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E-services for the social inclusion of people with disabilities: A literature review

Mirfa Manzoor^a, Vivian Vimarlund^b

^aPhD Candidate in Informatics, Jönköping International Business School (JIBS); ^bProfessor of Informatics, Director of the Research Centre CENIT/IS, Jönköping International Business School (JIBS) and Linköping University, Dept. of Computer Science, Sweden

^aEmail: mirfa.manzoora@ju.se

^bEmail: vivian.vimarlund@ju.se

Abstract

Background: It is assumed that e-services support persons with disabilities in their everyday life by improving communication and interaction with healthcare organizations and whilst facilitating their social inclusion.

Aim. The aim of this study is to examine the contribution of e-services in terms of how they diminish barriers and constraints on social inclusion.

Method: A literature review was performed, covering the period between 2010 and 2016 (6 years). Only studies that discussed the social inclusion of people with disabilities or presented prototype solutions to this problem were included.

Results: The results of this study show that there is a lack of theoretical framework which can be used to measure the effectiveness of the e-services or innovations in the area of e-services in the contexts that were examined. The existing research studies are normally generic and do not discuss whether the requirements that are imposed on a particular e-service differ depending on (i) type of disability, (ii) the ICT-maturity or skill of the end-user, or (iii) context in which the e-service will be used. In general, previous research in this area claims that e-services do assist people with disabilities access to society (defined as the community in which they live), even when no evidence is actually presented about the impact such services have in this area of the end-user's life.

Conclusion: The results of the present study present us with new knowledge about the types of ICT-based innovations and e-services that have been proposed to facilitate the social integration of people with disabilities.

Keywords: e-services, people with disabilities, social inclusion.

1. Introduction

The European Commission has reported that some 70 % of people with disabilities are poor According to the World Health Organization (WHO), approximately 1 billion people out of the world's current population of 7 billion suffer from one disability or another [1, 2]. It is assumed that information- and communication technology (ICT) will improve communication and interaction between people with disabilities and the communities that they live in. It is also assumed that ICT will contribute the development of an ecosystem where citizens with different requirements (because of their disabilities) will be able to use e-services to perform their everyday activities [3], or to sustain their everyday life functions [4], thereby allowing people to be independent and participate fully in the societies that they live [5]. The properties associated with ICT-based services that make such an ecosystem possible

include the ability to access, gather, and present information, and the ability to communicate this information to various groups in real time [6].

The European Union (EU) and the Convention on Rights of Persons with Disabilities (UN) [7] have continuously work on identifying and defining strategies that will remove barriers and facilitate the inclusion of people with disabilities in the community[2].The provision of services in domain areas such as e-health, education, employment, and participation in community is considered as one of the major issues related to facilitating the inclusion of people with disabilities in society [7] and the reduction of social gaps [8].

Previous research which has examined the social inclusion of people with disabilities has mainly focused on the description of technologies or prototype services or applications that (i) promote independent living for the elderly at home [9] (ii) allow patients manage pain, (iii) support people suffering from chronic diseases, (iv) remotely monitor people with disabilities and the elderly, or (v) train families in the use of assistive technologies for younger patients [10-12]. Projects that specifically focus on how ICT-based application or e-services can support the integration of people with disabilities into society have also focused on the implementation of telecommuting, and on the importance of “large-letter computer screens, elevators, wider doorways for wheelchairs, accessible work stations, and special parking spaces” [13]. Generally, it is assumed that the services that have been developed so far will be used by whole populations, with no specific consideration being taken into account for people who suffer from different disabilities[1]. Notwithstanding this, specific applications, such as audio and visual media applications that facilitate the interaction of people with visual impairment, do appear in studies published in the early 2000s [14]. In general, however, the focus of studies into the implementation and use of e-services for people with disabilities has been somewhat ‘generic’; both in terms of the discussion of the proposed e-services that are examined, and in terms of the discussion of the barriers that people with disabilities are confronted with in their (effective) use of innovations. Other issues that have been examined include issues that influence the adoption of innovations and factors relevant to the sustainability of implemented innovations, for example, the level of ICT maturity in the end-user, the user’s ability to interact with the technology, the level of independence in the use of technologies, and access to devices [11]. The majority of the studies included in this review conclude that the suggested e-services (or prototypes of such services) could help people access their community, and, as a consequence of this, mitigate the effects of some disabilities. These studies also remark on the need to develop context-based solutions [11] so as to avoid increasing the risk of the patient being excluded from full participation in society [15].

The aim of this study is to examine the contribution of e-services in terms of how they diminish barriers and constraints on social inclusion. We have limited the scope of the study to include the examination of studies that discuss e-service solutions (or prototype solutions) that are intended to facilitate (i) the inclusion of people with disabilities within their communities, (ii) allow such people access to e-health services, (iii) promote their inclusion in the work-market, or(iv) their access to educational activities.

The knowledge that is presented in this study may be of relevance to decision-makers and to the development of policies that will improve and sustain the use of innovative e-services that will facilitate the social inclusion of people with disabilities.

Definitions

- ***Social inclusion*** refers to the achievement of ‘active participation of individuals with disabilities in society, this includes both the society and workplace’, and as a consequence of this inclusion attain an improvement in the person’s quality of life [8].

- **Participation in community** ‘[...] ensures that persons with disabilities enjoy all the benefits of EU citizenship; it remove barriers to equal participation in public life and leisure activities; and promotes the provision of quality based community services’ [8].
- **E-services** can be defined as consumer-driven services that are delivered over the Internet [16, 17]. The concept of an ‘e-service’ has been used in several areas, including e-health, e-education, and e-government [18]. It is assumed that e- services benefit people in two ways: [18] (i) by enabling to people to interact with each other by using computer-based applications that are independent of geographical and time limitations, for example, the ability for remote monitoring, and (ii) by making it possible to transfer knowledge via electronic channels, without human interference, i.e., e-learning.
- **E-health** is ‘an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology’ [19].

2. Method

A literature review was performed, covering the period between 2010 and 2016 (6 years). Only studies that discussed the social inclusion of people with disabilities or presented prototype solutions to this problem were included.

We searched for relevant publications in various databases, including Medline, ERIC, the Wiley online library database, and Jönköping University’s database. The following keywords (and combinations of keywords) were used to search for publications: *disability* and *technology*, *disability* and *e-services*, *learning disability* and *e-services*, *mobility disability* and *e-services*, *mobility disability* and *technology*, *hearing disability* and *e-services*, *vision disability* and *e-services*, *e-learning services* and *disability*, *disability* and *community access* and *e-services*, *disability* and *participation* and *e-services*, *disability* and *social inclusion* and *e-services*.

The search included rules such as MeSH (subject headings and use of qualifiers) and employed filters and limiters to search for related material. The list of keywords and the databases that were used during our searches are presented in more detail in Table 1.

Table 1: Database, year of publication, keywords, number of articles, domain areas

Database	Year	Filters	Keyword(s) and MeSH terms	Number of articles found	Number articles relevant to this study	Domain
Jönköping University database	2010-2016	Scientific and peer-reviewed article	Mobility disability AND e-services	43	45	E-services for health-related services from a distance, community access, education, and the labour-market
			Hearing AND disability AND e-services	22		
			Mobility AND disability AND technology	197		
			Disability and social inclusion and e-services	27		
			Vision AND disability AND e-services	21		
			E-learning AND services AND disability	173		
			Disability AND technology AND e-services	99		

			Disability AND employment AND e-services	20		
			Disability AND "community access" AND e-services	19		
			Disability AND participation AND e-services	21		
MEDLINE	2010-2016	<ul style="list-style-type: none"> • Term present in full text • Journal articles 	E-services AND (disability or disabled or disabilities)	13	1	E-services for health-related services from a distance
			((MH "Health Services for Persons with Disabilities") OR (MH "Occupational Health Services")) AND (e-services AND (disability or disabled or disabilities))	0		
			S2 OR S3) AND S1 S1 = (MH "Technology"), S2 = (MH "Disabled Persons") OR (MH "Intellectual Disability") OR (MH "Disabled Children") OR (MH "Developmental Disabilities") OR (MH "Vision Disorders") OR (MH "Learning Disorders") OR (MH "Communication Disorders"), o S3 = disability or disabilities or disabled or persons with disabilities.	0		
Wiley Online Library	2010-2016	<ul style="list-style-type: none"> • Term present in full text • Journal articles 	E-services and disability	99	1	E-services for health-related services from a distance
			E-services and disabled people or persons with disabilities	67		
			E-services and disabilities	79		
ERIC	2010-2016	<ul style="list-style-type: none"> • Journal articles 	E-services and disability, E-services and disabled people, E-services and disabilities, (((DE "Disabilities" OR DE "Learning Disabilities") AND (DE "Innovation" OR DE "Information Services")) AND (DE "Technology"))	0	0	-

In total, 899 articles containing one or more of the keywords mentioned above were found during the search. Articles that were considered relevant to this study focused on any kind of e-service that had been developed, designed, implemented, or recommended (n = 47) as being important to social inclusion. All of the selected articles were read in their totality. They were analyzed and categorized into groups of articles that belonged to the domain areas of relevance for this paper (e-health, education, participation in the community, and employment). The categorization of the articles was made according to the following factors: year of publication, journal, object of study, method used to collect data, theoretical approach, findings/results, type of services described and their functionality. See (Appendix 1).

We limited our review to peer-reviewed articles that had been published in scientific journals, in English. Books, abstracts, and studies published in non-peer-reviewed journals were excluded. We

excluded papers that focused on assistive technology, i.e., wheelchairs, robots, or walkers. We also excluded articles that did not discuss direct support for people with disabilities as the primary user of the e-service, thereby excluding studies that discussed support for nurses and/or doctors in their daily work. Note that these studies were excluded even when they discussed how doctors and nurses could use the e-services to gather medical data and provide support for people with disabilities. In the next chapter, we present an overview of the results of the present study.

The articles that were included in our review were classified according to the areas they claimed that they contributed to. These areas are (i) e-services that were aimed to support people with disabilities access their local community, (ii) e- services that were aimed to support individuals with disabilities to access and use health services from a distance, (iii) e- services to support the inclusion of people with disabilities the labour market, and (iv) e-services to support the inclusion of persons people with disabilities in educational activities.

3. Results

The results of the analysis of the papers that were reviewed are presented in this chapter. We also discuss the contribution of ICT-innovations and of prototyped or suggested e-services that are intended to diminish the effects of barriers and constraints for social inclusion in their respective areas.

3.1 E-services aimed to support access to the community for people with disabilities

Overall, the studies [11, 12, 20-22] belonging to this area (n=5) examined e-services that were designed to support independent living [12], leisure activities[20], dealing with an emergency [22], and discussions on how people with cognitive, intellectual, [12] and mobility [20] disabilities might manage the available e-services. (See Appendix 1).

The majority of the studies that were examined were related to basic technological innovations that supported interaction between the individual and the application, or provided access to information. Some examples of this were: the audio-based step pad [11], SOS phone applications [22], monitoring services [12], the wayfinder [11], and GPS for active trips [20]. These services were aimed at assisting people with making emergency calls, sending text by using special interfaces, receiving video instructions to support community access, learning how to use transport facilities, supporting health and social care personnel in their daily delivery of services, or assisting in the delivery of training programs, for example, training in the use of a wheelchair.

The articles appeared in journals that represent a number of different research areas, including *Neuron-rehabilitation* [11], *Applied Ergonomics* [21], *Universal Access in the Information Society* [22], and the *Disability and Health Journal* [20]. The research approaches that were used to collect data mostly consisted of surveys [21], literature reviews [11, 12], and prototype development [22].

The majority of the studies that are part of this review concluded that new technologies and e-services increase the opportunities for people with disabilities to participate in their community or access community services [11, 12, 20]. Some of the studies indicated that the involvement of elderly people and of people with disabilities in the design and development of ICT-based applications and e-services can increase the use of e-services and thus promote social inclusion [12].The majority of the studies identified a need to focus on issues of ‘usability’ and on issues that would improve the sustainability of the services [11, 21].

3.2 E- services aimed to support the access and use of health services from a distance for people with disabilities

We identified 31 articles that describe how services in the area of e-health can support individuals with

disabilities. Frequently, the overall aim of these studies was to examine, evaluate, test, and propose designs for e-services that were aimed at maintaining the health status of persons with disabilities. Survey based questionnaires [23-27] and descriptions of the methods that are used to develop ICT-based applications as e-services [28-31] were the two most common approaches that were used in this category of study. These studies covered a wide range of issues and discussed, for instance, how screening tools can be used to evaluate the potential use of e-health services for older persons with or without cognitive impairment, (ii) the multidimensional analysis of the disabilities, (iii) the presentation of evidence concerning the digital divide in the use of the Internet [32], (iv) validation of the use of video conferencing technology in the assessment of PTSD [24], and (v) the intra-oral computer interface an learning [33].

The results of the studies focused on how technology can be best used for the further development of e-services for health maintenance, or they introduced ICT-based applications such as tele-health [10, 24, 27, 34], tele-rheumatology [35], tele-rehabilitation [36], tele-medicine [29], and Gerontechnology [12]. Example of services that were suggested in these studies include blind aid virtual reality services [28], eHAB tele-health systems [10], WebGAD [37], Iwalker [38] video training [39], NAVSTAR GPS [30], home monitoring systems [12, 40], virtual reality [41], and video conferencing [24, 42].

The studies also revealed an absence of any meaningful discussion about cost and usability of e-services, and they noted the limited information about e-services that exists today. All of these issues were considered as constituting obstacles to the promotion of e-services.

In addition to reporting on different areas of e-service implementation, the publications, perhaps unsurprisingly, appear in a variety of different academic journals, including the Journal of Intellectual Disability Research [27, 43, 44], Ageing & Mental Health [23, 45], Disability and Rehabilitation [25, 46], and the Archives of Physical Medicine & Rehabilitation [34, 47, 48].

A general conclusion that can be draw after reviewing studies is that more e-services and technologies are needed because e-services have positive impacts on changing the lives of people with disabilities and they allow many of their users to improve their health. These studies also noted the need to focus on the cost and infrastructure of the technologies so as to make them accessible to all users.

3.3 E- services that increase the inclusion of people with disabilities into the labour-market

Only three articles [49-51] focused on services that were aimed at providing support to people with a disability to access and to participate in the work-market. Overall, the aim of these studies was to develop services that allow people to work at distance [49], to understand the utilization of professional and social networking sites or social media to obtain information [50], and to evaluate e-services that help people with disabilities to obtain some form of employment [51]. Two of the articles discussed the development of specific examples of services, such as ‘ticket-to-work’ and ‘making-it-work’ [49, 51]. One of the studies [50] examined the role of social media in the lives of individuals with disabilities and reported that LinkedIn and Facebook are potential channels which can be used to search for employment because, according to the results obtained in the study [50], individuals with disabilities do actually use social media to find work.

The studies mentioned above were published during the period between 2012 and 2014 and appeared in three different journals: the E-services Journal [49], Telematics and Informatics [50], and BMC Medical Informatics and Decision-Making [51]. All of the studies indicated that there is a need to continue to perform research with focus on the use of technology and the constraints that are placed on the use of technology because of a lack of ICT-literacy.

3.4 E- services that support the inclusion of people with disabilities in educational activities

We identified eight 8 articles [52-59] that focused on e-services that support the inclusion of people with

disabilities in educational activities. In general, the aim of these studies was either to examine existing learning services [52-54, 56, 58] or to discuss the approaches used to develop e-learning services [55, 57, 59]. Surveys and literature reviews were commonly used methodologies in these studies. The articles describe services such as AccessScope [57], speech synthesis [59], screen recording [58], time use diaries [54], ONTODAPS [53], and C-Print application [52].

The majority of the articles were published 2010 and 2014, whilst only article [56] was published in 2016. The publications appeared in different journals, including Campus-Wide Information Systems [53], Library Hi Tech [58], the Journal of Computer Science [55], Disability and Rehabilitation [56, 57], Child: Care, Health and Development [54], and the Journal of Deaf Studies and Deaf Education [52].

The studies mentioned above concluded that the users of the e-services greatly enjoyed using the services because they had facilitated their potential integration into the educational systems. The studies identified several barriers that should be removed if these services are to be successfully implemented. Issues such as cost and technology, and the need to personalize education by moving away from traditional pedagogical models to more dynamic models were identified as being of key importance.

Discussion

The present article has presented a literature review that was performed with the aim to examine the contribution of e-services in terms of how they diminish barriers and constraints on social inclusion for people with disabilities. It is interesting to note that the largest number of studies found belong to the e-health domain (31). In second place, we find studies that focus on the area of access to educational [8]. Studies that investigated participation in the community [5] and inclusion in the work-market [3] were not so frequent and were published during 2012 and 2014, with some exceptions.

An interesting observation was that the studies were published in different journals, since they belong to different disciplines and had different aims. Consequently, this made it difficult to make direct comparison of the methodologies that were used in these papers. Furthermore, the potential replication of the outcome, the identification of patterns of contribution, or the evaluation of the degree to which e-service innovations actually diminish barriers against the social inclusion of people with disabilities was also made quite difficult.

Studies in the area of e-health are published in journals pertaining to the field of public health, including Aging & Mental Health, Disability and Health Journal, the Journal of Intellectual Disability Research, Psychological Services, Disability and Rehabilitation, and the Journal of Rehabilitation Research & Development. Only a handful of studies in the area of e-health were published in journals related to ICT or Information Systems, for example, BMC Medical Informatics and Decision Making [51] and Telematics and Informatics [50]. The fact that these articles appeared in journals not immediately related to e-health diminishes the probability that the solutions proposed in these papers will be replicated or that the technological innovativeness of the proposals presented in these papers will be properly critiqued. The other areas of interest including community inclusion, educational inclusion, and labour-market inclusion follow the same pattern; only 6 studies that were found to examine these issues were published in journals that focus on computer science [36, 49, 50, 53, 55, 58]. None of these studies discussed how barriers against the implementation of e-services might be removed, nor did they specify solutions that might facilitate the social inclusion of people with disabilities.

In general, the studies lacked any theoretical framework which could be used to measure the effectiveness of the e-services that were discussed, or even recommended. Another important finding is the absence of user-involvement during the design or development of e-services. None of the studies mentioned issues (pros and cons) of user-involvement during the design or development of the e-services that were examined. No studies presented an evaluation or description of how the implementation

process was or could have been performed. No discussions of implementation policy were presented in these studies either.

However, notwithstanding the above remarks, some issues were identified that were common to all of the studies that were included in this review, independent of the area that they belong to. First, the overall aim of these studies was to report on or examine ICT-based applications of any form, including e-services that can be used to support the integration of people with disabilities into society, even when no specific disability was mentioned. Second, most of the studies used qualitative methods to conduct the research, but there is no information or report about how one might attempt to replicate the results of these studies with respect to how one might apply and re-use accumulated knowledge in other areas or applications. Third, e-health was the topic that dominated in all areas, and the domain in which some services have actually been implemented [23, 27, 32, 35, 37, 46]. The studies reveal that e-services do seem to enable people with disabilities maintain their health [43] and/or increase their chances of being included in educational programs [52], or employment [49], and improved access to their community [21, 22], even when there no evidence was presented on the impact that these services have had.

Most of the studies that were reviewed in this study concluded that there is a need to involve end-users in the process of designing ICT-based applications and e-services [12, 32], as well as in the implementation of applications [12] in everyday contexts and for large numbers of people. Moreover, the studies argue that there is also a need to focus on understanding the end-users' preferences [12]. The field of e-service provision for people with disabilities is a complex field, because the types of disabilities that the studies report on are not well-defined in the publications. In addition, several different terms, applications, and devices are used in the studies. In many of the studies, people with disabilities and the elderly are categorised as constituting a single group [3, 11, 12]. Some of the main issues that influence the effectiveness of the e-services developed for people with disabilities, as stated in most of the reviewed articles [11, 12, 24, 35], were related to: (i) an inadequate understanding of the end-user's needs [12], (ii) the absence of knowledge about which applications or services are best suitable, (iii) the complexity of the implementation processes, (iv) economic constraints on the implementation of innovative services [35], and (v) the level of training that new applications require and the consequences of a lack of IT-maturity and IT skills in the end-user [35]. Further to these immediate obstacles, the limited resources that are available for more research in this area, including the investigation into of how innovations such as ICT-based applications and e-services are to be designed and developed for this specific group of users were also considered as obstacles to the development of e-services [10-12].

Final remarks

The current lack of studies that assess user experiences during and after the implementation of e-services, as well as a lack of quantitative studies that may develop indicators of acceptability, adoption, and effectiveness of the services are issues that need to be addressed by further research. Similarly, we note a lack of comparative studies that investigate the socio-economic effectiveness of proposed e-services. In further studies, it will be necessary to perform quantitative comparisons that measure the acceptance and sustainability of the proposed solutions.

Furthermore, we did not find any articles in which approaches to the implementation of e-services or ICT-based innovations in this area were developed. We also did not find articles that suggested any approaches, policies, or strategies to more systematically advance and promote the transformative potential of ITC and e-services for people with disabilities. It is clear from the results of the present study that more research on how to implement, distribute, and finance e-services for people with disability is needed. It is also necessary to more clearly define specific categories of disabilities when e-services are presented as offering solutions to people with such disabilities. Generic solutions do not satisfy the needs of all people. The strategies and objectives that exist today are too general and do not

define different categories of disability, thus leading to analyses of the potential of ICT-based applications and e-services that are too broad and lack grounding in real-world applications.

Despite the limitations of the present study, we have provided with new knowledge about the types of e-services and ICT-based innovations that have been proposed to facilitate the integration of people with disabilities into society, as well as knowledge about the potential of proposed and prototyped solutions.

Conclusions

As indicated in the introduction of this article, ICT-based innovations and e-services have been identified as constituting the most important factors that can reduce the existing social gap that most people with disabilities experience, by facilitating their inclusion into society [8]. In this review, it has not been possible to identify any one study that reported on the real benefits or the impact of ICT-based applications or e-services on the social inclusion of people with disabilities. We found either no information about (i) how policy-makers and stakeholders ensure that existing programs or services are made accessible to people with disabilities, (ii) how they interact with society (enterprises and organizations), and (iii) how they ensure and/or support the participation of persons with disabilities in, for example, the labour market. However, despite these constraints, this study provides a helpful overview of the topic of ICT-based innovations and e-services for people with disabilities in several areas of relevance, including social inclusion. This review has also identified several relevant issues that should be taken into consideration in future studies into the development and implementation of ICT-based applications and e-services that should satisfy people's preferences

Future studies should focus on how we can develop ICT-based programs and e-services that allow the government, organizations, and the private sector to work hand in hand, by developing ICT-solutions that satisfy the needs of people with specific disabilities. It seems rational to assume that different disabilities demand different solutions. General solutions do not solve the problem for large groups of people. To accomplish solutions, it is important that we study and evaluate which particular e-services can be used as enablers for different groups of people. It is also necessary that we acquire more experience about how multi-stakeholder agreements can be achieved so as to ensure sustainability in the area.

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Appendix -1

Table 2. Studies relating to e-services in the four domain areas of interest (community access, health-related services at distance, work-market, and education)

Areas	Authors	Year	Journal	Study objectives	Method	Findings/Results	Name of services	Functionality of services
E-services for community access	[11]	2011	Neurorehabilitation	To identify the limitations of emerging technologies.	<ul style="list-style-type: none"> - A review of several barriers to independent community access for people with cognitive disabilities, as well as opportunities that technology may offer to overcome these barriers. - Joel's case study 	<ul style="list-style-type: none"> - The results showed that new technologies are needed to support independent community access for people with intellectual and cognitive disabilities. - There is a need for continued research and development of cognitively accessible technologies to facilitate community access. - This may include usability studies of existing technologies. 	<ul style="list-style-type: none"> - Audio-based Step Pad - Smartphone-based Visual Assistant system - Electronic tour guide - Jitterbug - Computer-based video instruction - Mobility for All (MfA): WayFinder application 	<ul style="list-style-type: none"> - Audio-based Step Pad provides navigation within buildings. - Smartphone and tour guide provide them assistance in different areas through audio and visual options. - Jitterbug to help people in travelling - The video instructions support independent community access, including teaching bus use. It provides a simulated environment to teach bus transportation skills. - The MfA provides visual and auditory cues to users to support (bus to board, when to get off, and where to go next").
	[21]	2013	Applied Ergonomics	To investigate the effects of button size and gap size on performance of individuals with varied motor abilities.	53 participants completed two questionnaires.	The results indicated that as button size increased, there was a decrease in misses, errors, and time to complete tasks. Understanding how people interact with touch screens may allow designers to improve usability of touch screen technology.	Touch screen for people with disabilities	It allows users to make emergency calls with a single click.
	[22]	2014	Universal Access in the Information Society	To present a mobile application that enables emergency calls to be made without requiring audio capabilities.	The study presented a prototype of a mobile application, named SOS Phone.	The results showed that extensive tests were needed to validate the application in a production scenario. It is suggested to include a video tutorial before using the application.	Iconographic touch interface for deaf	It enables users to make emergency calls and to write short messages using an iconographic touch interface designed.
	[12]	2014	The journal of nutrition, health & aging	To provide a narrative view of the current technology appropriate for older adults to use at home.	The study conducted an extensive review on technologies aimed at preventing disability in frail older persons.	<ul style="list-style-type: none"> - The results indicated that many barriers exist in incorporating monitoring technology into clinical care. - Older persons use technologies if they feel that the system provides 	Video phone monitoring, electronic pendant, Visio phonic communication, fall detector, vital signs, verbal prompts for daily home activities, night monitoring, message pager	<ul style="list-style-type: none"> - All these services help older adults perform home-based activities more efficiently. - The purpose of these services is to help cognitive disordered and BPSD persons achieve independence at home.

						relevant benefits and if access to the technology is suitably adapted. - Inadequate comprehension of user needs are also a major barrier to the generalization of health care technology. - Involving elderly people and care giver in the process of preliminary design is feasible and could lead to devices that are more acceptable and relevant to their needs.	system, online caregiver support and home monitoring	
	[20]	2015	Disability and Health Journal	To examine the relationship between active trips and objective measures of the home neighborhood's built environment.	The authors conducted an original cross-sectional observational study. - The data collected on 28 adult age 50+ with mobility disabilities.	- The system can increase the rate of active trips in older with mobility disability.	GPS-measured active trips	The built environment supports active trips, especially in older adults who have mobility issues
E-services for health-related services at distance	[27]	2010	Journal of Intellectual Disability Research	To investigate the use of video conferencing for persons with intellectual disability.	Eleven participants were tested on Video Conferencing first and eight were tested in-person using the Wechsler Abbreviated Scale of Intelligence (WASI) and the Beery-Buktenica Test.	The results of the informal questioning of participants found that most of the participants enjoyed the VC experience.	Video conferencing	Video conferencing helps people with disabilities undergo various psychological tests while sitting at home.
	[23]	2014	Aging & mental health	To investigate the perceived access to and the potential to use technologies important for e-health services among older adults.	The study was conducted by using the Everyday Technology Use Questionnaire (ETUQ).	The results indicated that older adults in all subsamples perceived that they had access to e-health technologies and potentially would use several e-health services competently.	- Cell phone: text message - Cell phone: call - Cell phone: answer - Answering machine: leave message - Ask-the-doctor online service - E-prescriptions	All these services provide a means to share information between patients and providers and support them in taking their prescribed medication.
	[32]	2010	The Information Society: An International Journal	To examine the Internet digital divide between people with and without disabilities from a multidimensional approach.	A survey was conducted in ten European countries.	The results showed that only 35 percent used the Internet, compared with 61 percent among those without impairments. The results suggested that input from people with disabilities is needed to design ICT surveys.	- Person with disabilities used services: downloading learning content, taking an online course, searching for health information, finding	All these services are used by people for different purposes, but the most commonly used services are for maintaining health.

							information on healthy lifestyles.	
[24]	2014	Psychological Services	To promote the use of telehealth technologies to deliver mental health care to veterans with limited access to services on account of geographic and other barriers.	The study used the following methods: -Semi-structured clinical interview designed to assess the 17 core symptoms of PTSD. -Videoconferencing Participant Satisfaction Questionnaire	The results suggested that the CAPS can and should be used via video teleconferencing with veterans who have barriers to face-to-face evaluations.	- Telehealth video conferencing service	The service helps people with disabilities assess and control stress disorders.	
[37]	2010	BMC Psychiatry	To reduce the prevalence of the disorder, to reduce disability and to lower the costs of the disorder to the community.	The study was designed as a five-arm randomized controlled trial with three active interventions and two comparators.	The WebGAD trial represented an opportunity to test the potential benefit of a population-based preventive intervention for a mental disorder in adults.	- WebGAD	WebGAD helps reduce disability and lowers the costs of the disorder to the community.	
[35]	2012	Internal Medicine Journal	To explore the use of telerheumatology technology in Australian rheumatology practice	This review summarizes the current evidence base, outlines telehealth's strengths and weaknesses in managing rheumatic disease.	The study found that there were barriers to implementation, such as cost, training and technology requirements, as well as potential complications, including the need to clarify how teleconsultations will be managed by insurers.	- Telehealth: teleconsultation and telerheumatology	Teleservices helps in the treatment of rheumatic disease via video conferencing.	
[46]	2011	Disability and rehabilitation.	To evaluate the Television-Assisted Prompting (TAP) system, which provides a novel method of delivering intensive in-home therapy prompts.	The study approach used testing, interviewing and record logs.	All participants reported that the use of the TV was effective and useful in delivering exercise program reminders and instructions.	- Television-Assisted Prompting (TAP)	TAP provides a novel method to deliver intensive in-home therapy prompts for dysphagia exercise.	
[48]	2013	Archives of Physical Medicine and Rehabilitation	To describe the methods used in operationalizing environmental factors.	Instrument development included an extensive literature review, item classification and selection, item writing, and cognitive testing and interviews.	The results suggested that clinicians and researchers are interested in identifying aspects of the environment that are potentially modifiable; their interventions could focus on problematic environmental factors that limit participation and life satisfaction.	- Patient-Reported Outcomes Measurement Information System.	The system helps assess cognitive disorder and conduct different cognitive tests.	
[25]	2015	Disability and rehabilitation.	To describe an evaluation of SMART2, a personalized self-management system.	The study used four different types of questionnaires.	The findings showed that technology that provides feedback and functions as an external agent has great potential for supporting	- SMART2	The SMART2 is a personalized self-management system incorporating activity planning and review and feedback on behavior-	

						the self-management of chronic pain.		and acceptance-based therapeutic exercises.
[43]	2013	Journal of Intellectual Disability Research	To provide an overview of how surveillance technology is viewed by (care) professionals and ethicists.	The study conducted a concept mapping method that combined qualitative and quantitative.	The results indicated that the generated views represented six categories, varying from surveillance being beneficial to the client, reducing restraints, being based on a clear vision to appropriately equip staff, maintaining user friendliness and attending to the client.	- Smart homes: surveillance technology (ST)	The ST is used in residential care for people with an intellectual disability (ID).	
[12]	2014	The journal of nutrition, health & aging	To provide a narrative view of the current technology appropriate for older adults to use at home.	See above	See above	Telehealth service Video Communication system and Internet multimedia support program.	The services help co-ordinate the care of patients with chronic conditions and assists independent living at home, with promising results.	
[10]	2012	Pain Practice	To provide a rationale for the potential benefits of telehealth-based pain management services.	A recent literature review focusing on telehealth for pain was conducted.	The study showed that considering telehealth as a pain treatment option is strongly encouraged based on the findings on Telehealth for Pain Management.	University of Queensland eHAB telehealth system Television-based health visits with a physician and nurse.	eHAB helps patients assess pain while sitting at home Cable television-based health visits also helps them treat their diseases themselves, in particular the treatment of chronic pain	
[47]	2011	Archives of Physical Medicine and Rehabilitation	To identify quantitative measurement variables that characterize mobility in older adults, meet reliability and validity criteria, distinguish fall risk, and predict future falls.	Observational study with 1-year follow-up of weekly falls.	The study showed that the mobility battery provided a sensitive prediction of future injury falls and screening for multiple subsequent falls by using tasks that should be appropriate for diverse participants.	Short Physical Performance Battery (SPPB)	The mobility battery provides a sensitive prediction of future injury falls and screening for multiple subsequent falls based on tasks.	
[60]	2015	Physical Therapy	To discuss the potential role of body-worn movement monitors for balance and gait assessment and treatment in rehabilitation.	This article reviewed 3 important advantages to using body-worn movement monitors for the assessment and treatment of balance and gait disorders.	The results showed that movement monitors can provide impairment-level metrics to characterize how and why functional performance is impaired to better focus treatment on the underlying causes.	Body-worn movement monitors	The monitors help in balance and gait assessment and also in rehabilitation treatment.	
[26]	2012	Gait & posture	To evaluate the relationship between WiiFit™ Plus balance tests, and	34 older adult participants completed a questionnaire and were involved	The results indicated that the Wii balance score, as measured by the Basic Balance Test of the	WiiFit™	The service is used for fall prevention, training and assessment of balance in older adults.	

			standardized tests of older adult fitness, balance, mobility, self-reported balance confidence, and visual attention and processing.	in a 24-week exercise program to compare the Wii and WiiFit balance test.	WiiFit™, did correlate with visual processing speed as measured by the Useful Field of View (UFOV®) test.		
[28]	2012	Disability and rehabilitation.	To present a virtual reality system (the BlindAid) developed for the orientation and mobility training of people who are newly blind.	This case study focused on a woman who is newly blind.	The results of this study helped identify several issues concerning the contribution of the BlindAid system to the exploration strategies and learning processes experienced by the participant.	Blind Aid virtual system	The system allows users to interact with different virtual structures and objects via auditory and haptic feedback.
[36]	2010	Assistive technology: the official journal of RESNA	The objective of this study was to measure satisfaction based on one's evaluation and prescription as well as comfort level when being evaluated by telerehabilitation (TR).	The data were collected at four remote sites, all of which were established by the clinical research team. -Telerehabilitation Survey	The results indicated a high level of patient satisfaction with tele-rehabilitation. - Patient acceptance of TR is an integral part of the future success of incorporating technology into clinical service delivery.	Tele-rehabilitation, remote wheelchair.	The service helps them assess their rehabilitation process remotely.
[38]	2015	Disability and rehabilitation.	To evaluate the utility of an ambulatory assessment approach to examine balance and mobility in everyday conditions compared to a laboratory assessment.	Three neurological rehabilitation in-patients were assessed under two different conditions.	This study illustrated a greater reliance on the rollator during challenges in everyday use compared to laboratory assessment and provided evidence of specific circumstances associated with destabilizing events that may precipitate falls in non-laboratory settings.	Iwalker	The Iwalker is used for mobility training and to measure variables related to the balance control.
[29]	2016	Parkinsonism & related disorders	To discuss the growth of the field of neurorehabilitation treatment for disease using new developments.	The study reviewed the potential for growth in the field of neurorehabilitation.	The study results showed that neurorehabilitation can make a real impact on improving the quality of life of patients affected by Parkinson's disease.	-Games (virtual dancing, bicycling) -Telemedicine	-Provides training for gait and balance management. -Telemedicine allows for the delivery of expert rehabilitation advice to patients in their own home.
[34]	2013	Archives of Physical Medicine and Rehabilitation	To determine whether the conditions for use of clinical video telehealth technology might affect the accuracy of measures of physical function.	Repeated-measures study design. Three healthy adult volunteers for a sample size of n=30 independent trials of each physical function tasks.	The results indicated there may be a need for improved technology and infrastructure to better meet the clinical requirements for telehealth.	Clinical video telehealth technology	This video telehealth technology is used to assess a fine-motor task, gross-motor task, and spatial relations.
[33]	2014	Disability and	To evaluate typing and pointing performance and improvement over time of	Training with the intra-oral tongue-computer interface was	The results illustrated that the inductive tongue-computer interface was able to emulate text input and	Intra-oral computer interfaces	This service provides individuals with severe upper-limb mobility impairments the opportunity to

		rehabilitation.	four able-bodied participants.	performed by playing games over 18 sessions.	pointing devices using standard HID USB drivers.		control computers and automatic equipment.
[61]		Trials, 2010,	To examine a multifaceted telerehabilitation (TR) intervention that uses telehealth technology to simultaneously evaluate the home environment.	The telerehabilitation (TR) intervention used a combination of three videotaped visits and five telephone calls, an in-home messaging device, and additional telephone contact as needed over a 3-month study period.	The study results indicated that the use of TR in providing home assessments and follow-up training in prescribed equipment had the potential to effectively supplement existing home health services, assist the transition to home and increase efficiency.	Videotaped visits, telephone calls,	This intervention is used to assess patients' rehabilitation performance.
[42]	2014	Social Work With Groups	To explore the dynamics of a long-term telephone support group, implemented over eight years, for individuals with multiple sclerosis (MS).	The study offered observations about the relationships between individual self-esteem, group participation, and the use of technology in mental health treatment.	The study showed that training MSW students in this modality might help the social work field generate treatment tools that are effective and sustainable, especially with a population who is increasingly physically disabled and isolated.	Conference call technology	The support group helps individuals with multiple sclerosis (MS) in their treatment.
[41]	2010	Gait & Posture	To demonstrate the sensitivity of virtual reality (VR)/motion tracking to detect global functional gait impairment resulting from an emulated knee disability	Eleven adults participated in the study, and their activities were observed.	This study demonstrated that VR can be used to detect and quantitatively characterize mobility impairment with an emulated disability.	Virtual reality (VR)/motion tracking	The technology is used to detect global functional gait impairment resulting from an emulated knee disability.
[40]	2015	Neurorehabilitation and neural repair	To test the feasibility of providing quantitative feedback on daily walking performance and motivating greater skills practice via remote sensing.	Patients participated in conventional therapies and were monitored.	The study illustrated that wireless sensing allowed clinicians to monitor skills practice and provided grounded data regarding changes in clinically important, mobility-related activities.	Wireless sensing or remote monitoring	This technology helps in walking therapies
[30]	2010	Disability and rehabilitation.	To improve the global positioning system (GPS) navigation of electric powered wheelchairs (EPWs) through the addition of an electric compass (EC).	The PC software functions of the GPS system were developed and evaluated.	The results illustrated that the system was helpful for people who used powered wheelchairs and that they were comfortable with it.	NAVSTAR GPS (NAVigation Satellite Timing and Ranging Global Positioning System)	This technology is used for the navigation of powered wheelchairs.
[39]		Journal of Rehabilitation Research & Development	The authors hypothesized that the effects of immediate video feedback (IVF) on training ramp, wheelie, and curb wheelchair skills for persons with spinal cord	In-person interviews and a written survey.	The study demonstrated that research on this issue and effective ways to prepare employers to properly work with and accommodate veterans are urgently needed.	Immediate video feedback (IVF) on training ramp	IVF helps provide wheelchair training.

				injury (SCI) would be equivalent to or better than traditional wheelchair skill training.				
	[45]	2012	Aging & Mental Health	This pilot study focused on the feasibility, acceptability, and effectiveness of a three-month use of Global Positioning System (GPS) by care receivers and caregivers.	People with dementia and their caregivers were investigated using various tests.	The study indicated that the track and trace technology used in this study seemed to be promising for care receivers in the early stages of dementia and their caregivers.	Use of GPS by the care receiver and caregiver	GPS helps these individuals go outside independently without risk of getting lost.
	[31]	2016	AJOT: American Journal of Occupational Therapy,	To test and further develop an innovative method of driving powered wheelchairs for people whose impairments prevent them from operating commercial wheelchair controls.	The authors compared the pre-post functional power wheelchair driving skill data of 4 participants, measured by the Power Mobility Program, using descriptive analyses.	The results indicated that all 4 participants who completed the 12-wk intervention improved their functional power wheelchair driving skills using SPOOCI.	Self-referenced Personal Orthotic Omni-purpose Control Interface (SPOOCI)	This innovation provides a way of driving power wheelchairs to new users.
	[44]	2010	Journal of Intellectual Disability Research	To evaluate and compare the effectiveness and efficiency of prompting when provided by onsite standard care and remote telecare staff on the independent performance of consumers.	Investigators compared the effectiveness of prompting provided by onsite standard care staff and by a remote telecare provider.	The study results demonstrated that consumers achieved slightly more independence when prompted by the telecare support provider.	Telecare system	Remote telecare supports were provided to adults with intellectual disabilities living in integrated community settings to their home-based activities.
E-services for work-market	[49]	2012	E - Service Journal	To provide employment opportunities to people with disabilities.	The authors developed and evaluated a disability employment information system prototype.	The study suggested that the inter-organizational complexity of the e-government arrangement also required more attention to better understand how different entities participate and behave within the same e-government network.	Ticket-to- Work (TTW)	TTW is aimed at helping people with disabilities to assist people in gaining employment.
	[50]	2013	Telematics and Informatics	To understand the degree to which people with disabilities and older adults utilize these websites for social and professional networking.	Surveys were conducted with member groups within both the Facebook and LinkedIn platforms.	The results suggested that the potential use of Facebook and LinkedIn maximizes their interactions within society.	Facebook and LinkedIn	The e-services help people with disabilities, as well as those aging, be a part of the community and search for employment through online interactions
	[51]	2014	BMC Medical Informatics and	To evaluate the effectiveness of the program at preventing work cessation and improving at-work productivity and to perform a	526 participants were recruited for this study. The intervention consisted of online group sessions, web-based e-learning	The study demonstrated that their program had the potential to generate great cost savings for society and to have a substantial personal impact on people's lives.	"Making It Work"	To help people with inflammatory arthritis (IA) address employment issues and improve at-work productivity.

			Decision Making	cost-utility analysis of the intervention.	modules; and consultations with an occupational therapist.			
E-services for Education	[53]	2012	Campus-Wide Information Systems	To show how personalization of learning resources and services can be achieved for students with and without disabilities.	This paper reviewed current e-learning systems that provide personalization for students.	The results revealed that ONTODAPS was flexible enough to provide sufficient control and freedom to drive their learning.	ONTODAPS	ONTODAPS is an e-learning system that provides personalization for students, including their strengths and weaknesses.
	[54]	2011	Child: Care, Health and Development	To investigate whether time-use diaries can provide an acceptable tool for exploring the daily lives of parents of child with disability.	A pre-coded time-use diary divided into 15-min time slots was designed. Father–mother pairs were asked to complete a day diary.	The results demonstrated that the time-use diaries were acceptable to the majority of parents and provided detailed information about their daily lives.	Time-use diaries	The online time-use diary is used to help students with disabilities improve efficiency by identifying the activities they performed at home.
	[55]	2013	Journal of Computer Science	To present examples of how universally designed technology hardware, software and tech applications promote increased learning.	This reviewed paper defined mobile technologies, universally designed devices and technology for learning.	The results showed that students mainly appreciated the mobile devices and technology.	Augmentative and Alternative Communication (AAC) system for Students with Developmental Disabilities.	This service help students with developmental disorders who need an individual plan to support their education.
	[56]	2016	Disability and rehabilitation.	To help students with disabilities (SwD) participate more in the physical space and become more engaged in school.	A pilot study was conducted with SwD who used IMAGINE's navigation and wayfinding functionality, the subjects reported that IMAGINE aligned well with their needs.	The results showed that after completing training and using the tool, SwD reported that they were more likely to use the tools.	Interactive, mobile, AGile and novel education (IMAGINE)	IMAGINE advises and reminds students and allows them to make requests for key learning resources (LRs).
	[57]	2010	Disability and rehabilitation,	To remotely view slide specimens and control all functions of a research-level light microscopy workstation	Users with upper limb mobility impairments and low vision were recruited to assist in the design process of the AccessScope personal computer (PC) user interface.	The results illustrated that with AccessScope, students were able to perform common light microscopy functions independently through an Internet browser.	AccessScope	AccessScope helps students remotely view slide specimens and control all functions of a research-level light microscopy workstation.
	[58]	2011	Library Hi Tech	To observe the execution of a database search by students with print disabilities who use screen readers to access information online.	Survey data were collected pre- and post-study as well as after each database search session.	The findings showed that there was a lack of research on the intersection between database design and its impact on the information literacy skills of students with print disabilities.	Screen-recording software provided video and audio documentation of the process.	The software helps students explore research databases in an efficient manner.
	[59]	2010	Science Direct, Procedia	This paper highlights the need to respect international accessibility and e-learning standards when creating	Development of Computer assisted learning	The results revealed that the system increased the chances of integration into the educational system, labor market or in society.	Synthesize speech from text (TTS)	Increases their chances of integration into society, education, and labor market.

			Social and Behavioral	websites or assistive software and provides solutions.				
	[52]	2014	Journal of Deaf Studies and Deaf Education	This study compared the extent to which four different groups of students benefitted from C-Print notes for STEM lectures.	The study used test-study-test cycle for each subject and presented data from students' responses to questionnaire items.	The results indicated that students acquired measurable amounts of information from studying these types of notes for relatively short periods of time.	C-Print Pro Tablet software application	It helps students with disabilities in their education.