| | regress | -1 | 0,05 |
| **Political and legal area** | | | |
| Proportion of PWD in municipality councils and local authorities offices and departments | growth | +4 | 0,50 |
| | stabilization | +2 | 0,45 |
| | regress | -3 | 0,05 |
| Laws, resolutions and ordinances of public bodies, supporting persons with disabilities | growth | +3 | 0,50 |
| | stabilization | +1 | 0,45 |
| | regress | -2 | 0,05 |
| Representation of disabled people in local self-governments (Number of plenipotentiaries of PWD in local governments) | growth | +3 | 0,70 |
| | stabilization | +1 | 0,25 |
| | regress | -2 | 0,05 |
| Advocacy for the rights of people with disabilities (Number of social organizations fighting for the rights of PWD) | growth | +3 | 0,70 |
| | stabilization | +1 | 0,25 |
| | regress | -2 | 0,05 |
| Availability of electronic voting procedures (number of European countries having the electronic voting procedures available) | growth | +5 | 0,70 |
| | stabilization | +1 | 0,35 |
| | regress | -2 | 0,05 |
| **International area** | | | |
| Number of countries complying with the rules of United Nations Convention on the Rights of Persons with Disabilities (CRPD | growth | +2 | 0,70 |
| | stabilization | +1 | 0,25 |
| | regress | -2 | 0,05 |
| Iimplementation of Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies (countries with full implementation of directive) | growth | +3 | 0,70 |
| | stabilization | +1 | 0,25 |
| | regress | -2 | 0,05 |
| Accessibility of websites and mobile applications - number of websites and application complying with WCAG standards in business and civic sector | growth | +3 | 0,60 |
| | stabilization | +1 | 0,35 |
| | regress | -2 | 0,05 |

| Cooperation in the field of social integration, including digital integration between organizations from different countries; exchange of good practice in field of digital inclusion (Number of international projects on disabilities) | growth stabilization regress | +2 +1 -1 | 0,60 0,35 0,05 |
|---|---|---|---|
| Establishing international funds for people with disabilities | growth stabilization regress | +3 +1 -2 | 0,50 0,45 0,05 |

Source: own studies, 2019

Taking into account the data included in table 2, it is possible to build three scenarios of the environment states: optimistic, pessimistic and most likely (tables 3-5).

**Table 3.** Optimistic scenario - trends having a positive impact on the Assistive Technologies sector for digital inclusion of persons with disabilities and elderly people in Europe in 5 years' time

| The elements of scenario | Impact factor |
|---|---|
| **Economic area** | |
| Growth of economic situation in Europe (GDP per capita) | +5 |
| Growth of vocational integration of persons with disabilities (unemployment rate of PWD) | +5 |
| Growth of amount of public funds for social integration for persons with disabilities, including tax reduction due to expenses for rehabilitation (Euro) | +5 |
| Growth of mobility of persons with disabilities and their assistants or carers (number of European Mobility Cards) | +5 |
| Growth of sale of Assistive Technologies ICT devices | +5 |
| **The average impact factor** | **+5** |
| **Technological area** | |
| Growth of development of information and communication technologies for digital integration of persons with disability (number of AT ICT devices launched) | +5 |
| Growth of new assistive technologies devices more attractive: lighter, safer, stronger, easier to use (number of new AT launched) | +5 |
| Regress of development of medical technologies compensating disabilities-health science | +3 |
| Growth of availability of ultra-fast broadband internet | +5 |
| Growth of innovative ways of transmitting and receiving digital information | +5 |
| **The average impact factor** | **+4,6** |
| **Social area** | |
| Growth of population of people with disabilities | +3 |
| Growth of population of elderly people: 65 plus. | +4 |
| Growth of educational integration of persons with disabilities and elderly people in education, (e.g. third age universities) | +4 |

| | |
|---|---|
| Growth of persons with disabilities and elderly people enjoying recreational and tourist services | +4 |
| Growth of persons with disabilities participating in social and vocational rehabilitation (participants in occupational therapy) | +3 |
| **The average impact factor** | **3,6** |
| **Political and legal area** | |
| Growth of proportion of PWD in municipality councils and local authorities offices and departments | +4 |
| Growth of laws, resolutions and ordinances of public bodies, supporting persons with disabilities. | +3 |
| Growth of representation of disabled people in local self-governments (Number of plenipotentiaries of PWD in local governments) | +3 |
| Growth of advocacy for the rights of people with disabilities (Number of social organizations fighting for the rights of PWD) | +3 |
| Growth of availability of electronic voting procedures (number of European countries having the electronic voting procedures available) | +5 |
| **The average impact factor** | **3,6** |
| **International area** | |
| Growth of number of countries complying with the rules of United Nations Convention on the Rights of Persons with Disabilities (CRPD | +2 |
| Growth of implementation of Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies (countries with full implementation of directive) | +3 |
| Growth of accessibility of websites and mobile applications - number of websites and application complying with WCAG standards in business and civic sector | +3 |
| Growth of coperation in the field of social integration, including digital integration between organizations from different countries; exchange of good practice in field of digital inclusion (Number of international projects on disabilities) | +2 |
| Growth of establishing international funds for people with disabilities | +3 |
| **The average impact factor** | **2,6** |

Source: own studies, 2019

**Table 4.** Pessimistic scenario - trends having a negative impact on the Assistive Technologies sector for digital inclusion of persons with disabilities and elderly people in Europe in 5 years' time

| The elements of scenario | Impact factor |
|---|---|
| **Economic area** | |
| Regress of economic situation in Europe (GDP per capita) | -4 |
| Regress of vocational integration of persons with disabilities (unemployment rate of PWD) | -4 |
| Regress of amount of public funds for social integration for persons with disabilities, including tax reduction due to expenses for rehabilitation (Euro) | -5 |

| | |
|---|---|
| Regress of mobility of persons with disabilities and their assistants or careers (number of European Mobility Cards) | -3 |
| Regress of sale of Assistive Technologies ICT devices | -3 |
| **The average impact factor** | **- 3,8** |

| Technological area | |
|---|---|
| Regress of development of information and communication technologies for digital integration of persons with disability (number of Assistive Technologies - ICT devices launched) | -3 |
| Regress of new assistive technologies devices more attractive: lighter, safer, stronger, easier to use (number of new ICT Assistive Technologies launched) | -1 |
| Growth of development of medical technologies compensating disabilities - health science | -1 |
| Regress of availability of ultra-fast broadband internet | -3 |
| Regress of innovative ways of transmitting and receiving digital information | -4 |
| **The average impact factor** | **- 2,4** |

| Social area | |
|---|---|
| Regress of population of people with disabilities | -1 |
| Regress of population of elderly people: 65 plus | -2 |
| Regress of educational integration of persons with disabilities and elderly people in education, (e.g. third age universities) | -4 |
| Regress of persons with disabilities and elderly people enjoying recreational and tourist services | -2 |
| Regress of persons with disabilities participating in social and vocational rehabilitation (participants in occupational therapy) | -1 |
| **The average impact factor** | **-2,0** |

| Political and legal area | |
|---|---|
| Regress of proportion of PWD in municipality councils and local authorities offices and departments | -3 |
| Regress of laws, resolutions and ordinances of public bodies, supporting persons with disabilities | -2 |
| Regress of representation of disabled people in local self-governments (Number of plenipotentiaries of PWD in local governments) | -2 |
| Regress of advocacy for the rights of people with disabilities (Number of social organizations fighting for the rights of PWD) | -2 |
| Regress of availability of electronic voting procedures (number of European countries having the electronic voting procedures available) | -2 |
| **The average impact factor** | **- 2,2** |

| International area | |
|---|---|
| Regress of number of countries complying with the rules of United Nations Convention on the Rights of Persons with Disabilities (CRPD | -2 |
| Regress of implementation of Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies (countries with full implementation of directive) | -2 |

| | |
|---|---|
| Regress of accessibility of websites and mobile applications - number of websites and application complying with WCAG standards in business and civic sector | -2 |
| Regress of cooperation in the field of social integration, including digital integration between organizations from different countries; exchange of good practice in field of digital inclusion (Number of international projects on disabilities) | -1 |
| Regress of establishing international funds for people with disabilities | -2 |
| **The average impact factor** | **- 1,8** |

Source: own studies, 2019

The situation in the Assistive Technologies sector for the digital inclusion of persons with disabilities and elderly people in Europe in 5 years' time – Optimistic Scenario versus Pessimistic Scenario is shown on the Fig. 1.

**Fig. 1.** Situation in the Assistive Technologies sector for digital inclusion of persons with disabilities and elderly people in Europe in 5 years' time – Optimistic Scenario versus Pessimistic Scenario
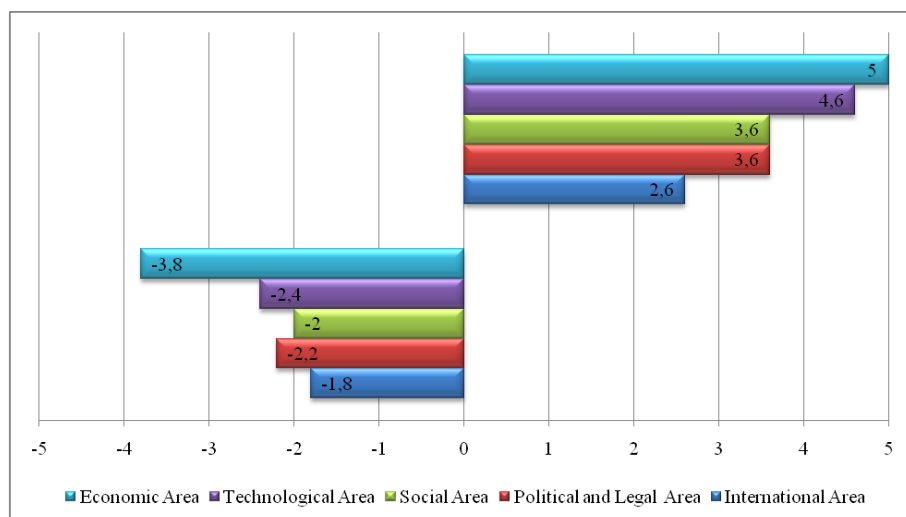


Source: own studies, 2019

Figure 1 shows that in the Assistive Technology sector for the digital inclusion of persons with disabilities and elderly people in Europe in 5 years' time, the most turbulent, unpredictable area will be the Economic area, while the most stable shall be the International area.

In the Political and legal area, the fewest number of opportunities with a strong positive impact have been identified, and in the International area the most threats with weak negative impact can be observed.

Taking into account the data included in Table 5, it can be concluded that in the Assistive technologies sector for the digital inclusion of persons with disabilities and elderly people, negative phenomena in the analyzed period of 5 years are basically not predicted. In all areas of the global environment analyzed by the scenario method, almost 100% of the elements are assessed as opportunities. The exception is the Growth of Development of Health Technologies from the Technological Area, which may be a serious threat for this type of activity.

Taking into account the data included in Table 5, it should be noted that most of the so-called key processes, characterized by the highest probability and very high impact factor, can be identified in the Technological area. Moreover, all key processes have been identified as opportunities.

**Table 5.** The most likely scenario - trends which occurrence is the most likely
– the "negative" and "positive" impact of the digital inclusion of PWD

| The elements of scenario | Most likely | Negative | Positive |
|---|---|---|---|
| **Economic area** | | | |
| Stabilization of economic situation in Europe (GDP per capita) | 0,70 | - | +1 |
| Growth of vocational integration of persons with disabilities (unemployment rate of PWD) | 0,50 | - | +5 |
| Growth of amount of public funds for social integration for persons with disabilities, including tax reduction due to expenses for rehabilitation (Euro) | 0,50 | - | +5 |
| Growth of mobility of persons with disabilities and their assistants or carers (number of European Mobility Cards) | 0,60 | - | +5 |
| Growth of sale of Assistive Technologies ICT devices | 0,50 | - | +5 |
| **The average impact factor** | **-** | **-** | **+ 4,2** |
| **Technological area** | | | |
| Growth of development of information and communication technologies for digital integration of persons with disability (number of AT ICT devices launched) | 0,8 | - | +5 |
| Growth of new assistive technologies devices more attractive: lighter, safer, stronger, easier to use (number of new AT launched) | 0,7 | - | +5 |
| Growth of development of medical technologies compensating disabilities-health science | 0,75 | -1 | - |
| Growth of availability of ultra-fast broadband internet | 0,8 | - | +5 |
| Growth of innovative ways of transmitting and receiving digital information | 0,7 | - | +5 |
| **The average impact factor** | **-** | **-1** | **+5** |

| Social area | | | |
|---|---|---|---|
| Growth of population of people with disabilities | 0,65 | - | +3 |
| Growth of population of elderly people: 65 plus | 0,85 | - | +4 |
| Growth of educational integration of persons with disabilities and elderly people in education, (e.g. third age universities) | 0,60 | - | +4 |
| Growth of persons with disabilities and elderly people enjoying recreational and tourist services | 0,70 | - | +4 |
| Growth of persons with disabilities participating in social and vocational rehabilitation (participants in occupational therapy) | 0,50 | - | +3 |
| **The average impact factor** | **-** | | **+3,6** |
| Political and legal area | | | |
| Growth of proportion of PWD in municipality councils and local authorities offices and departments | 0,5 | - | +4 |
| Growth of laws, resolutions and ordinances of public bodies, supporting persons with disabilities. | 0,5 | - | +3 |
| Growth of representation of disabled people in local self-governments (Number of plenipotentiaries of PWD in local governments) | 0,7 | - | +3 |
| Growth of advocacy for the rights of people with disabilities (Number of social organizations fighting for the rights of PWD | 0,7 | - | +3 |
| Growth of availability of electronic voting procedures (number of European countries having the electronic voting procedures available) | 0,7 | - | +5 |
| **The average impact factor** | **-** | | **3,6** |
| International area | | | |
| Growth of number of countries complying with the rules of United Nations Convention on the Rights of Persons with Disabilities (CRPD | 0,7 | - | +2 |
| Growth of implementation of Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies (countries with full implementation of directive) | 0,7 | - | +3 |
| Growth of accessibility of websites and mobile applications - number of websites and application complying with WCAG standards in business and civic sector | 0,6 | - | +3 |
| Growth of cooperation in the field of social integration, including digital integration between organizations from different countries; exchange of good practice in field of digital inclusion (Number of international projects on disabilities) | 0,6 | - | +2 |
| Growth of establishing international funds for people with disabilities | 0,5 | - | +3 |
| **The average impact factor** | **-** | **-** | **+2,6** |

Source: own studies, 2019

## Conclusions

The analysed sources and legal documents regarding the role of AT and digital inclusion for the social integration of persons with disabilities allow to formulate the following trends:

- the European Union continues to shift to a knowledge-based economy and that is why digital inclusion is becoming a priority area for policymakers at every level of government. However, equitable access to digital technology is no longer enough. Digital life requires that users are nowadays as much content creators as they are content consumers.
- Despite the increasing availability of assistive technology devices, they are often paid for by individuals and families out of their own pocket rather than by the contribution of third parties. People in a difficult economic situation are more likely to have an unmet need for as Assistive Technology device mainly because they cannot afford to buy them.
- Due to the multiplicity of jurisdiction systems, a person with a disability arriving in a given country often does not have access to facilities that are used by its residents with the same disability. For example, a blind citizen of one country, visiting his blind friend in another country, must pay the full price for the ticket, and his host bears half of these costs or does not pay them at all. Therefore steps have been taken at the international level to harmonize activities for people with disabilities.
- The aging of population is contributing to an increased number of Assistive Technologies, but there are other factors contributing to this increase, such as: the reduced costs of technology, improved and increased attractiveness of design.
- The introduction of Industry 4.0 - the concept of creating an interactive network between production and the digital sphere. As a consequence of the development of industry 4.0, there will be many structural changes in the world of work, including the vocational integration of people with disabilities. The effects of these changes for people with disabilitiesare difficult to predict at the current time.
- From the point of view of employers and people with disabilities, the future is less than certain; but from perspective of the Assistive Technologies' sector, the results of the analysis featured here show great opportunities in the development and use of AT products.