

Towards Inclusive and Adaptable Information Services in Digital Library Environments

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Abstract

Background: The advent of digital technology in libraries, combined with advances in accessibility and universal design, has created the opportunity to create inclusive information services. A main challenge of these services is the inclusion of people with print disabilities who have been served through special libraries designated for their use. The objective of this research was twofold. First, it attempted to identify the barriers of the access to digital content by users with print disabilities; second, it aimed to explore how the advances in accessibility and universal design could be applied to remove such barriers.

Methodology: The research was designed as a qualitative study that employed the techniques of semi-structured interviews, usability testing, prototyping, use of survey data, documentation analysis, and literature reviews. Thirteen participants with print disabilities and eight digital service librarians were included in the study. In addition, part of a survey data collected from a survey completed by 113 people with print disabilities were used. The International Classification of Functioning, Disability and Health (ICF) model was employed to identify the barriers and to develop a framework for removing them. Moreover, a postphenomenological analysis was conducted to reexamine the role of technology in user-information mediation from the perspective of digital inclusion.

Results: In addition to the bodily impairments that affect users' ability to read printed text or perceive certain colors, users' own attitudes and perception of libraries are part of the personal barriers identified and discussed in the study. Contextual barriers that can be attributed to the failure of digital library environments to accommodate the needs of people with disabilities are also detailed and discussed. The design of search interfaces according to accessibility guidelines, the use of accessibility and regular metadata for accessible search, and the development policies and procedures that include the needs of persons with print disabilities are among the solutions this research recommended for inclusive access to digital content. The results showed that people of similar disabilities could have contrasting preferences. Moreover, it was observed that the demands of "one-time users" could differ from those of frequent users. Therefore, inclusive design practices need to consider not only the disabilities of users but also the diversity of needs and varying patterns of use. Thus, the research provided a framework which recommends adherence to accessibility guidelines as the minimum requirement and add other requirements, such as provision of alternative content and adaptable search interface,

catering to the needs of one-time as well as frequent users. Moreover, the results of the phenomenological analysis revealed different types of relations, such as embodiment, hermeneutics, alterity, and background, which may occur when users interact with search interfaces. The results showed how postphenomenological analysis could help in diagnosing the barriers that may affect user–information mediation.

Conclusion and Recommendations: The realization of inclusive digital library environments cannot be achieved solely by following accessibility guidelines or laws and conventions that protect peoples’ rights of access to information. It requires a user-centered approach that acknowledges the diversity of needs and preferences and reexamines the role of digital technology in mediating the access to information. This research was conducted in the Norwegian context. Further studies in similar or different contexts could be required to confirm or expand the solutions presented in this research.

Keywords: Digital accessibility, accessible search, inclusive design, universal design, digital library environments, digital inclusion, the digital divide.

Sammendrag

Bakgrunn: Den økende bruken av digital teknologi i biblioteker har sammen med utviklingen innen tilgjengelighet og universell utforming åpnet for muligheten til design av inkluderende informasjonstjenester. En av hovedutfordringene er å lage disse tjenestene slik at de også inkluderer folk med funksjonsnedsettelse som gjør det vanskelig å lese trykt tekst (*print disabilities*). Denne forskningen forsøker for det første å identifisere barrierer for tilgang til digitalt innhold for brukere med denne type funksjonsnedsettelse, og for det andre å utforske hvordan utviklingen innenfor tilgjengelighet og universell utforming kan innarbeides for å fjerne disse barrierene.

Metode: Forskningsdesignet er en kvalitativ tilnærming med semi-strukturerte intervjuer, brukertester av søkeverktøy for bibliotek og en høyoppløselig (high-fidelity) prototype, bruk av undersøkelsesdata, analyse av dokumentasjon, samt gjennomgang av forskningslitteratur. Tretten deltakere med funksjonsnedsettelse som gjør det vanskelig å lese trykt tekst og åtte bibliotekarer som administrerer digitale tjenester er inkludert i studien. I tillegg er det tatt inn en del av data fra en spørreundersøkelse med 113 deltakere med funksjonsnedsettelse som gir vansker med å lese trykt tekst. Den internasjonale klassifikasjonen av funksjon, funksjonshemming og helse (ICF) ble benyttet som modell for å analysere og forklare barrierer for tilgang til informasjon og anbefale et rammeverk for å fjerne dem. Videre ble det gjennomført en post-fenomenologisk analyse for å undersøke på nytt den rollen teknologi har i mediering mellom bruker og informasjon, og identifisere steder der barrierer kan oppstå.

Resultater: I tillegg til de fysiske funksjonsnedsettelsene som klart påvirker brukernes evne til å lese trykt tekst eller oppfatte enkelte farger, vil brukernes egne holdninger og oppfatning av biblioteker utgjøre de personlige barrierene identifisert og diskutert i studien. I tillegg vil manglende tilpasning til behovene til personer med nedsatte funksjonsevner utgjøre en del av de kontekstuelle barrierene. Design av søkegrensesnitt i henhold til retningslinjer for tilgjengelighet, bruk av metadata for tilgjengelighet og vanlige metadata for å gjøre søkeprosessen tilgjengelig, samt utvikling av retningslinjer for innkjøp av ressurser som tar opp hensynet til tilgjengelighet, er en del av løsningene for å fjerne tilgjengelighetsbarrierer for tilgang til digitalt innhold. Forskningen fant at personer med lignende funksjonsnedsettelse kunne ha motvirkende preferanser. Videre ble det observert at «engangsbrukere» kunne ha andre behov enn hyppige brukere. Derfor er det nødvendig at inkluderende designpraksis tar

hensyn til ikke bare funksjonsnedsettelsene til brukerne, men også forskjeller i behov og skiftende bruksmønstre. Følgelig har forskningen gitt et rammeverk som anbefaler å overholde retningslinjer for tilgjengelighet som et minimumskrav og i tillegg ha løsninger som alternativt innhold og et søkegrensesnitt som kan tilpasses behovene til henholdsvis «engangsbrukeren» og hyppige brukere. Dertil viste den post-fenomenologiske analysen forskjellige typer teknologimedierte relasjoner som kan oppstå mellom brukere og søkegrensesnittet mens brukeren søker etter informasjon, som legemliggjøring (*embodiment*), hermeneutisk (*hermeneutics*), annethet (*alterity*), og bakgrunn (background). Forskningen viste også hvordan en slik analyse kan hjelpe med å identifisere barrierer som kan påvirke hver type relasjon.

Konklusjon og Anbefalinger: Realiseringen av inkluderende digitale biblioteksmiljø kan ikke oppnås bare ved å følge retningslinjer for tilgjengelighet eller lover og konvensjoner som beskytter folks rett til tilgang til informasjon. Det krever en brukersentrert tilnærming som anerkjenner diversitet i behov og preferanser, og en ny granskning av den rollen digital teknologi har ved mediering av tilgang til informasjon. Denne forskningen ble gjennomført i en norsk kontekst. Videre studier i lignende eller ulike kontekster kan være påkrevd for å stadfeste og utdype de løsningene som er presentert i denne forskningen.

Acronyms

ADHD: Attention Deficit Hyperactivity Disorder

AfA: Access for All

AT: Assistive technology

CRPD: Convention on the Rights of Persons with Disabilities

CUD: Center of Universal Design

Difi: The Norwegian Agency for Public Management and eGovernment

DL: Digital library

DLS: Digital library system

DLMS: Digital library management system

DRM: Digital rights management

GPII: Global public inclusive infrastructure

HCI: Human Computer Interaction

HiOA: Høgskolen i Oslo og Akershus (Oslo and Akershus University College)

ICF: International Classification of Functioning, Disability and Health

ICT: Information and communication technology

IFLA: International Federation of Library Association

LMS: Learning management systems

MVT: The Marrakesh Treaty to Facilitate Access to Published Works for Persons Who are Blind, Visually Impaired, or Otherwise Print Disabled

NLB: Norsk Lyd og Blindeskriftbibliotek (The Norwegian Library of Talking Books and Braille)

RDT: Resource discovery tool

UDHR: Universal Declaration of Human Rights

UiO: University of Oslo

UN: United Nations

W3C: World Wide Web Consortium

WAI: Web Accessibility Initiative

WAI-ARIA: Web Accessibility Initiative Accessible Rich Internet Applications

WCAG: Web content accessibility guidelines

WHO: World Health Organization

WIPO: World Intellectual Property Organization

WSIS: World Summit on the Information Society

Tables and Figures

Tables	Page
Table 1. Principles of Universal Design -----	27
Table 2. WCAG Principles and Guidelines-----	28
Table 3. Methodology-----	57
Table 4. Barriers to the Access to Information-----	79
Table 5. Augmenting the DC metadata element <i>Format</i> -----	86

Figures

Fig. 1: The domain of digital inclusion-----	4
Fig. 2: The DELOS digital library framework -----	7
Fig. 3. A typical digital library environment -----	8
Fig. 4. The Gap model of disability-----	23
Fig. 5. The research design-----	56
Fig. 6. Results list Presentation on Oria -----	81
Fig. 7. Giving users control in adding shortcuts to search interfaces -----	85
Fig. 8. A framework for inclusive and adaptable information services-----	91

Table of Contents	Page
1. Introduction	4
1.1. Digital libraries.....	6
1.2. Digital library environments	8
1.3. Print disability	8
1.3.1. Dyslexia.....	9
1.3.2. Low-vision Impairment.....	10
1.4. Access for Persons with Print Disabilities.....	11
1.5. The Research Context	13
1.6. Contributions of This Research.....	13
1.6.1. User Perspective	14
1.6.2. Focus on Resource Discovery and Access	14
1.6.3. Improved Conceptualization of Access to Digital Content	15
1.6.4. Summary: contributions of This Research	15
1.7. Structure of the Thesis.....	15
2. Conceptual Background and Review of Related Works	17
2.1. Inclusion: Philosophical and Historical Roots	17
2.1.1. Studying Inclusion.....	19
2.2. Digital Inclusion.....	24
2.3. Designing for Inclusion.....	26
2.3.1. Universal Design and Inclusive Design	30
2.3.2. Accessibility vs. adaptability.....	34
2.3.3. Adaptability vs. adaptivity.....	36
2.3.4. Process-driven approach.....	37
2.4. Digital Inclusion and Libraries.....	38
2.4.1. Designing inclusive digital library environments.....	39
2.5. Previous Research on Digital Accessibility and Inclusion in Libraries	39
2.5.1. Library Websites	40
2.5.2. Library Databases.....	42
2.5.3. Resource Discovery Tools.....	44
2.5.4. Library GPII	46
2.6. Research Gaps	47
2.7. Theoretical Framework	47
2.7.1. Access to Information	49
2.7.2. Technology, Limitations, and Mediation	50
3. Research Design and Methodology.....	54

3.1.	The Research Design.....	54
3.2.	Methods of Data Collection	58
3.2.1.	Users’ perspective (Papers 1 and 2).	58
3.2.2.	User’s perspective (Paper 6).....	61
3.2.3.	Users’ Perspective (Paper 7)	62
3.2.4.	Librarians’ perspective	62
3.2.5.	Documentation and literature review	63
3.3.	Reflections on Methodological Limitations	63
3.3.1.	Sample size.....	63
3.3.2.	User Tests and Interviews with Participants	65
3.3.3.	User Testing with a Prototype	66
3.3.4.	Interviews with Librarians.....	66
3.3.5.	Survey data	66
3.3.6.	Summary: Reflections on Methodological Limitations.....	67
3.4.	Generalizability	67
4.	Ethical Considerations.....	68
4.1.	Handling Participants	69
4.2.	Privacy and Personal Data.....	69
4.3.	Integrity	70
5.	Summaries of the Publications	71
5.1.	Identifying Barriers of Access to Information.....	71
5.1.1.	Paper 1	71
5.1.2.	Paper 2.....	73
5.1.3.	Paper 3.....	76
5.1.4.	Summary: Barriers of access to information	78
5.2.	Removing Barriers of Access to Information.....	79
5.2.1.	Paper 4.....	80
5.2.2.	Paper 5.....	82
5.2.3.	Paper 6.....	84
5.2.4.	Paper 7.....	87
5.2.5.	Summary: Removing barriers.....	88
6.	Discussion	90
6.1.	Barriers of Access to Digital Content.....	90
6.2.	A Framework for Inclusion in Information Services.....	90
6.3.	Rethinking Human- Technology-Information Relation from Inclusive Design Perspective	93
6.3.1.	Approaches.....	93

6.3.2. User-technology-information mediation	94
6.4. Recommendations for Future Research.....	98
6.5. Significance of the Research	99
7. Conclusion.....	100
References	101
Project Registration Confirmation (APPENDIX I).....	121
Consent Form for User Participants (APPENDIX II)	123
Consent Form for User Participants (APPENDIX III)	124
Consent form for Librarians (APPENDIX IV)	125
Papers.....	126

Papers

Paper 1: Beyene, W. (2016). Resource discovery and universal access: understanding enablers and barriers from the user perspective. *Studies in Health Technology and Informatics*, 229, 556–566. IOS Press. Retrieved from <https://doi.org/10.3233/978-1-61499-684-2-556>

Paper 2: Beyene, W. (2018). Digital inclusion in library context: A perspective from users with print disability. *Journal of Web Librarianship*, 12(2), 1–20. Retrieved from <https://doi.org/10.1080/19322909.2018.1427657>

Paper 3: Beyene, W. M. (2016). Realizing inclusive digital library environments: Opportunities and challenges. In N. Fuhr, L. Kovács, T. Risse, & W. Nejdl (Eds.), *Research and advanced technology for digital libraries* (pp. 3–14). Springer International Publishing. https://doi.org/10.1007/978-3-319-43997-6_1

Paper 4: Beyene W. M., & Ferati M. (2017). A case for adaptation to enhance usability and accessibility of library resource discovery tools. In M. Antona & C. Stephanidis (Eds.), *UAHCI 2017. Lecture notes in computer science, vol. 10277*. Cham.: Springer. Retrieved from https://doi.org/10.1007/978-3-319-58706-6_12

Paper 5: Beyene, W. (2017). Metadata and universal access in digital library environments. *Library Hi Tech*, 35(2), 210-221. <https://doi.org/10.1108/LHT-06-2016-0074>

Paper 6: Beyene, W., & Godwin, T. (2018). Accessible search and the role of metadata. *Library Hi Tech*, 36(1). <https://doi.org/10.1108/LHT-08-2017-0170>

Paper 7: Beyene, W. M., & Aasheim, M. W. (2018). Improving resource discovery and access through user-controlled adaptation: Exploring the role of library metadata. In M. Antona & C. Stephanidis (Eds.), *Universal access in human–computer interaction: Design and development approaches and methods*. UAHCI 2017. *Lecture Notes in Computer Science*, vol. 10908 (pp. 397–408). Cham.: Springer. <https://doi.org/10.1007/978-3-319-92052-8>

1. Introduction

Universal design (UD), inclusive design, barrier-free design, and accessible design are terms used to describe the same intention of removing barriers of access to facilities and services (Ostroff, 2001; Persson et al., 2014). These terms signify a shift from designing for the average user to designing for all, that is, to include those who are marginalized because of their disabilities or other social, political, and economic circumstances. In information services, these terms could be used to elaborate the scope of digital inclusion.

Digital inclusion attempts to bridge the digital divide, which was initially understood as the gap between those who have access to information and communication technology (ICT) and those who do not (Harrington, 2008; Selwyn & Facer, 2009). Libraries have been working to bridge that gap by providing their communities with access to ICT, digital content, and digital literacy programs. However, it is evident that although people have access and skills, they can remain excluded because of their disabilities or other limitations, which some call the “second digital divide” (Burgstahler, 2008). Thus, a comprehensive approach to digital inclusion requires addressing not only the issues of access and literacy but also issues related to participation and usage (Jaeger et al., 2012).

The focus of this research is on ensuring inclusion in digital library environments. It focuses on the second digital divide and the issues related to participation and usage (see Fig 1). It considers accessibility and universal / inclusive design as efforts to bridge the second digital divide, and it explores the matter from the perspective of users with print disabilities.

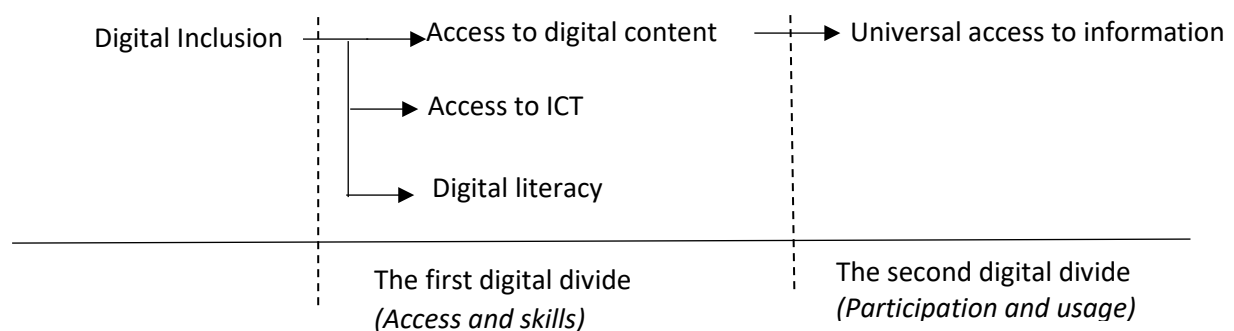


Fig. 1. The domain of digital inclusion

In the traditional approach, special libraries are set up to better serve the needs of people with print disabilities. However, the introduction of digital technology and the demands for UD have created a favorable ground for demanding inclusive information services in both mainstream

and specialized libraries. The main aim of this research is to identify barriers to inclusive access to information, taking the Norwegian context as an example, and explore ways to overcome them. First, this research attempts to identify the barriers from the perspectives of users with a print disability. Second, it examines how research and development in accessibility and UD could be applied to remove those barriers. Third, it proposes solutions that could be explored in future studies.

Thus, the following questions were formulated to guide the research:

RQ1: What are the problems that users with print disability face when they attempt to access digital resources in mainstream libraries?

RQ2: How could advances in accessibility and universal design be harnessed to solve those problems?

To address these questions, studies have been conducted and published in the following journal articles (papers 2, 5, and 6) and conference proceedings (papers 1, 3, 4, and 7):

1. Beyene, W. (2016). Resource discovery and universal access: Understanding enablers and barriers from the user perspective. *Studies in Health Technology and Informatics*, 229, 556–566. IOS Press. doi: 10.3233/978-1-61499-684-2-556
2. Beyene, W. (2018). Digital inclusion in the library context: A perspective from users with print disability. *Journal of Web Librarianship*, 12(2), 1–20. doi:10.1080/19322909.2018.1427657
3. Beyene, W. M. (2016). Realizing inclusive digital library environments: Opportunities and challenges. In N. Fuhr, L. Kovács, T. Risse, & W. Nejdl (Eds.), *Research and advanced technology for digital libraries* (pp. 3–14). Springer International Publishing. doi:10.1007/978-3-319-43997-6_1
4. Beyene, W. M., & Ferati, M. (2017). A case for adaptation to enhance usability and accessibility of library resource discovery tools. In M. Antona & C. Stephanidis (Eds.), *Universal access in human–computer interaction: Design and development approaches and methods*. UAHCI 2017. *Lecture Notes in Computer Science 10277*. Cham. Springer. doi:10.1007/978-3-319-58706-6_12
5. Beyene, W. (2017). Metadata and universal access in digital library environments. *Library Hi Tech*, 35(2), 210–221. doi:10.1108/LHT-06-2016-0074.
6. Beyene, W., & Godwin, T. (2018). Accessible search and the role of metadata. *Library Hi Tech*, 36(1), 2–17. doi:10.1108/LHT-08-2017-0170
7. Beyene, W. M., & Aasheim, M. W. (2018). Improving resource discovery and access through user-controlled adaptation: Exploring the role of library metadata. In M. Antona & C. Stephanidis (Eds.), *Universal access in human–computer interaction: Design and*

development approaches and methods. UAHCI 2017. *Lecture Notes in Computer Science*, vol. 10908 (pp. 397–408). Cham.: Springer. doi: /10.1007/978-3-319-92052-8

Papers 1 and 2 identify barriers to resource discovery and access from the users' perspective. They also present a framework for understanding and tackling the barriers. Paper 3 focuses on the providers' (i.e., the librarians') perspective. It describes the digital services available in selected libraries, the practices being followed to meet the demands of UD, and the gaps between the provider's approach and the user's needs and preferences. Papers 4 and 5 review previous studies and the advances in accessibility and UD, exploring how they could be harnessed to solve the problems identified in this research. Paper 6 proposes solutions for accessible search. Paper 7 attempts to present solutions through a simple prototype that could be explored and expanded in further studies. Briefly, papers 1, 2, and 3 aimed to answer the first research question, and papers 4, 5, 6, and 7 attempted to answer the second research question.

The rest of this chapter is organized as follows. Next, the key elements of the research theme are introduced followed by an explanation of the research context. The contributions of this research are discussed next. Then, the chapter concludes by introducing the structure of the thesis.

1.1. Digital libraries

Technology has transformed the library world, leading to the emergence of digital libraries. According to the UNESCO/IFLA Manifesto, a digital library is defined as:

An online collection of digital objects, of assured quality, that are created or collected and managed according to internationally accepted principles for collection development and made accessible in a coherent and sustainable manner, supported by services necessary to allow users to retrieve and exploit resources.(International Federation of Library Associations [IFLA], 2018).

Digital libraries should not be equated with digital collections (Catarci et al., 2009, pp. 41–41):

A digital collection is a mere gathering of information, whereas the digital library brings the digital collection via mechanisms used to search, browse, accumulate, synthesize, and correlate information into knowledge.

The DELOS¹ framework, which exploited the “collective understanding” of research groups who were active in digital libraries, defined the digital library universe as a three-tiered system with components such as a digital library (DL), a digital library system (DLS), and a digital library management system (DLMS) (Candela et al., 2011, p.10). The DL is a possibly virtual organization that collects, organizes, and preserves digital content selected according to codified policies and provides users access to that content. The DLS is a software system with a defined architecture that is designed to provide all the functionalities desired from a digital library. It also allows users to interact with the DL. The DLMS is a system software that provides the functionalities for developing and administering DL and integrating additional software to offer refined and advanced functionalities (see Fig 2).

Digital libraries share many of the accessibility issues of web-based systems. The accessibility guidelines of the World Wide Web consortium (W3C)’s Web Accessibility Initiative (WAI) could be employed to make DLs, DLSs and DLMSs accessible. However, digital libraries have qualities that make them different. They provide access to digital objects (e-books, multimedia resources, electronic journals, etc.), which are carefully selected, organized and managed. The collection of resources is expected to be informed by user requirements (Coleman & Sumner, 2004). Each resource in a DLS is described according to a set of metadata standards which needs to incorporate elements that describe not only the content but also the accessibility status of the resource (Neville, 2002).

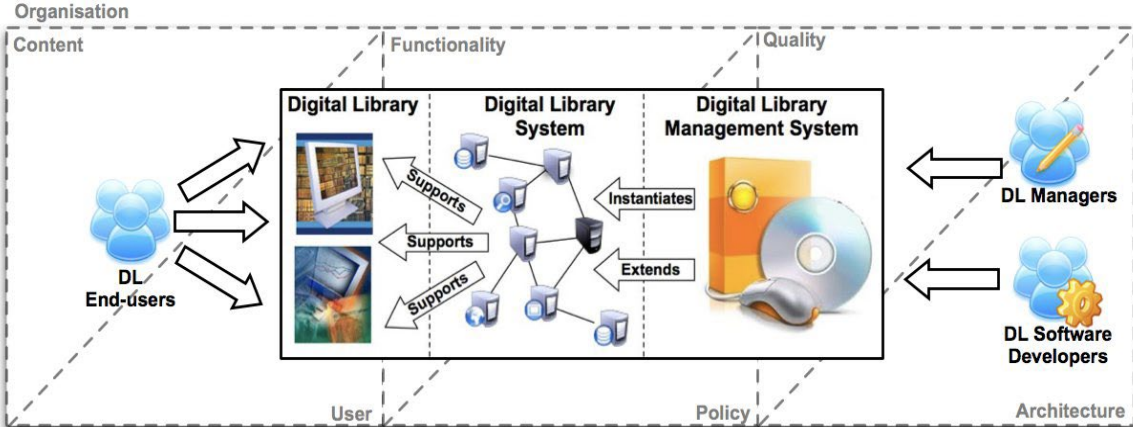


Fig. 2. The DELOS digital library framework (Candela et. al, 2011)

¹ DELOS is a Network of Excellence on Digital Libraries. It is not clear what the abbreviation stands for

1.2. Digital library environments

In addition to stand-alone digital libraries, there are digital library environments where there is a possibility for the business models of publishers and libraries to coexist (Dempsey, 2009; Markscheffel, Fischer, & Stelzer, 2007). University and college libraries, for instance, may set up digital libraries and repositories, and, at the same time, subscribe to vendor databases (see Fig. 3). The libraries' business model includes collecting and organizing information for the benefit of users, whereas the publishers' emphasizes profit (Markscheffel et al., 2007). Libraries may also implement web-scale resource discovery tools (RDTs) to provide a single point of access to the variety of resources stored in local and remote repositories (Walters, 2013).

Addressing accessibility and inclusion in digital library environments involves managing the interplay between users' and publisher's rights and examining the processes, policies, and procedures followed to manage, acquire, and lease information resources.

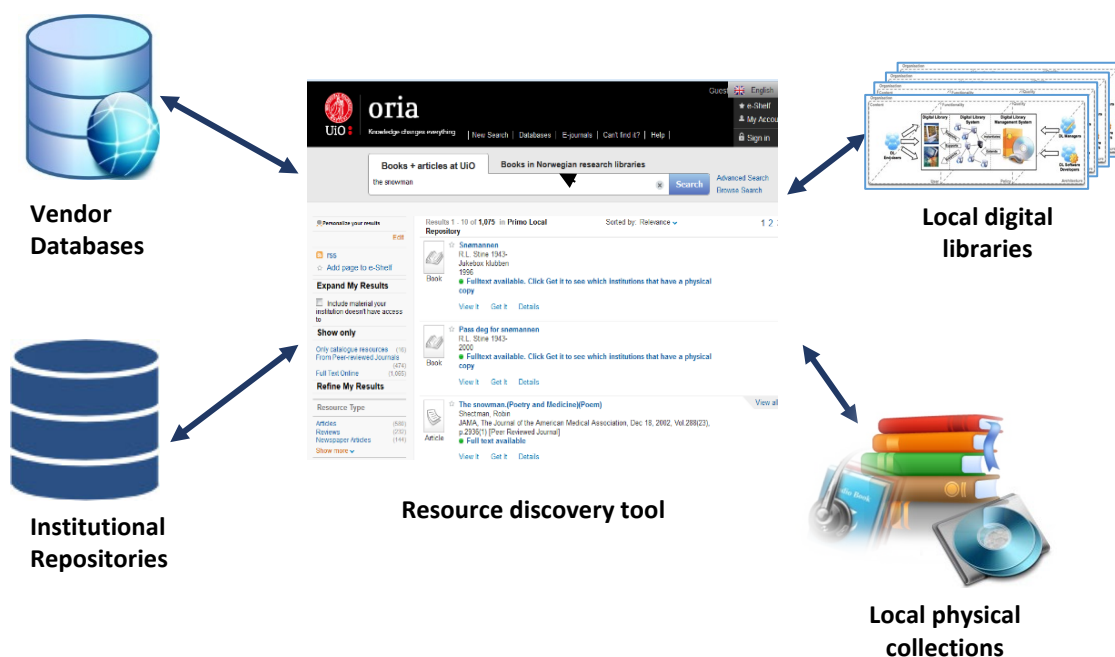


Fig 3. A typical digital library environment

1.3. Print disability

Print disability is a term used to describe the difficulty of reading printed text because of visual, cognitive, motor, and other disabilities (Blansett, 2008). There is, however, a variation regarding whom to include in the category. Bookshare, a digital library of accessible eBooks

for persons with print disabilities, accepts people with learning disabilities, low vision/blindness, and physical disabilities as members if an established authority can confirm that their conditions significantly affect their reading ability (Bookshare, 2018). Bookshare doesn't accept members with autism, Attention Deficit Hyperactivity Disorder (ADHD), hearing loss, dysgraphia and dyscalculia unless their conditions are compounded with others such as dyslexia and visual impairments (Bookshare, 2018). The Norwegian Library of Talking Books and Braille (Norsk Lyd og Blindeskriftbibliotek (NLB)) accepts patrons with visual impairment, dyslexia and other reading difficulties, ADHD, Physical impairments such as Parkinson's that make reading a book difficult, cognitive challenges or speech impairments (Norwegian Library of Talking Books and Braille [NLB], n.d.). According to Vision Australia (2018), print disabilities include vision impairments, physical dexterity problems, learning disability such as dyslexia, cognitive impairment, literacy difficulties, and early dementia.

The Marrakesh Treaty to Facilitate Access to Published Works for Persons Who are Blind, Visually Impaired, or Otherwise Print Disabled (MVT) listed its beneficiaries as persons who a) are blind, b) have a visual impairment or a perceptual or reading disability that cannot be improved to reach to the level of those without an impairment, and 3) are unable to hold or manipulate a book or move the eyes to the extent that would be convenient for reading (World Intellectual Property Organization [WIPO], 2013).

The examples given above show discrepancies in defining print disability. Bookshelf's and NLB's position on ADHD are different. MVT didn't specifically mention dyslexia though it cited "perceptual or reading disability". Some have broader and others have narrower interpretation of print disability. Epp (2006) remarked that such inconsistency would affect people's access to information services and reduce some users to lower-priority patrons.

This thesis is focused on the experience of users with dyslexia and low vision impairment as they interact with digital library environments. The justification behind the selection of such participants is discussed later in the following sections and in Chapter 3. Next, a brief discussion on each of those disabilities is presented to illustrate the different origins of print disabilities and the state of the efforts towards encountering them.

1.3.1. Dyslexia

Dyslexia is a type of learning disability of neurological origin that affects an individual's ability of word recognition, spelling and decoding (Lundberg, 1999; Lyon, Shaywitz, & Shaywitz,

2003). Dyslexic readers may have a problem of sentence/language comprehension (Rello & Baeza-Yates, 2015) and may struggle to clearly see letters and their orders (Stein, 2014).

Vellutino, Fletcher, Snowling, & Scanlon (2004) described reading as a process with depends on two component processes: word identification and language comprehension. As explained by Vellutino et al. (2004), Word identification involves a visual recognition of ordered sets of letters and remembering what they stand for; language comprehension requires integrating the meanings of the words in a sentence and understanding the broader concept they represent. People with dyslexia may have short-term memory impairment that affects their reading ability (Vellutino et al.,2004). Short-term memory or primary memory retains information on what the person is currently reading or thinking about (Swanson, Zheng, & Jerman 2009). With short-term memory impairment, persons with dyslexia would struggle to read longer and complex sentences (Vellutino, et al.,2004). Dyslexic readers may also struggle to correctly decode letters written with some fonts (Rello & Baeza-Yates, 2013). Several studies have attempted to recommend dyslexia-friendly fonts. For instance, Rello & Baeza-Yates (2013) said that fonts such as “Helvetica”, “Courier”, “Arial”, “Verdana” and “Computer Modern Unicode”, are good fonts for dyslexic readers. Bachmann & Mengheri (2018) stated that the font “EasyReading” improves the reading performance of dyslexic readers.

Colors may also affect the reading competency of readers with dyslexia (Rello & Baeza-Yates, 2012). The black-white pair (black text and white background) may be suitable for regular readers. However, some dyslexic readers may prefer color pairs with lower contrasts (Rello & Baeza-Yates, 2012). A pure white background color may obscure text for readers with dyslexia (de Santana, de Oliveira, Almeida, Baranauskas, 2012) whereas backgrounds with warm colors such as peach, orange, and yellow may improve their reading performance (Rello & Bigham, 2017).

1.3.2. Low-vision Impairment

According to Legge (2016), low vision is a term coined in the 1950s by eye-care clinicians to describe a state of vision that is between the extremes of Sighted and Blind. It refers to visual impairments other than blindness that cannot be corrected by regular eyeglasses or contact lenses (Legge, 2016; Scheiman, Scheiman, & Whittaker, 2007). W3C categorized low vision impairment into five categories: visual acuity, light sensitivity, contrast sensitivity, field of vision, and color vision. (World Wide Web Consortium [W3C], 2016a).

Visual acuity refers to the clarity or sharpness of vision (Marsden, Stevens, & Ebri, 2014). Some people may find it difficult to read texts written with smaller fonts and lines of paragraphs written without spaces between them (Rubin, 2013).

Light sensitivity describes the condition of people who are extremely sensitive to bright light. Reading text with a white background could be painful for those people unless they are able to change the background color to a darker one (W3C, 2016a). Contrast sensitivity is the ability to distinguish an object from its background, for instance, a text from its background (Barten, 1999; W3C, 2016a). Persons with color blindness have a problem of perceiving some colors correctly.

Field of vision describes the area a person can see when his/her eyes are fixed on one position. According to W3C (2016a), types of field loss can be grouped as central field loss, peripheral field loss, and other field loss. With central field loss, vision could be lost or obscured in the middle of a person's vision (Kanonidou, 2011). With peripheral field loss, a person sees only things at the center of his/her vision. With other field loss, a person would have a "scattered patch of obscured vision" either at the left or right side of his/her vision (W3C, 2016a). W3C (2016a) also added that some people would have the combination of low vision impairments presented above.

1.4. Access for Persons with Print Disabilities.

Regardless of the origins of their disabilities, all persons with a print disability share the same problem: they struggle to read printed text. The solution MVT proposed was the introduction of limitations and exceptions to copyright laws of countries to allow the reproduction of published works in alternative formats. Having text resources in braille and audio alternatives could be a step toward accommodating the needs of users with print disabilities (Epp, 2006). That is what libraries have been doing for a long time. However, there is a trend that people with visual impairments are increasingly preferring electronic text over audio and braille books because electronic text is less cumbersome than braille books and easily navigable than audiobooks (Suzor, Harpur, & Thampapillai, 2008). That implies the need for tools that ensure barrier free access to electronic information.

The literature review made by McCarthy & Swierenga (2010) identified features that may complicate reading on-screen text for dyslexic users. They included confusing Web layout, poor color selection, too small graphic and text size and complicated language. The literature review also showed that dyslexic users' preferences vary depending on the severity of their disability.

Therefore, part of the solutions recommended in the literature reviewed was to allow users customize font, type, size and color of on-screen text as they want. McCarthy & Swierenga, (2010) finally remarked that the solutions recommended may benefit non-disabled users. W3C (2016a) also recommended similar solutions for users with low vision impairment (W3C, 2016a).

De Santana et al. (2012) made a literature review on the state-of-the-art of dyslexia and Web accessibility to compile 41 guidelines that may improve accessibility of digital information for people with dyslexia. The guidelines covered elements of Web design such as navigation, text presentation, colors, writing, layout, images and charts, audio and video, end user customization, and markup. The guidelines recommended to avoid scrolling pages and dynamic menus to make navigation simpler for users with dyslexia. The guidelines advised using bigger text sizes (not less than 12x) and adding spaces between paragraphs and lines of paragraphs to improve their readability. Moreover, the guidelines supported the use of shorter sentences to help dyslexic readers decode faster. The guidelines also recommended the use of images in text documents because images are more appealing than words for dyslexic persons. Moreover, the guidelines recommended the use of alternative texts for images and icons so that they can be read by screen readers. Many dyslexic persons use screen readers (McCarthy & Swierenga, 2010).

As shown in the examples above, there are similarities between the problems faced by dyslexic and low vision impaired users. For instance, reading text with white background might be challenging for some readers from both disabilities. Some may also struggle to read text with small font size or sentences without line and paragraph spacing. There are also similarities in the solutions proposed. Evett & Brown (2005) compared guidelines produced by the Royal National Institute of the Blind and the British Dyslexia Association and found a “significant overlap” between the two guidelines (p. 453). Both guidelines were designed to make text easily readable for persons with visual impairments and dyslexia respectively. Comparing that to what is discussed above by de Santana et al. (2012) and McCarthy & Swierenga (2010), it is possible to see that addressing some types of print disabilities, regardless of their origin, would contribute to making digital content accessible to others with different disabilities.

In this project, it was decided to include participants with dyslexia and low-vision impairment believing that they would help to cover wider range of issues related to fonts, colors, navigation,

digital content, and others that may affect the access of readers with print disabilities to information. A more detailed explanation of the selection process is presented in Chapter 3.

1.5. The Research Context

The Norwegian library system includes public libraries, county libraries, school libraries, research and academic libraries, the national library and the NLB (Ministry of Culture, 2017) . The NLB is dedicated to persons with print disabilities, whereas the other libraries are open to everyone (Gundersen, 2011; NLB, n.d.; University of Oslo Library, n.d.). For the purpose of this research, the libraries are categorized into two: mainstream libraries and the NLB (i.e., the special library for the print disabled).

NLB stated that its' assignment is to “ensure that everyone has equal access to literature and information” and more specifically to “enable persons with print disabilities to participate in equal footing with others” (NLB, n.d., para 2). Sections 17 and 17a of The Norwegian Intellectual Property Right grants NLB the right produce literature for its users in accessible forms (Aanensen & Frisvold, 2015). As the result, the library produces books in audio and braille formats. The audiobooks are narrated either by a person or with synthetic speech. NLB also maintains an audiobook app called Lydhør, which users can use on their mobile phones to access audiobooks produced by the library.

This research is designed with the understanding that user's information needs may transcend library walls. The resources at NLB alone may not satisfy the information needs of people with print disabilities. The state of the art of digital technology has made it possible for users to access digital resources stored at any library using a single search interface. For instance, Oria.no provides a unified search service to students, researchers, and other users to resources stored in research and academic libraries in Norway. Moreover, the requirement for UD in the Norwegian Equality and Anti-discrimination Act (2017, § 17) creates a condition for people with a print disability to demand digital services in all libraries to accommodate their needs and preferences. Therefore, this research was designed on the belief that digital services at mainstream libraries should accommodate the needs of users with print disabilities. It is thus focused on exploring barriers and enablers of access to digital content in mainstream libraries.

1.6. Contributions of This Research

The review of related works presented in section 2.3. shows that many of the previous studies in library accessibility were focused on checking the compliance of library websites and

databases to anti-discrimination laws and accessibility guidelines. Most of the studies were also technical, which utilized heuristic evaluations and experiments to identify barriers of access for persons with disabilities. Those studies already have contributed a great deal of knowledge regarding accessibility of digital services. However, the fact that similar problems were being reported time after time invites investigating the matter from a different perspective.

Hence, this research contributed the following to the already existing knowledge in the field of library accessibility and inclusive design. First, it presented a user perspective to complement the previous positivist studies (that focused on compliance to laws and guidelines) with some interpretivist approach that tells the user side of the story. Second, it contributed an approach for identifying problems users with print disability face in the process of resource discovery and access; it also presented recommendations for making the process more inclusive. Third, it attempted to present an improved conceptualization of digital inclusion (more specifically, inclusive access to digital content). Detailed explanation of the contributions is presented next.

1.6.1. User Perspective

Users are the most important sources of information regarding their inclusion or exclusion in some activity in life (Douglas et al., 2007). Users are also the primary reason that library services are designed. However, as noted by Hill (2013) and found in the literature review conducted (see section 2.5), there is a scarcity of studies in library accessibility that present the user's perspective. Therefore, it was deemed important to complement the previous top-down, compliance-based, and product-focused studies by a study that used the bottom-up approach. One argument could be whether users know what they want (Nielsen, 2001). However, users who have a good knowledge of the benefits of a system may provide valuable input (Nielsen, 2001). The very notion of the usability of an information system is subject to the users' interpretation of "the degree to which the environment restricts and supports the satisfaction of their goals and desires, often without any reflections on compliance with norms and official guidelines" (Iwarsson & Stahl, 2003, p. 60; Steinfeld & Danford, 1999). This research has thus conveyed the voices of experienced users articulating the barriers and enablers that affect their access to information. This could be a valuable information for researchers and practitioners who endeavor to create an inclusive information environment.

1.6.2. Focus on Resource Discovery and Access

The relationship between users and libraries can be explained in terms of resource discovery and access. Libraries provide resources and discovery tools. Users interact with the tools to

search and retrieve resources. Previous studies have largely ignored the discovery aspect while addressing the accessibility issues related to user interfaces and resources such as e-books, journals, and other texts. This research attempted to address both access and discovery in detail using the available conceptions and models of disability and access to information, which are discussed later in section 2.7, to list different personal and environmental, as well as technical and non-technical, barriers that may hinder access to information. Second, it has explored the role of metadata in improving accessibility in resource discovery and access.

1.6.3. Improved Conceptualization of Access to Digital Content

This research underlines the importance of applying accessibility and UD to elaborate the already existing conception of digital inclusion in libraries. Access to digital content is one of the concerns of digital inclusion (Bertot et al., 2015). It is also the main theme of this research. The overall findings and discussions presented in this research may help to elaborate what concept.

1.6.4. Summary: contributions of This Research

This research has the following major contributions to existing knowledge and practice in digital inclusion. First, it has contributed a template that may help to identify different types of barriers that may occur as users interact with library systems (see Table 4, p.79). Second, it has contributed a framework that can be considered for planning inclusive information services (Fig. 7, p. 85). Third, it has offered a theoretical analysis on the role of technology in mediating access to information. These at least could encourage further exploration of the issues by scholars in the field.

1.7. Structure of the Thesis

This thesis is structured as follows.

Chapter 1 introduces the research and the questions it attempted to answer. It introduces key elements of the research theme such as digital libraries, digital library environments, print disability, and access of information for people with print disability. It introduces the research context and discusses the gaps this research attempted to fill.

Chapter 2 presents the conceptual background of the thesis and review of related works. It explains the genesis of the research theme by tracing the origin of the concept of digital inclusion and the subsequent introduction of accessibility and UD to libraries. It discusses

different approaches to designing for inclusion and examines their applicability to libraries. It then it provides an overview of the research on accessibility and UD related to libraries. at the end, it presents the theoretical framework used in this research.

Chapter 3 explains the research design and the methodology used. It reflects on the limitations of the methods used. It also adds argument on the generalizability of the research.

Chapter 4 explains the ethical considerations taken during the research, starting from registering the project with the Norwegian Center for Research Data (NSD) to ensuring the privacy of participants and handling the data collected from participants.

Chapter 5 presents summaries of the publications done as part of this research, categorizing them by the research question they attempted to answer.

Chapter 6 discusses the findings and proposes a framework for ensuring inclusive and adaptable information services in digital library environments. It also reexamines the role of technology in facilitating inclusive information services and discusses the barriers that may affect user–information mediation. The chapter also includes recommendations for further research.

Chapter 7 concludes the thesis.

2. Conceptual Background and Review of Related Works

2.1. Inclusion: Philosophical and Historical Roots

Several different accounts exist regarding the origin of the concept of inclusion. According to Renzaglia et al. (2003), the principle of normalization is the philosophical foundation of the concept. The principle of normalization was first introduced in Scandinavia to make the living conditions of persons with intellectual disabilities as close as possible to the norms and patterns of the mainstream society (Nirje, 1999; Wolfensberger et al., 1972). It then evolved to include people with different types of disabilities as well as others which were marginalized because of their age, ethnic background, and other differences (Renzaglia et al., 2003; Wolfensberger et al., 1972). According to Nirje (1999, p. 17), elements of the normal pattern of life include the following:

1. A normal rhythm of the day
2. A normal rhythm of the week
3. A normal rhythm of the year
4. The normal experiences of the life cycle
5. Normal respect for the individual and the right to self-determination
6. The normal sexual patterns of the culture
7. The normal economic patterns and rights of their society
8. The normal environment patterns and standards of the community

Understanding the rhythms, routines and patterns was regarded as important for applying the Principle of Normalization so that that people with disabilities can be equal partakers in the normal routines and opportunities of the everyday life (Nirje, 1999; Renzaglia et al., 2003).

Another account draws inclusion from the concept of social exclusion and the need to overcome it. Social exclusion was a term coined by René Lenoir who was Secretary of State for Social Action in a French government (Peters & Besley, 2014; Sen, 2000). Lenoir's conception of the "Excluded" included the "mentally and physically handicapped, suicidal people, aged invalids, abused children, substance abusers, delinquents, single parents, multi-problem households, marginal, asocial persons, and other social "misfits" (Lenoir, cited in Sen, 2000, p. 1). With the popularization of anti-poverty programs, the concept spread first to other European countries, then throughout the western hemisphere, and eventually to the rest of the world (Mathieson et al., 2008).

Sen (2000) cautioned against the indiscriminate usage of the term social exclusion, citing its versatility. O'Reilly (2005) and Mathieson et al. (2008) also affirmed that exclusion is a semantically flexible concept which requires context-dependent interpretations that allow looking past poverty and deprivation to identify “processes driving inequality, power relationships, agency (exclusion by whom?), . . . [and] the multidimensionality of disadvantage and the interlinkages between different forms of deprivation (exclusion from what?)” (Mathieson et al., 2008, p. 7). Thus, the facets of social exclusion include groups that risk exclusion, what they are excluded from (e.g., property, credit, housing, education, skills, , etc.), the problems related to their exclusion (e.g., low income, poor health, unemployment, and poor skills), the process that drives exclusion and the levels of exclusion (e.g., politics, economy, prevailing values, and “inferior” and “superior” relationships between groups and territories), and the agents or actors involved (e.g., social environments, economic conditions, and government policies)(Mathieson et al., 2008).

Disability has contributed to the rise of the concept of social exclusion. However, according to Sen (2000), poverty and different forms of deprivation have been part of the discourse as far back as Aristotle. The Aristotelian conception of poverty stems from the Aristotelian perspectives on life, in which an “impoverished life” is interpreted as a life in which the freedom to participate in life activities is absent (Sen, 2000). In that conception, poverty is understood as the deprivation of capability, which could be interpreted as disability. Such interpretation may elevate disability to represent diverse types of deprivations, which could be physiological, environmental, political, social, and economic.

Moreover, deprivation can be absolute or relative (Duclos & Grégoire, 2002). Absolute deprivation could be understood as the absence of the minimum level of means for a person to subsist and participate actively in a society, whereas relative deprivation could refer to societal inequalities between individuals or groups in the distribution of income and goods (Ladin, 2014). According to the theory of deprivation, relative deprivation is “the discrepancy between what one expects in life and what one gets” (Hak, 1998, p. 136). Thus, social exclusion and inclusion could also be relative concepts that are subject to the individual’s interpretation of what he or she feels about his or her status in a society. Thus, individuals could also be viewed as the most important sources of information regarding their inclusion or exclusion in activities in life.

2.1.1. Studying Inclusion

The scientific study of a social phenomenon requires a representation of that phenomenon. Woolgar (1988) explained a potential problem in the adequacy of the link between an object and its representation, which can be manifested in three main ways. First is the constant availability of alternative versions of the same event, which raises the possibility of falsifying every attempt to make the representation. Second is the difficulty of providing a comprehensive and full representation of an object, which creates the relentless need for further clarifications and elaborations. Third is the reflexivity between the representation and the represented object, in which “the former is elaborated by drawing on ‘knowledge of’ the latter, and knowledge of the latter is elaborated by what is known about the former” (Woolgar, 1988, p.28). In this case, the component parts of a representation–object couple are interdependent, which could have a profound consequence for certain forms of interpretive practices. One strategy recommended by Woolgar for fixing such “methodological horror” was to appeal to a hierarchy of knowledge. According to Woolgar, this approach would enable the discussion of a problem in the context of a particular hierarchy of situations where it had a distinctive applicability. Mjøset (2009) also mentioned the existence of “methodological dilemmas” that are pluralistic in nature and discussed the importance of the contextualist methodology in establishing the relevance of a problem to a specific context. According to Mjøset (2009), the contextualist methodology recommends delimiting a case through three operations: identify the problem, select the process to achieve the outcome, and define the context in which the problem takes place. Fay (1985, p. 152) also advised practitioners in the social sciences to “examine the foundations of their enterprise in order to seek direction and guidance as to how they should proceed” because of the lack of a “commanding theoretical paradigm” in the field.

As discussed earlier, the concept of inclusion could present a dilemma for researchers and practitioners involved in the field because it can be interpreted differently in varying professional, cultural and theoretical contexts (Sandell, 2003). For instance, Lalvani (2015) showed that teachers and parents could have different views regarding inclusion in classrooms. For the parents of students with disabilities, an inclusive education may remove the sense of otherness or stigmatization their children might feel if they were educated separately. In context, some teachers may think that inclusion is a politically correct, which may not work in actual classroom settings. Hence, inclusion in digital library environments could be perceived differently by users, librarians, and other stakeholders in the information industry.

Simplican et al. (2015) noted that inclusion may be confused with other social issues, such as social integration, social work, community participation, and social capital. This lack of clarity would trigger the exploration of available theories to formulate a framework for studying inclusion in a particular context.

“Good” and “bad” theories?

A theory is “a system of assumptions, principles, and relationships posited to explain a specified set of phenomena” (Bates, 2009, p. 1). Theories shape our views and actions, which could be perceived as “good” by some and “bad” by others. For instance, as Wolfersberger et al. (1972) noted, “[a] belief in a theory that [cognitive impairment] is primarily hereditary logically leads to treatment nihilism, while an environmental theory impels toward treatment activism” (p.9). Therefore, a choice of a theoretical perspective requires precaution to avoid an incomplete or inaccurate representation of facts.

As discussed earlier, the Normalization principle is regarded by some as the philosophical foundation of the concept of inclusion. However, critics have questioned its adequacy in describing the experience of the “excluded.” For instance, Oliver argued that the normalization principle is inadequate in explaining “why disabled people are oppressed in capitalist societies and [offers] no strategy for liberating [them] from the chains of that oppression” (Oliver, 1999, p.164). Oliver claimed that the materialist theory fares better in describing the experience of people with disabilities because it enables him to see that capitalism, which is characterized by the speed of factory work, enforced discipline, timekeeping, and production norms, labels the disabled as unfit, thus forcing their exclusion. Moreover, Oliver argued that the notion of “normality” would cause the creation of the normal/abnormal dichotomy, which would further stigmatize the disabled. Jaffee (2016) also added that the materialist theory addresses the root cause of disability, that is, oppression in the capitalist economy. In the capitalist economy, “ability” is defined in relation to the capacity to accumulate capital. Therefore, Jaffee described ableism as a form of oppression.

People in the disability movement pushed for the use of critical theories to identify and change the circumstances that exclude people with disabilities from the opportunities available in their societies (Bohman, 2005; Horkheimer, 1982; Oliver, 1999). Critical theory has both narrow and broad meanings. In the narrow sense, capitalized as “Critical Theory”, it refers to generations of social theorists and philosophers in Western European Marxist tradition which is also known as the Frankfurt School (Bohman, 2016; Corradetti, 2018). In the broad sense, “critical theories”

refers to theories that emerged as the result of many social movements (Bohman, 2016). Critical theories are concerned with explaining, critiquing, and transforming a social reality (Bohman, 2016).

Critical theories emerged out of the desire to make philosophy practical and applicable to promote democracy, equality, and social justice (Corradetti, 2018). One of the strengths of critical theories is the possibility they offer to combine the separate poles of philosophy and the social sciences (Bohman, 2016). This practical approach could help researchers to transcend methodological silos and emancipate themselves from the “methodological horrors” described earlier (see Mjøset, 2009; Wilson, 2008).

By focusing on social justice and equality, critical theory appeals to studies on inclusion and exclusion. However, it has been criticized for being idealistic, “fact-loathing,” and preoccupied with negativity (Delaney, 2016). Its emphasis on societal factors could also suppress individual factors that may not be blamed on society.

In summary, inclusion can be studied differently in different contexts and therefore interpreted through competing theoretical lenses. The philosophical and methodological debates discussed so far reveal that inclusion could have structural (i.e., the materialist perspective), interactional and functional (i.e., the normalization principle), and relativist (i.e., relative deprivation theory) elements. The fact that each theoretical perspective has a potential weakness suggests the need for the formulation of a rigorous or grand theory of inclusion which could help in obtaining a “fuller” account of the phenomenon. That aside, defining inclusion would require defining the context. The theoretical orientation of this research is discussed in section 2.7.

Models of Disability

Inclusion, at its core, addresses some form of disability which can be of medical or non-medical nature (see section 2.1). Beside the theories mentioned in the above section, there are different models of disability that may underpin approaches towards social inclusion.

The medical model of disability views disability as medical in nature. It treats persons with disabilities as objects of medical care, imposing charitable or paternalistic attitudes toward them (Retief & Letšosa, 2018; Toboso, 2010). In contrast, the social model interprets disability as the failure of a social environment to accommodate the needs of people with disabilities, focusing on systemic factors (Grue, 2011; Toboso, 2010; Marks, 1997).

According to Watson and Shakespeare (2001), the shift from bodily limitations to disabling practices in society has made two major contributions for addressing disability-related problems. First, it helped the introduction of political strategies that are focused on the removal of barriers. Second, it was liberating for people with disabilities to know that disability is not their fault but the fault of the society. However, Watson and Shakespeare (2001) argued that the social model is obsolete for the 21st century. One major shortcoming they mentioned of the model was its inadequacy in addressing barriers that are not generated by the environment. Bickenbach (1993) added that addressing disability solely from the perspective of social issues, such as stigmatization and exclusion, makes it difficult to distinguish it from gender, race and other rights issues.

The economic model of disability is an extension of the social model, but it departs from the issue of social justice. It interprets disability as a difference in ability (Travability, 2011). It thus encourages understanding disability in terms of varied needs and abilities of consumers in a demand-driven environment. The economic model sees the market opportunity especially with increasing number of retirees. Hence, the economic model helps to understand accessibility as benefitting not only people with disabilities but also all members of a society, including businesses.

The gap model recognizes that impairment can happen at any time to any segment of a society. It defines disability as the gap between a person's capabilities and the demands of the environment (Grue, 2011). The model categorizes a person's capabilities as well as the demands of the environment as physical, psychological and social (Aslaksen, Bergh, Bringa, & Heggem, 1997). As depicted in Fig 2, assistive devices augment the level of functioning demanded from individuals whereas UD decreases the demands of the environment (UD is discussed in section 2.3.1.) The gap model differs from the medical model by acknowledging that disability is not necessarily the fault of an individual. It also differs from the social model by acknowledging the existence of personal limitations that require the use of assistive technologies to perform functions in an environment.

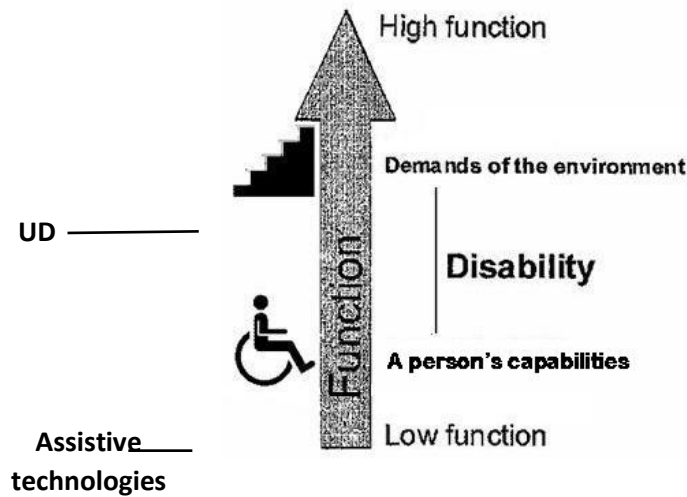


Fig. 4. The Gap model of disability (Guzman & Toboso, 2009)

The ICF model, which was developed by the World Health Organization (WHO) combines the social and medical models of disability, interpreting disability and functioning as products of the interactions between health conditions (e.g., diseases, disorders, and injuries) and contextual factors (World Health Organization [WHO], 2002). The contextual factors consist of environmental factors (e.g., social attitudes, architectural characteristics, legal and social structures, climate, terrain, etc.) and personal factors (e.g., gender, age, coping style, social background, education, profession, past and current experiences, overall behavior pattern, character, etc.). The ICF model classifies human functioning into three levels: body or body part, the whole person, and the whole person in a social context. Disability is thus interpreted as dysfunctioning at any of the three levels as impairment, activity limitation (i.e., execution of task by an individual), or participation restriction (i.e., involvement in a life situation). Hence, the ICF model places disability in the continuum between ability and disability and considers it as an experience that can happen to anyone (Kostanjsek, 2011).

According to Douglas, Corcoran, and Pavey (2007), the ICF model was developed with “more emphasis on developing an inclusive agenda and on social participation,” and with a “useful structure and vocabulary for examining the physical restrictions of impairment while simultaneously acknowledging the barriers that lead to social exclusion” (p. 37). Some of the key terms (Douglas et al., 2007; WHO, 2002) are the following:

- *Activity* – execution of a task or action by an individual
- *Participation* – involvement in a life situation
- *Participation restriction* – problems an individual may experience in life situations

- *Impairment* – problems in body function and structure, such as significant deviation or loss
- *Environmental factors* – The physical, social, and attitudinal environment in which people live and conduct their lives
- *Barriers* – environmental factors that limit activities or restrict participation
- *Facilitators* – environmental factors that may remove barriers or restrictions

Other models include the following: the expert or professional model, which provides a framework for experts to identify impairments and the associated limitations; the charity or tragedy model, which views the disabled as victims who deserve pity; and the moral model, which views disability as a punishment for the “bad actions” of parents (Langtree, 2016).

In summary, disability is interpreted as a physiological or cognitive limitation, a mismatch, a gap, or a punishment depending on the model of disability used. Nevertheless, critics of disability models caution against simplistic and reductive views, underlining the importance of acknowledging different factors surrounding a disability (Bishop & Rhind, 2011; Haegele & Hodge, 2016). The ICF’s definition of disability was appropriate to the purpose of this research. The rationale behind the choice is discussed in section 2.7.

2.2. Digital Inclusion

Digital inclusion is as an extension of the concerns of social inclusion in the information society (Alam & Imran, 2015; Andrade & Doolin, 2016; Helsper, 2012; Ragnedda, 2017; Warschauer, 2002). The information society, which is linked to concepts such as the post-industrial society, network society, and postmodern society (Grenz, 1996; Webster, 2014), is characterized by the expanded role of information in the lives of organizations and the public (Moore, 1997). It is also characterized by the use of ICT to facilitate the flow of information to help organizations improve their efficiency and to help citizens to have access to information that is crucial for participating in the social, cultural, and political affairs of their communities (Moore, 1997; “World Summit on the Information Society,” 2005). As was in the preceding stages of societal development, the information society has its own classes of the “haves” and the “have-nots.” Those having skills and access to ICTs gain the upper hand. This disparity, which is known as the digital divide, gave rise to the concept of digital inclusion (World Summit on the Information Society [WSIS], 2005).

Bertot et al. (2015) described digital inclusion as occurring when people “overcome the digital divide and become digitally ready to better interact with modern society” (p. ix). They interpreted digital readiness as the ability to use the ICT to find information on the Internet, create digital content, take online courses, and perform other activities in life. Hatlevik and Christophersen (2013) described that ability as “digital competence.” Bertot et al. (2015) described it as “user empowerment” to harness ICT for employment, education, entrepreneurship, and community engagement. Access to ICT is also essential for digital inclusion. Thus, empowering people includes ensuring that they have equitable and affordable access to digital content (Bertot et al., 2015).

Digital inclusion has several stakeholders. According to Meneses and Mominó (2010), schools are responsible for decreasing digital inequalities by creating opportunities for learners to achieve digital literacy. Misuraca, Centeno, and Torrecillas (2014) mentioned public libraries, social workers, and public access points as “eInclusion intermediaries” that play a “crucial role in providing access and digital literacy to excluded groups” (p. 2). Moreover, Jaeger et al. (2012) and Thompson et al. (2014) discussed the role of governments in crafting public policies that could influence the definition of key terms, such as digital inclusion and digital literacy, which could affect the operations of other stakeholders.

The action plan drafted by the World Summit on the Information Society (WSIS, 2005), listed the stakeholders as governments, private organizations, and non-governmental organizations. The summit, which was sponsored by the UN, was conducted in two phases. The first was held in 2003 in Geneva, and the second was held in 2005 in Tunis. The main aim of the summit was to bridge the global digital divide (WSIS, 2015). The WSIS action plan included recommendations for the tasks each stakeholder should perform. For instance, governments were expected to develop e-strategies on e-government, e-business, e learning, e-health, e-employment, e-environment, e-employment, e-agriculture, and e-science. The e-strategies were expected to include the following:

- Devising appropriate universal access policies and strategies
- Encouraging the design and production of ICT equipment that are affordable and easily usable by all, including people with disabilities and other vulnerable groups
- Supporting the creation and development of digital public library and archive services adapted to the information society
- Encouraging open and free access to journals and books

- Promoting research and development to facilitate accessibility of ICTs to all, including marginalized and disadvantaged groups
- Creating policies that respect, preserve, promote, and enhance cultural and linguistic diversity
- Promoting e-literacy skills for all and collaborate for promoting affordable high-speed Internet connection to support communication of scientific and other information

As presented above, digital inclusion involves laying out ICT infrastructure, developing digital content, and ensuring the accessibility of digital content to persons with disabilities. This is supported by international conventions, treaties and anti-discrimination laws. For instance, Article 19 the Universal Declaration of Human Rights (UDHR) describes access to information as part of human rights (United Nations, 1948). Article 9 of the United Nations Convention on the Rights of Persons with Disabilities (CRPD) requires state parties to act and ensure people with disabilities access to information (United Nations, 2006). MVT, which was adopted by WIPO member countries, obligates the signatories to provide for limitations or exceptions to copyright laws in order to allow the production of an accessible copy of a work for the benefit of persons with print disabilities (WIPO, 2016). In addition to these legislative tools are technical guidelines and practices, like those discussed in the next section, which could facilitate inclusive access to information.

2.3. Designing for Inclusion

There have been several approaches introduced for designing inclusive products, services and environments. A literature review by Lima et al. (2012) divided them into six distinct traditions. The first refers to the studies by Sasaki (2009), which adopted a broad overview of the barriers of access to physical and digital environments. The barriers were categorized as architectural (physical barriers), communicational (barriers between people), methodological (barriers related to methods and techniques), instrumental (barriers related to tools and instruments), programmatic (barriers rooted in public policies, laws, rules, etc.), and attitudinal (barriers related to prejudice, stereotypes, stigma, and discrimination).

The second tradition mentioned by Lima et al. was UD, which hails from the Center for Universal Design (CUD) at South Carolina State University. UD was rooted in the architectural concept of designing buildings and physical spaces that are equally accessible to all. The principles of UD shown in Table 1 guide endeavors that subscribe to this tradition (Center for Universal Design [CUD], 1997).

Table 1. Principles of Universal Design

Principles	Guidelines
<p>Principle 1: Equitable Use The design is useful and marketable to people with diverse abilities.</p>	<p>1a. Provide the same means of use for all users: identical whenever possible; equivalent when not. 1b. Avoid segregating or stigmatizing any users. 1c. Provisions for privacy, security, and safety should be equally available to all users.</p>
<p>Principle 2: Flexibility in Use The design accommodates a wide range of individual preferences and abilities.</p>	<p>1d. Make the design appealing to all users. 2a. Provide choice in methods of use. 2b. Accommodate right- or left-handed access and use. 2c. Facilitate the user's accuracy and precision. 2d. Provide adaptability to the user's pace.</p>
<p>Principle 3: Simple and Intuitive Use Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.</p>	<p>3a. Eliminate unnecessary complexity. 3b. Be consistent with user expectations and intuition. 3c. Accommodate a wide range of literacy and language skills. 3d. Arrange information consistent with its importance. 3e. Provide effective prompting and feedback during and after task completion.</p>
<p>Principle 4: Perceptible Information The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.</p>	<p>4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information. 4b. Provide adequate contrast between essential information and its surroundings. 4c. Maximize "legibility" of essential information. 4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions). 4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.</p>
<p>Principle 5: Tolerance for Error The design minimizes hazards and the adverse consequences of accidental or unintended actions.</p>	<p>5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded. 5b. Provide warnings of hazards and errors. 5c. Provide fail safe features. 5d. Discourage unconscious actions in tasks that require vigilance.</p>
<p>Principle 6: Low Physical Effort The design can be used efficiently and comfortably and with a minimum of fatigue.</p>	<p>6a. Allow user to maintain a neutral body position. 6b. Use reasonable operating forces. 6c. Minimize repetitive actions. 6d. Minimize sustained physical effort.</p>
<p>Principle 7: Size and Space for Approach and Use Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.</p>	<p>7a. Provide a clear line of sight to important elements for any seated or standing user. 7b. Make reach to all components comfortable for any seated or standing user. 7c. Accommodate variations in hand and grip size. 7d. Provide adequate space for the use of assistive devices or personal assistance.</p>

Lima et al.'s third tradition is related to the works of W3C-WAI. W3C-WAI introduced the Web Content Accessibility Guidelines (WCAG), the Authoring Tool Accessibility Guidelines (ATAG), and the User Agent Accessibility Guidelines (UAAG) to help the design of accessible Web. According to W3C (2018b), WCAG explains how to make web content such as text, images, and sounds more accessible for persons with disabilities. WCAG is regarded as the dominant guideline in the accessibility of online information and services (Sloan et al., 2006).

ATAG explains how to make authoring tools accessible so that people with disabilities create web content. UAAG explains how to make user agents such as browsers, browser extensions, media players and others that render web content accessible to users with disabilities. These guidelines are being used for evaluating accessibility of materials such as news websites (e.g., Kessel, Sanderson, & Chen, 2014), learning management systems (e.g., Chen, Sanderson, Kessel, & Królak, 2015), and library catalogs (e.g., Southwell & Slater, 2013).

There is an observable similarity of concerns between UD principles (Table 1) and the WCAG guidelines (Table 2). For example, the UD principle of perceptible information could relate to WCAG's guideline of perceivability: both recommend presentation of content in alternative formats. Both require systems to accommodate assistive technologies, and both require handling potential hazards. WCAG proposes the removal of audio and video-related (i.e., flashing) hazards in designing digital content, whereas the UD principles included the need for warnings. Similarly, both recommend the use of language(s) that can be easily understood by users. Moreover, both recommend the use of error identification and feedback mechanisms. A main difference could be the fact that WCAG is oriented to digital accessibility and contains more detailed instructions.

Table 2. WCAG Principles and Guidelines

WCAG Principles	Guidelines
Perceivable	<ul style="list-style-type: none"> • Provide text alternatives for non-text content • Provide alternatives for time-based media • Provide content that can be presented in different ways (adaptability) • Make it easier for users to see and hear content, including separating foreground from background
Operable	<ul style="list-style-type: none"> • Make all functionality available from a keyboard • Provide users enough time to read and use content (including allowing users to turnoff or adjust the time limit) • Do not design content in a way that causes seizures (e.g. anything that flashes more than three times in a second should be avoided) • Provide ways to navigate, find content, and determine where they are
Understandable	<ul style="list-style-type: none"> • Make text content readable and understandable (beware of unusual words, abbreviations, reading levels, pronunciations) • Make web pages appear in a predictable way • Help users to avoid and correct mistakes (e.g., error identification and suggestion)
Robust	<ul style="list-style-type: none"> • Maximize compatibility with user agents, including assistive technologies.

The fourth trend mentioned by Lima et al. (2012) is related to the Access for All (AfA) initiative. As the authors explained, the AfA framework rests on three pillars: 1) the development of accessible web using W3C-WAI guidelines; 2) the identification of users of the resource; 3) the utilization of content description standards to match users' needs with content (Cheetham et al., 2014; Lima et al., 2012). The AfA group is linked to an ongoing project on accessibility metadata. Their accessibility metadata recommendations have been accepted by schema.org, which is "an organization that that keeps a list of agreed-upon tags that all search engines can use in common so that users of those search engines can refine their searches to find exactly what they are looking for" (Rothberg, 2014, para. 2). Closer examination of the metadata reveals an attempt to use WCAG 2.0 guidelines to formulate metadata fields that could be used to annotate resources according to their accessibility attributes (see Batanero et al., 2014). This trend includes the Global Public Inclusive Infrastructure (GPII), which sought to utilize the cloud as a platform where individual needs and preferences are matched with the available accessibility solutions (Vanderheiden et al., 2014b). The GPII is a project of the Raising the Floor consortium (RtF), which has more than 80 partner organizations, including the European Commission, Google, Adobe, W3C, and other well-known organizations and universities. The GPII's aim is to "utilize cloud computing to create the infrastructure to provide affordable assistive services whenever and wherever a user demands them," including public access points, libraries, banks (web-based and terminals), schools, travel kiosks, educational institutions, and private homes (Vanderheiden et al., 2014b, p. 494).

The fifth trend mentioned by Lima et al.'s (2012) links accessibility with usability, treating accessibility problems as usability problems. Here, the accessibility of websites to people with disabilities is evaluated with the use of the International Standards Organization (ISO) usability standard (ISO-9241) and recommendations from the studies made by Jakob Nielsen. For instance, Nielsen's usability heuristics (Nielsen, 1994) included guidelines for reducing user's memory load. That could be applied to improve the usability/accessibility of a website for users with cognitive impairments. ISO 9241-940 has provisions for improving the accessibility of haptic (tactile) human system interactions for persons with physical and cognitive impairment (International Standards Organization, 2017). Works subscribing to this tradition could refer to these resources to improve the accessibility of their products.

Lima et al. (2012) referred to Carvalho's (2001) work as "an isolated initiative" and the sixth trend of studies in accessibility and inclusion (p.324). Carvalho (2001) used the information behavior models developed by Kuhlthau (1988) and Wilson (1999) to identify barriers of access

to information encountered by visually impaired people. Beyene and Byström (2017), however, indicated that many studies in information behavior share that interest of “identifying barriers.” These studies include Gooda Sahib, Tombros, & Stockman,(2014), which identified problems in multi-session search tasks that affect visually impaired users, and the work by Pálsdóttir, (2012) who studied the information behavior of older people adapting a to a new situation.

Having discussed the traditions in accessible design, the question would be which line would be more appropriate for the purpose of this research. The following sections focus on those which we have found as dominating the current discourse on digital inclusion and accessible design.

2.3.1. Universal Design and Inclusive Design

The terms UD, inclusive design, and design-for-all describe the efforts to create products and services that are usable and accessible by all (Iwarsson & Stahl, 2003; Persson et al., 2014). The account presented in section 2.2 shows that they are part of the answers sought to bridge the digital divide.

Some writers recognize the 1950’s United States Supreme Court case, which ruled against the segregation of public schools, as the beginning of UD (D’Souza, 2004; Ostroff, 2001). Others trace the origin from the 1960s civil rights movements in the United States (Imrie, 2012). Others described UD as a trend in line with disability movements of the 1970s, which were inspired by the social model of disability (Winance, 2014). The term, however, was coined in the mid-1980s by Ronald Mace, an architect and founder of the CUD. The idea was to communicate an approach for designing “products and environments to be usable by all people, to the extent possible, without the need for adaptation or specialized design” (CUD, 1997). Ostroff (2001), however, said that the underlying concepts of UD were first conveyed by the term “barrier-free design,” which was later replaced by “accessibility”. Persson et al. (2014) also added that UD originated from barrier-free design and accessible design. However, UD has a broader scope. Barrier-free design is focused on providing access to people with disabilities, whereas UD aspires to design for all, regardless of disability, gender, age, and cultural differences (Carr et al., 2013; Kose, 1998).

Notwithstanding its importance in inspiring designs that include the needs of persons who are different from the “average user”, there are critiques that identified problems in the UD approach. Imrie (2012) identified some shortcomings. The first was UD’s disproportionate reliance on technology for achieving accessible design. Imrie argued that UD falls short of

addressing attitudinal and socio-cultural matters that influence the use of an accessible design. The second shortcoming Imrie mentioned is related to the institutionalization of UD through a network of professionals who share a common belief and commitments concerning UD. According to Imrie, those professionals are mostly educated and/or residing in the West. They promote UD by lobbying politicians, policy makers, and corporate business leaders on the ethical obligations of designing inclusive environments. Adding to the fact that UD has gotten its root in socio political struggles of people with disability in countries such as USA and UK, such institutionalization of UD would imply imposition of values and tenants from the western disability studies on the rest of the world (Imrie, 2012). This would make UD look insensitive to socio-cultural variations (Imrie, 2012). That concern may be reinforced by the UD principle 3, which recommends designs to be easy to understand by all regardless of socio-cultural and linguistic differences (Imrie, 2012). The third problem of UD, according to Imrie, lies in the notion of the universalism of design. By definition, UD is against specialized designs for persons with disabilities. However, the phrase “to the extent possible” in the definition of UD seems to hint the acknowledgement of the need for specialist design in some circumstances. Thus, Imrie argued that the concept of universalism in UD needs more clarification.

Winance (2014) claimed that the UD approach is based on two paradoxes. The first is UD’s inclusion of diversity and, at the same time, its reduction of diversity in the design process. Winance mentions UD principles 1 and 2, which are on equitability and flexibility of use, and stated that those two principles recognize users have diverse abilities. However, principles 3, 4, and 7 (which are on simplicity, perceptibility, size, and space) reduce users with diverse abilities to a “minimal user” (p. 1335). Thus, Winance urged that “[r]ather than thinking about the reduction of diversity through the unity of the universal, it should reflect on ways of drawing on it in order to design a plural environment endowed with varied resources and characteristics that respond to and encourage the diversity of ways of taking action that people put in place” (p. 1341) The other paradox Winance mentioned was UD’s understanding of dis/abilities. On one hand, UD attributes users’ variations of capabilities to the physical and mental states of individuals (Story, Mueller, & Mace, 1998). That makes UD aligned with the medical model of disability. On the other hand, UD’s acknowledges that the design of objects or environments determines a user’s ability to act, whether that person is disabled or not disabled. That aligns UD with the social model. The medical and social models could be polar opposites to each other (Shakespeare, 2005), and subscribing to both of them may sound paradoxical. However, Winance perhaps could have seen a different outcome had she examined UD through the ICF

model. Winance also added that UD has a functional view of use and abilities of users, discounting the role of users' experience in influencing their use.

Literature shows interchangeability in the use of the terms UD and inclusive design. Ostroff (2001) said that UD is the dominant terminology in Japan and Norway, and it is used interchangeably with inclusive design in the United States. Clarkson & Coleman (2015) pointed that inclusive design is known as UD in the USA. However, some draw distinctions between the two. According to the British Standards Institute (2005), inclusive design is defined as “The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible . . . without the need for special adaptation or specialized design.” The word “reasonably” was added to show that it may not always be essential to design for the entire population (University of Cambridge, 2017). Thus, UD is seen as more aspirational whereas inclusive design is more practical (Clarkson & Coleman, 2015; Harper, 2007; Persson et al., 2014).

There have been debates on which approach could be more suitable for designing digital services. The Inclusive Design Research Center [IDRC] (n.d.) presented three main reasons why they preferred inclusive design over UD: First, the IDRC said that they work in the digital realm where the constraints, design options and design methods are very different from architectural and industrial design. They claimed that the digital realm gives them the flexibility to pursue the “one-size-fits-one” personalized design approach to inclusion. According to Harper (2007), the “one-size-fits-one” approach considers that every person is a unique individual. Harper also added, “universal usability is possible but not by using this design-for-all ethos, in point of fact we suggest that it is only possible by design-for-one” (Harper, 2007, p. 111). Second, the IDRC said that the term UD is associated with disabilities and the categorization of disabilities. They claimed that inclusive design helps them to focus on the diversity of needs, while acknowledging that the needs may not necessarily arise from disabilities. Third, the IDRC argued that UD is concerned with creating common designs that suit everyone, whereas inclusive design recognizes the role of context, which requires designing a system that can adapt, morph, or stretch to fit individual demands. However, the IDRC admitted that their argument was not rooted in the formal definition of UD but on “the popular assumption” about the term. Nevertheless, the IDRC acknowledged that inclusive design can be seen as UD with a number of preconditions.

Wobbrock et al. (2011) found weaknesses with both UD or inclusive design approaches. They said that UD has a “one-size-fits-all” element that may work for door handles, knives, and building entrances but not for interactive computer systems. Wobbrock et al. also said that inclusive design creates cognitive load on designers because it requires them to be aware of design practices that may unintentionally exclude some users. As it is practically difficult to think about every possible type of barrier a design would pose for a person with disability, the cognitive load would make the designers ineffective. Wobbrock et al. thus recommended “Ability-based design”, a design concept centered on people’s abilities rather than their disabilities. They justified their approach saying: “In making the shift to ability-based design, we move away from assisting human users to conform to inflexible computer systems, and instead consider how systems can be made to fit the abilities of whoever uses them.” (p. 2). As discussed above, the proponents of the inclusive design approach seek to shift from focusing on disabilities to users’ needs and preferences. Therefore, the question would be, how can targeting user’s ability be different from targeting his/hers needs and preferences?

Newell et al. (2011) criticized both universal and inclusive design approaches, saying that neither is effective in including older and disabled people. They argued that both approaches could encourage designers to follow the traditional design path which involves developing prototypes and investigating how the interfaces could be modified to cope with the needs of people with disabilities. According to the authors, this design path would result in products which are accessible for people with disabilities but unusable in practice. Therefore, Newell et al. (2011) proposed a “user sensitive inclusive design” approach that would enable designers to develop “real empathy” using ethnography, professional theater, and other creative methods to better understand the requirements of users who may not be able to clearly articulate their needs. The theatrical technique was described as a method for gathering information about users’ requirements, where professional actors play the role of a user or a group of users (Newell et al., 2006). The technique was regarded as important in communicating the requirements of older people as well as those with dementia and other forms of disability, from whom it might be difficult to get informed consent because of legislative barriers and ethical issues (Newell et al., 2006; Newell et al., 2011).

As mentioned earlier, the UD is the term used in Norway. This term is used in the Norwegian Equality and Anti-discrimination Act, which demands UD in the design of ICT solutions and physical accommodations in schools, workplaces, and public services (Equality and Anti-Discrimination Act, 2017, § 17). Therefore, the term UD was used more often in the

publications produced as part of this research. However, the overall understanding was that, despite the differences in approaches and interpretations, the terms universal and inclusive design both imply the desire to achieve one common goal: designing for inclusion.

2.3.2. Accessibility vs. adaptability

Accessibility means “people with disabilities can use a product”(Henry, 2007, p.28). Ensuring accessibility is understood as “ removing barriers that prevent people with disabilities from participating in substantial life activities, including the use of services, products, and information” (Bergman & Johnson, 1995, p. 2). Making user interfaces accessible means making them “perceivable, operable, and understandable for people with a wide range of abilities” (Henry, 2007, p. 28). Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with websites, tools, and technologies (W3C, 2016b). As shown in these definitions, accessibility is often associated with disability. in that sense, the way disability is understood (according to the disability models discussed in Section 2.1.1.) may define the breadth of scope of accessibility. It may be possible to argue that accessibility may approximate UD if disability is interpreted using the ICF or the gap models.

Two major approaches for attaining accessible web based systems are presented in literature: designing for accessibility (i.e., the guidelines-based approach) and designing for adaptability (Green et al., 2013; Kelly et al., 2009).

Accessibility guidelines have several benefits. One obvious advantage described by W3C (2016b) is that they simplify access to Web-based services for persons with disabilities. Guidelines would ensure that websites can be navigated and read aloud by screen readers, enlarged by screen magnifiers, and accept voice inputs (W3C, 2016b). They help to make web content accessible to persons with disabilities. Thus, accessibility guidelines may extend the reach of products and services by expanding the audience, which is a desired outcome for businesses (W3C, 2018a), government organizations, libraries and others. Despite such advantages, there are shortcomings reported about the guidelines-based approach. Sloan et al. (2006) referred to past studies and argued that accessibility of websites has not reached to a satisfactory level despite works on tools that support authoring accessible materials and the dissemination of best practices in accessible web design. Sloan et al. attributed that problem partly to the flaws in WCAG and its dominance as an “authoritative and unambiguous measure” of digital accessibility (p. 124). Sloan et al. further discussed some shortcomings of WCAG. The first is its dependence other WAI guidelines. For instance, designing WCAG conformant

website is not enough if it requires a UAAG conformant browser. The second is the burden and cognitive demand it imposes on end-users and web content creators. WCAG requires end-users to be aware of technologies (e.g. browsing and assistive technologies) that suit their needs. It also expects web content creators to understand the principle behind a specific guideline and when/where to apply it. Almeida and Baranauskas (2010) stated that the WAI guidelines are extensive, but they do not inform designers whether a particular guideline is relevant to the application they are evaluating.

Studies done over several years revealed that users uncover accessibility issues which are not covered in accessibility guidelines. Stewart et al. (2005) evaluated 37 library database interfaces for their accessibility and usability using two methods. First, they checked the interfaces for their compliance with Section 508 of the American Disability Act and WCAG guidelines. Then they conducted usability tests with minimally trained users performing search-related tasks. The results showed that the databases were largely compliant with the accessibility guidelines. However, their user-friendliness for people with disabilities was found to be low. Power et al. (2012) conducted task-based evaluations of selected websites with blind users and found that only half of the problems identified by these users were covered by WCAG 2.0 guidelines. Rømen and Svanæs (2012) conducted controlled usability tests with disabled users on two websites and found that only half of the accessibility problems identified by the users were identified by WCAG 2.0. Rømen and Svanæs (2012) compared the results of the usability test with WCAG 1.0 and concluded that WCAG 2.0 showed a marginal 5% improvement in identifying website accessibility problems. The latest version, WCAG 2.1, was made available online on 5 June 2018. Its stated purpose was to improve the accessibility of web content to a wider range of people with disabilities, including those with low vision, learning, and cognitive disabilities. However, it was admitted that the new version doesn't cover the needs of all users (W3C, 2018b). Therefore, it could be possible to conclude that accessibility guidelines are not sufficient to ensure web accessibility for all users (Rømen & Svanæs, 2012; Power et al., 2012).

Medina et al. (2010) stated that a web application may satisfy the maximum level of web accessibility according to WCAG guidelines but remain unusable for persons with disabilities. They demonstrated that by an example of a search interface which satisfies every WCAG verification points but was difficult for a screen reader users to navigate, for instance, through search results. The problem was that the page was “designed to be usable by sighted users and “only” accessible by blind users” (p. 565). Thus, Medina et al. recommended pairing

accessibility with usability. Sloan et al (2006) mentioned that there were websites which did not meet certain WCAG criteria but were performing extremely well with people with disabilities. Sloan et al. thus recommended following a holistic approach to accessibility that takes the context of use into account. Context of use includes user characteristics such as their abilities and disabilities, domain requirements such as the tasks that need to be supported, social and cultural dynamics and communication patterns, technological requirements and performance requirements such as task success rates, and task completion rates (Sloan et al., 2006).

The other related problem associated with the guidelines-based approach is the use of automatic testing tools. There are several of them used in different studies. Studies showed that some of those tools may be unreliable and provide false positives during accessibility tests (Comeaux & Schmetzke, 2013; Harpur & Suzor, 2014; Schiavone & Paternò, 2015; Stewart et al., 2005; Vigo, Brown, & Conway, 2013).

Others who noted the weaknesses of the guidelines-based approach called for a Web adaptability framework that “encourages the development of web-based services which can be resilient to the diversity of uses of such services, the target audience, available resources, technical innovations, organizational policies and relevant definitions of [. . .] ‘accessibility’” (Kelly et al., 2009, p. 212). It is worth noting that the concept of adaptation is mentioned in UD principles as well as in the WCAG 2.0 guidelines. For example, WCAG 2.0 guideline 1.3 describes adaptable content as a “content that can be presented in different ways (for example simpler layout) without losing information or structure.” (W3C, 2008). The UD principle 2, which is presented in Table 2, described the need for adaptation as “flexibility.” However, the problems observed with the guidelines-based approach have helped critics to accentuate distinctions between designing for accessibility and designing for adaptability.

2.3.3. Adaptability vs. adaptivity

Adaptation is a means of catering to user diversity, which can be done through adaptability or adaptivity (Brusilovsky & Maybury, 2002). Adaptable systems allow users to modify a system’s parameters to display information and functionalities that suit their individual needs. for instance, adaptable user interfaces allow the user to modify the appearance of elements such as font, theme, menus, search results, and visual cues (e.g., icons and thumbnails) (Gossen et al., 2013) In contrast, adaptivity is an automatic process where a system adapts to its users’

needs and preferences according to the information stored in user profiles (Frias-Martinez et al., 2006; Paternò & Mancini, 2000).

Research and development in digital accessibility has introduced recent approaches that seek to achieve inclusion through the adaptive approach. For instance, the goal of projects such as GPII (Prosperity 4All, n.d., para 3) was stated as:

developing a complete new paradigm in accessibility, by augmenting adaptation of individual products and services (2nd generation) with automatic personalization of any mainstream product or service a user encounters, using cloud technologies to activate and augment any natural (built-in) accessibility or installed access features the product or service has or recommending the appropriate third-party solutions, based on the user's needs and preferences.

The adaptable and adaptive approaches have advantages and disadvantages. Adaptability is better to give users control over a system. However, it may cost users time and energy. Adaptivity frees users from wasting time on customization. However, some automatic adaptations might be undesirable and would confuse those with cognitive disabilities (Paternò & Mancini, 2000; Peissner et al., 2012).

Closer examination of the UD principles and the WCAG guidelines reveals the need for some clarification regarding adaptation. For example, WCAG 2.0 success criteria 2.2. requires giving users control to adjust, extend, or turn off features on certain media. Moreover, WCAG success criteria 3.2 require websites to appear in a predictable way. UD principle 3 also requires predictability. These requirements could favor the adaptable approach. In contrast, UD principle 3 (simplicity) and 6 (less effort) seem to favor the automatic approach. Therefore, it might be safe to conclude that the suitability or superiority of either technique is determined by the user's needs, the context, and the problem at hand.

2.3.4. Process-driven approach

Critics of the guidelines-based approach also recommend the process-driven approach which consists of a series of steps to embed accessibility in organizational infrastructures. According to Horton and Sloan (2014), this approach entails the integration of the following:

- Organizational policies articulating the organizations' commitment to accessibility
- Content strategy that includes accessibility

- Code repositories for common elements of search interfaces such as menus and tabs. It includes publicly available examples of accessible user interface design patterns.
- Style guides informed by conventions, rules, and established best practices for designing accessible user interface features
- Content management and development tools that support the development of accessible solutions

The British Standard BS8878 has been mentioned as a process-oriented standard designed to help organizations ensure digital inclusion across key job roles and policies (Hassell, 2014). Its essence was explained as providing a framework to put the WAI technical-oriented design and testing elements of accessibility in organizational activities that impact inclusion.

Review of the approaches presented in section 2.3. may enables one to cluster UD and the guideline-based approach on one side and the inclusive design, the AfA, the adaptive and adaptable approaches on the other side. The former highlights the importance of principles and guidelines and the later highlights the importance of matching resources with users' needs and preferences. However, the later didn't discount the importance of accessibility guidelines. The argument is that the former is not sufficient to ensure digital inclusion. The later, therefore, contributes approaches that could complement the former and eventually advance digital inclusion.

2.4. Digital Inclusion and Libraries

Libraries are partners in digital inclusion. The roles they play include providing access to computers, the Internet, Wi-Fi connectivity, digital content, and digital literacy programs (Bertot et al., 2015). Their activities were mainly aimed at countering the effects of poverty on the digital divide and to cope with the demands of new technology that allows users to browse library contents, check out books, return loaned books, and check their loan status (Morrone & Witt, 2013; Thompson et al., 2014). Developments in UD and digital accessibility allow libraries to address the second digital divide, which is the result of inaccessible design, with a better depth.

Libraries are serving their print-disabled patrons in two ways. The first is the practice of arranging a special room for print disabled patrons in mainstream libraries. The room could be equipped with adjustable tables, scanners, braille printers, screen readers, and other materials which the print-disabled patrons may desire. The other alternative is the assignment of specialized libraries for the print-disabled. However, the proliferation of digital content in

libraries has created an opportunity for including the print disabled in mainstream information services (Lazar et al., 2014). That could be aided by W3C-WAI accessibility guidelines, the BS8878, and other techniques and approaches discussed so far. However, the implementation of those standards and techniques requires the understanding of the current relationship between libraries and technology.

2.4.1. Designing inclusive digital library environments

Digital library environments are complex systems where the libraries' and digital content vendors' business models co-exist (see section 1.2). Therefore, offering inclusive digital access to patrons may be a challenging task. For instance, libraries may have no option other than dealing with vendors of subscription databases to ensure the accessibility of electronic resources for their patrons with print disabilities. Moreover, librarians may not have full control over proprietary RDTs. With that, it may be difficult to pick an approach that would yield inclusive digital services.

Libraries provide web-based information services. Therefore, WAI guidelines could be important to ensure the accessibility of those resources. Libraries select and collect resources targeting a user community, and they organize resources employing metadata schemas. Thus, they may consider emulating the AfA's approach of matching resources with users' needs and preferences. Digital library environments consist of organizational structures, policies, and procedures that may influence the procurement of accessible digital content. Therefore, the process-driven approach presented by BS8878 may be a better alternative. Libraries are used by diverse groups of users who have different needs and preferences. That in turn would require weighing the pros and cons of the adaptive and adaptable approaches.

There have been works that looked into accessibility and UD/inclusive design issues in libraries. The following literature review presents some of them and, at the end, shows the gaps this research has attempted to fill.

2.5. Previous Research on Digital Accessibility and Inclusion in Libraries

Accessibility and inclusion have been concerns of libraries long before the introduction of anti-discrimination laws and accessibility guidelines (Bertot & Jaeger, 2015). For instance, IFLA's accessibility checklist categorizes the requirements as physical access, media formats, and service and communication to meet the needs of children, the elderly, and people with

disabilities (Irvall & Nielsen, 2005). Physical accessibility requirements include wheelchair-accessible gateways and pathways, stairs and steps marked with contrasting colors, easy-to-read signs with pictograms, and adjustable desks. The media requirements include talking books, talking newspapers, talking periodicals, large-print books, easy-to-read books, braille books, video/DVD books with subtitles and sign language, e-books, and tactile picture books. The service and communication checklist includes the training or orientation of library staffs to serve the needs of disabled patrons and providing outreach services to persons in institutions and care facilities.

As libraries adopted digital technology, they began to apply accessibility guidelines and design specifications that represented the knowledge about computer and information accessibility design (Farb, 2003). Consequently, library websites are being designed according to WCAG and other accessibility standards (Providenti & Zai, 2007). The IFLA checklist mentioned above also encourages practitioners to be informed about WCAG and other WAI guidelines.

UD is not equivalent to accessibility. However, there is a tendency to use accessibility guidelines to determine whether websites and web-based information systems are universally designed (Beyene, 2016). W3C (2016b) acknowledged that accessibility, usability and inclusion are closely related; and their goals, approaches, and guidelines overlap significantly. Thus, W3C recommended addressing those three aspects together in the development of websites and applications. However, W3C has maintained that accessibility should not be diluted in the broad scope of inclusion because its original purpose was to address the needs of people with disabilities. Nevertheless, scholars have claimed that the research on accessibility in libraries has been “scant” (Bonnici et al., 2015, p. 505; Hill, 2013). A review of some related works is presented in the following section.

2.5.1. Library Websites

According to Hill (2013), the largest share of the literature on library and information accessibility between 2000 and 2010 was related to technology. The majority of this literature was on accessibility tests conducted on library websites and databases. Studies published after this period showed the same trend. For example, Comeaux and Schmetzke (2013) analyzed library website accessibility from 2002 to 2012 and showed an improving trend in the compliance with accessibility guidelines. The study also revealed the reliance on automatic accessibility testing tools. Billingham (2014) presented the case of a library website that aspired to fulfill WCAG 2.0 level AA. Lush (2015) explained the measures taken to improve the

accessibility of Penn State University Libraries websites in response to a complaint from the National Federation of the Blind (USA). The measures included engaging content authors, developing new content roles and workflows for continual measurement, and maintaining the accessibility of web content. Charbonneau (2014) tested the adherence of public library websites to senior-friendly guidelines. The author utilized the guidelines developed by the National Institute on Aging and National Library of Medicine (USA) to evaluate 104 public library websites. The results showed that none of the websites fulfilled all the guidelines. According to the author, the guidelines that were adhered to included preserving all capital letters in headlines, avoiding backgrounds with patterns, avoiding horizontal scrolling, breaking up information into smaller sections, using left justification, and providing navigation buttons at the same place at every page.

Baker (2014) established that web accessibility as a major issue in libraries and discussed the potential of progressive enhancement and responsive web design using developments such as WCAG 2.0, HTML 5, CSS level 3, and Web Accessibility Initiative-Accessible Rich Internet Applications (WAI-ARIA). Responsive web design is a technique of designing flexible web pages that can adapt to the screen sizes of desktops, phones, and tablets to provide the user an optimal viewing experience (Peterson, 2014; W3C Schools, 2017). As explained by Baker (2014), HTML5 enables the meaningful markup of web content as <section>, <article>, <video>, <audio>, and others. This helps users who depend on screen reader technologies to navigate through the contents of a web page. CSS level 3 makes web pages flexible and enables the separation of content from its layout. An important advantage of CSS3 is the flexibility it offers in planning styles that are appropriate for different devices. WAI-ARIA is a technical specification published by the W3C to improve the accessibility of dynamic applications by users with disabilities, especially those who use screen reader technologies (WAI, 2016c). According to Baker (2014) and Riley-Huff (2015), automatic updates on websites could force screen readers to set focus on the updates, thus disrupting users from whatever they are reading. WAI-ARIA thus helps to set up screen reader to ignore updates unless the user wants them. Baker (2014) thus suggested that responsive web design would make library websites accessible to all users.

Yoon, Hulscher, and Dols (2016) conducted an “accessibility-usability” test of some library and non-library websites through tasks given to six participants who were screen reader users. The results showed that none of the participants was able to complete the tasks on library websites even with frequent help from the researchers. Thus, Yoon et al (2016) concluded that

library websites are more difficult to use when compared with non-library websites. It is important to note that the findings included the problems Yoon et al. observed with the library catalogs which were available on the library websites. The study showed that features such as filters and combo boxes make searching taxing for screen reader users. Moreover, misleading link labels and some linearization issues were identified as problems that complicate navigation with screen readers. Linearization is a technique used by screen reader technologies to “read” the content of a website according to its sequence in the source code. Hence, a screen reader could compile a long list of links and force the user to “read” irrelevant text if the text is not linearized with visual cues or skip links (Yoon et al., 2016). In a related study, Yoon et al. (2016) found that the most common accessibility barriers were related to the information architecture rather than errors in coding.

2.5.2. Library Databases

Libraries provide access to content stored in both local and remote vendor databases. Local databases include institutional repositories and digital libraries created and maintained by the libraries, whereas vendor databases offer electronic resources that are accessible online through contractual agreements between libraries and content providers. Some libraries provide information on accessibility of the databases to which they subscribe. For instance, the Healy Library² website informs users that the EBSCO, Gale and ProQuest databases are compliant with Section 508 of the Rehabilitation Act and/or the WCAG 2.0 guidelines. Similarly, Suffolk University’s³ web page provides a list of accessible library databases which are compliant with either Section 508 of the Rehabilitation Act or the WCAG 2.0 Level A guidelines.

There have also been studies on accessibility of databases. Borchard et al. (2015) tested 21 individual pages from Public Knowledge Project Open Journal Systems using automatic testing tools, such as WAVE, Fangs, and the Functional Accessibility Evaluator. The authors concluded that the tested pages did not pass minimum level of accessibility specified by WCAG 2.0. They added that most of the problems they found were easy to fix. Harpur and Suzor (2014) analyzed 12 academic e-book libraries and identified the features that prevented the full accessibility to content by users with print disability. They included CAPTCHAs⁴, e-book

² <https://umb.libguides.com/c.php?g=351270&p=2367336>

³ <https://suffolk.libguides.com/c.php?g=654172&p=4590096>

⁴ Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA) is a challenge-response authentication employed on websites to distinguish human input from machine input for the purpose of thwarting spam and automatic extraction of data from websites (<https://www.merriam-webster.com/dictionary/captcha>).

pages that opened as images (and thus were not detectable by screen readers), the lack of proper spacing between lines of book pages, and digital rights management (DRM) encryptions. DRMs are used by publishers as intellectual rights protection tools. However, they may block screen readers from accessing content (Ellis & Kent, 2011). Harpur and Suzor (2013; 2014) thus recommended the use of legal means, such as enforcing the MVT, to require publishers and retailers to produce accessible electronic versions.

There have also been studies that conducted user studies to identify accessibility issues with databases. Dermody and Majekodunmi (2010) examined the searching experience of users with print disabilities who were screen reader users. The experiment was conducted in a computer laboratory equipped with different screen readers. 10 participants with print disabilities were asked to search on three different proprietary databases for three academic articles, select two full-text scholarly articles, access the articles and read the first pages of each article (with their screen readers). A screen reading software was used to record the participant's activities on the databases. The study explored barriers such as inaccessible PDFs, unreadable links and too many links, and the participants' inability to executing Boolean searches formulate Boolean. The researchers attributed the problems partly to the database vendors failure to deliver accessibility and partly to the participants' low level of information literacy. Dermody and Majekodunmi, at the end, recommend libraries to use their positions as buyers to include accessibility questions in their procurement policies and to train their patron's with print disabilities with information literacy skills.

Walker & Keenan (2015) recruited a blind student to explore the accessibility of digitized special collections stored in two institutional repositories (namely CONTENTdm and Digital Commons) used in their library. They asked the student to browse pre-selected pages using his own laptop and screen reader technology. They used a camera to record his interactions and encouraged the participant to think aloud. They also scheduled two interviews with him, one for each system. The study, at the end, presented a long list of problems explored on both content management systems and the possible solutions. Inconsistent or repetitive use of headings, poorly described links, inadequately marked page elements, poorly labeled page elements such as check boxes, page numbers, and "next page" links) and many other issues that complicate navigation for screen reader users was discussed in the paper. The authors ,at the end, had some recommendations to improve the accessibility of both institutional repositories.

The studies reviewed above showed two ways that have been used to evaluate the accessibility of library databases and content management systems: heuristic evaluation with guidelines and user tests. The studies also revealed that the accessibility of electronic resources is determined by what librarians and content providers do. The studies have also identified technical tools (accessibility guidelines), and non-technical tools (such as procurement policies, information literacy programs) that could help the design of accessible databases.

2.5.3. Resource Discovery Tools

Users' interactions with digital library environments are mediated by library search tools, which have evolved from card catalogs to present-day RDTs. The design of RDTs was inspired by the likes of Google and Amazon to offer the user a single entry point, with a single search box, to the content available in both local and remote databases (Breeding, 2015; Majors, 2012). However, previous studies generally agreed that library search tools are complex to use when compared with Internet search engines (Teague-Rector & Ghaphery, 2008; Walters, 2013).

Southwell and Slater (2013) conducted an accessibility test on the search tools used by 68 public and university libraries in the US. The researchers employed automatic and manual testing techniques. The findings showed several errors, such as the lack of alternative texts to images, suspicious alternative texts, broken skip links, and other problems that might not be unique to library search tools. The manual test conducted with two screen readers showed that one-third of the problems were related to navigation. Poor tagging of structures and lack of links to skip "unnecessary" blocks of information were some of the problems found in their study.

Yoon et al. (2016) investigated the problems encountered by the users of screen readers. Some users had difficulty in locating the library catalog on a library website, which also led to the non-completion of some tasks. Other issues included the difficulty of using the filter functionality with screen readers and the lack of proper formatting in the presentation of search results. The authors found that the titles in the result list were not formatted as headings, which prevented screen reader users from moving from title to title by pressing the tab button, thus avoiding detailed resource descriptions.

Carden, Osman, and Reed (2016) explained how accessibility and inclusion were prioritized in the procurement and implementation of a new library catalog at the University of Arts London. According to the authors, the project was aimed to make the library system, especially the search interface and user accounts, accessible to all users. It was started by a user study of their

existing catalog to obtain data that could inform the procurement of a new library management system (LMS) and the design of the initial search interface. Then, the library produced posters showing screenshots of the new catalog's home page, the search results page, and the user accounts page, and asked the stakeholders for feedback. The stakeholders included colleagues, the disability and IT teams, and students. The feedback was fed into the final design, which was then checked with AChecker, an open source accessibility testing tool, for its compliance with WCAG 2.0 accessibility level AA.

Beside the studies that studied the accessibility of search interfaces, there were others that sought to examine what hinders or facilitates the information seeking process of users with dyslexia. For instance, Berget and Sandnes (2015b) conducted a study on BibSys Ask, a library search tool used in Norwegian research and academic libraries. The objective was to examine the effect of dyslexia on information seeking behavior. The study involved 20 dyslexic students and 20 controls conducting experiments with 10 predefined search tasks. The results showed that dyslexic users would struggle to use search tools that are error-intolerant or that do not provide automatic query or spelling suggestions. Another study by Berget and Sandnes (2015a) aimed to investigate whether visual display improves information seeking performance of dyslexic users. The study was conducted with 21 dyslexic participants and 21 controls. Each participant was given 24 search tasks; 12 with visual content and 12 with textual description. The search activities were recorded with an eye tracker tool. From the experiments, the study concluded that replacing textual content with visual content doesn't improve the search performance of persons with dyslexia.

The study by Cole, MacFarlane, & Buchanan, (2016) also indicated that dyslexic users would have problems related to keyword creation and use of tools for filtering and expanding searches. The problems were attributed the working memory impairment of the dyslexic participants and also the participant's low level information literacy.

MacFarlane et al. (2010) conducted a research to understand the information searching behavior of people with dyslexia. They recruited 5 dyslexic participants and 5 controls to conduct an experiment. The participants were asked to fill in a questionnaire before they started the search experiment. The experiments were conducted on an Okapi interface and the 'participants were asked to conduct searches on two TREC⁵ topics. Sessions were recorded as participants log in, type keywords, press the return key, and examine search results. The results of the study (which

⁵ Text REtrieval Conference (TREC) refers to a series of workshops

the researchers referred to as pilot) showed that the dyslexic participants used less iterations in their searches when compared with the controls, and the iterations were longer. Another study by MacFarlane, Albrair, Marshall, & Buchanan (2012) built upon the prior study to investigate the impact of dyslexia cognitive profile on information search behavior. The experiments were conducted on the same system and same topics used in the prior study (MacFarlane et al., 2010). The study was conducted on the total of 16 (8 dyslexic and 8 non-dyslexic) university students, and cognitive tests were administered on the participants prior to the experiments. The result showed that the dyslexic participants judged less documents as irrelevant than the dyslexic participants. The researchers attributed that to the impaired short term memory that inhibits reading ability.

In general, past studies that looked into library search tools studied what hinders or facilitates user's interactions with the search interfaces. Moreover, they also investigated how the information seeking performance of persons with print disabilities could be improved. The studies reviewed above recommended solution such as conformance to accessibility guidelines, augmenting search tools with autocorrect and autofill query building aids, and improving the information literacy skill of persons with print disabilities.

2.5.4. Library GPII

Library GPII was intended as the first real world rollout of GPII (Vanderheiden et al., 2014a). GPII is a newer generation cloud-based accessibility solution that emphasizes matching resources to users' needs and preferences (see. section 2.3)

According to Vanderheiden et al., (2014a), Library GPII was a five-year project that was conducted in three phases: needs analysis, development, and empirical evaluation. The authors explained that the needs analysis would include several stakeholders, such as librarians, library staff, IT staff, administrators, library software vendors, assistive technology (AT) vendors, government bodies, publishers, and others. The authors also added that the preliminary testing would take place in 2015 followed by the broader deployment in 2016. We couldn't find a documentation on the current status of this project. However, there is a wiki page⁶ that provides detailed technical explanations of the project.

⁶ https://wiki.gpii.net/w/Library_GPII_System

2.6. Research Gaps

The review of related works shows a considerable amount of works that can inform design of inclusive digital services. However, there are some observable gaps. First, many of the studies presented above are product-based (e.g. websites, search tools, etc.) and many are technical. There is an apparent lack of a holistic approach that studies the digital library environment as a system. A library is a system comprised of different technical (e.g. discovery tools, websites, electronic resources, etc.) and non-technical (policies, practices, rules, procedures) components that make it a whole. Addressing the technical as well as the non-technical elements are important to make the digital library environment inclusive of persons with print disabilities.

The other gap is shortage of studies that carry the voice of users to articulate what includes or excludes them from mainstream digital services. Experimental studies usually involve interviews before or after the sessions. However, that may not be as broad as letting the participants explain their real-life experiences. That shows the need for more qualitative or interpretivist studies.

Another gap is the shortage of studies that aim to create diversity-resilient digital services. Universal/inclusive design are contrasted with specialist designs because they endeavor to accommodate diversity (see Imrie, 2012 and Winance, 2014). Libraries and related information services are known by serving diverse groups of users. Therefore, studies that contribute approaches for accommodating diversity could be helpful. Such gaps identified in the literature review inspired this research to make contributions discussed in section 1.7. They have also inspired the research design and methodology which are presented in the next chapter.

2.7. Theoretical Framework

According to Verdegem (2010), all empirical research is based on certain normative assumptions. Previous studies in digital inclusion have sought to incorporate the perspectives of different theories. For instance, Newman et al. (2017) used Pierre Bourdieu's critical theory as a lens to identify different sources of digital inequality to a group of participants with cerebral palsy. The authors used Bourdieu's critical theory to identify digital inequality at economic, social, and cultural levels. Other studies have used Max Weber's theory of social stratification to identify sources of digital inequalities in a society or across countries (Ragnedda, 2017; Ragnedda & Muschert, 2015). Verdegem (2011) also recommended critical theory to guide empirical studies in digital inclusion.

The drive for using critical theories in digital inclusion studies may have emanated from the desire for a theory that not only explains the experiences of persons with disabilities, but also transforms their experience by freeing them up from the barriers imposed by the digital divide (see Bohman, 2016). However, as discussed in section 2.1.1, the emphasis of critical theories on social factors would risk the abandonment of personal and individual elements that may not be attributed to the society.

This present research is also in the domain of digital inclusion. However, it was believed that the reliance on a single theory would yield an incomplete account of the research problem for three main reasons. First, accessibility and inclusion have both subjective and objective aspects (Iwarsson & Stahl, 2003). The objective aspect is manifested when existing guidelines and standards are followed to assess, for instance, the accessibility of websites. The subjective aspect is rooted in the notion that users are the best experts regarding their inclusion to or exclusion from the opportunities available in a society. Second, the concept of inclusion, at its core, implies removing barriers imposed by some type of disability, which could be medical or contextual in nature. Indeed, disability has been interpreted through different theoretical stances, which could be negative for some and positive for others (Wolfensberger et al., 1972). Third, this research is aimed to elaborate the concept of access to digital content by incorporating the concerns of UD. However, UD is largely atheoretical perhaps because it is a “melting pot between cross paradigms” (D’Souza, 2004, p. 4):

Universal design can come under functionalist paradigm (because it caters to utility), pragmatic (because it is instrumental in nature), positivist (because it strives for universal principles), normative (because it prescribes certain rules) and critical theorist paradigms (because it gives voice to the oppressed).

Therefore, instead of adopting a single philosophical orientation, this research explored theoretical perspectives that could be helpful in answering the two main research questions. First, the ICF model, coupled with Mathiesen’s (2014)’s facets of access, was used as the framework to identify the barriers. Then, Ihde’s (1990) postphenomenological analysis and Verbeek’s (2015) theory of technological mediation were used to examine how technological developments can address the problems explored in this research and ensure inclusive access to information. The following sections discuss the theoretical framework of this research.

2.7.1. Access to Information

Enshrined in Article 19 of the UDHR, the access to information is a fundamental human right. However, the concept of access seems less theorized in library and information studies when compared with other concepts, such as data, information and knowledge (Mathiesen, 2014).

Mathiesen (2014) said that she knew only “two fully developed accounts of the concept access” (p. 606). The first was a study by McCreddie and Rice (1999), which examined how access was conceptualized in different disciplines through an analysis of the scholarly literature. Their study found that access had been used in six different senses: technology, which presupposes that access to technology leads to access to information; commodity, which views information as a social and economic good with value, costs, and benefits; control, which equates the access to information with the access to control and predominance in a society; participation, which links the access to information with access to human rights and being an informed participant in a democratic society; communication, which implies that access to information means access to comprehension and understanding provided that the communication is relevant to the individual; and knowledge, which considers the access to information as the access to knowledge and its representations.

The tripartite theory of access was proposed by Burnett, Jaeger, and Thompson (2008), who presented three aspects of accessibility: physical, intellectual, and social. Physical accessibility relates to the physical or virtual location of a document, its formats, conditions, technologies, and skills as well as the knowledge required to obtain the resource. According to these authors, physical access is dependent on the user’s having knowledge of the information’s availability and the skills to retrieve it. They added that accessibility depends on the user’s ability to understand the information contained in the document, that is, intellectual accessibility, which relates to how the information is presented. Thus, they linked accessibility with usability. The concept of social accessibility draws on the theory of normative behavior, which defines the value of information in the context of norms and attitudes in a particular social world. Burnett et al. (2008).

Mathiesen (2014) viewed access to information as a human right. She used Henry Shue’s (1996) analysis of human rights as protections against standard threats to vital interests. This approach resembles those in which inclusion was defined according to the definition of exclusion (Mathieson et al., 2008; O’Reilly, 2005). Mathiesen listed the facets of access from the user

and the provider perspectives. From the user's perspective, information is not accessible under the following conditions:

- 1) The information is not available.
- 2) The information is not findable. For instance, the user may lack the skills required to find the available information.
- 3) The information is not reachable. For instance, the information may be behind pay walls that some users may not be able to afford.
- 4) The information is not comprehensible. For instance, the information may not be available in the user's language.
- 5) The information is not usable. For instance, the information may be out of date or inaccurate.

Thus, information is accessible if it is available, findable, reachable, comprehensible, and usable. Mathiesen later linked these factors with other factors from the provider perspective. For instance, the availability of information is dependent on its production. Therefore, facets of access from the provider's perspective include production, quality, organization communication, and distribution (Mathiesen, 2014).

Other conceptions of access may exist. Nevertheless, the availability of information does not equate its accessibility. Accessibility of information is multi-faceted challenge. By summarizing the three conceptualizations discussed above, one can see that access is constrained by both personal (e.g., the ability to comprehend and use information, skills to use a search tool, disability, attitude, and culture) and environmental and contextual (e.g., location, availability/findability, types, formats, technology, quality of a resource, technology, societal norms, etc.) factors. These factors correspond to the conceptualization of disability in the ICF model. In this research, The ICF model is used together with the Mathiesen's conception of access to present and integrate the findings that answer the first research question (see section 5.2.5).

2.7.2. Technology, Limitations, and Mediation

Technological advances have been interpreted as the results of humans' admission of their limitations. Ernst Kapp (cited in Reydon, 2018, para 1), whose book *Grundlinien einer Philosophie der Technik (Foundations of a Philosophy of Engineering)* is considered as the origin of the philosophy of technology, argued that technological artifacts are the results of the desires to overcome human limitations. Distance and time have been the well-known barriers

for timely transfer of information (Cecchini & Scott, 2003; Dhaka & Chayal, 2010; Hendriks, 1999). ICT has enabled humans to surmount those barriers and to exchange and share information within minutes. ICT has also created the opportunity for information resources to be accessible to their users at any place and at any time. However, users had to overcome other limitations, such as the lack of access to ICTs and the skills needed to use them. These limitations gave rise to the digital divide, which initially was understood in terms of poverty, the lack of access to ICT, and the lack of ICT skills (see section 2.2). Nevertheless, ICT has yet to help people overcome other limitations which are inherent in the design of the ICT artifacts. Accessibility, UD and others discussed in section 2.3 were introduced to remove those limitations. However, research has shown that the limitations persist. Therefore, it could be important to reexamine the role of information technology in mediating access to information.

Verbeek (2015) argued that the human–technology relations are more complex than functionality and usability, distinguishing three approaches to the relations. The first approach is described as extension, in which technologies are seen as instruments that help human beings to perform specific tasks. The second is dialectical, in which technologies are perceived as overpowering or alienating forces from which human beings need to free themselves. The Marxist critique of mechanization is as an example of this approach. Third is the hybrid approach. It combines the instrumentalist and the dialectic approaches and acknowledges that humans and technology are intertwined and shape each other. According to Verbeek (2015), the theory of technological mediation is important to investigate the hybrid aspect of human-technology relations and to analyze the roles technologies play in human existence and in society (Verbeek, 2015).

According to Verbeek (2015), the theory of technological mediation is based on the post-phenomenological approach which was introduced by Don Ihde. According to Ihde (2009), postphenomenology emerged from phenomenology. Phenomenology endeavors to understand human experience from subjective or first person points of view (Smith, 2018; Wilson, 2015). According to Wilson (2015), phenomenological research focuses on the lived experiences of people. Data are collected from written or spoken diaries, interviews, protocols (i.e., written accounts of a specific experience), and informal conversations. There is no fixed rule for the number of participants. Phenomenological research helps to gain deep insights into people's thoughts, feelings, and emotions. However, it demands high personal engagement from the researcher and the participant. Furthermore, it cannot produce a theory (Wilson, 2015).

According to Ihde (2009, p.23), postphenomenology is an adaptation of phenomenology oriented “to probe and analyze the role of technologies in social, personal, and cultural life”. It highlights the importance of technology in amplifying/reducing our perceptions and inviting/inhibiting our actions (Aagaard, 2017). Ihde’s (1990) postphenomenological approach involves the analysis of different aspects of human–technology relationship:

- Embodiment relations: technology taken to the user’s bodily awareness to reshape the user’s experience. E.g., talking through the phone, rather than talking to the phone; looking through eyeglasses, not at the eyeglasses.

(Human – technology) —>world

- Hermeneutic relations: human beings read how technology represents the world, such as reading an MRI scan to understand brain activity; “reading the display interface of the mediating technology” (Rosenberger & Verbeek, 2015, p. 17).

Human —> (technology – world)

- Alterity relations: human beings interact with technologies as if they are interacting with other human beings, with the world in the background of the interaction. E.g, withdrawing money from an ATM

Human —>technology (world)

- Background relations: a human-technology relation in which technologies form the user’s environmental context. The user doesn’t interact directly with the background technologies. However, background technologies can transform user’s experience and trigger the user to interact with them (Rosenberger & Verbeek, 2015).

Human (technology / world)

According to Rosenberger and Verbeek (2015), the postphenomenological approach has appealed to scholars who investigated technologies not merely as functional or instrumental objects but as mediators of human experiences and practice. Moreover:

Rather than “applying” philosophical theories to technologies, the postphenomenological approach takes actual technologies and technological developments as a starting point for philosophical analysis. (Rosenberger & Verbeek, 2015, p. 9)

The postphenomenological approach was appealing to this research too because the second research question was on the role of technological developments, such as those in accessibility

and UD, to help the user overcome personal and environmental barriers of access to information.

Information mediation is one of the traditional tasks of librarians (Hafner & Camarigg, 2009; Pawley, 2018). During the mediation process, the librarian is expected to know the user's background and information needs, translate the information needs to queries, present relevant information to the user, and help the user access the information (Zick, 2000). In digital library environments, that mediation is expected to take place mainly through the interfaces of RDTs. Thus, this study used the framework and vocabulary in Ihde's philosophy of postphenomenology and Verbeek's theory of mediation to reexamine the role of technology in mediating inclusive access to information.

3. Research Design and Methodology

3.1. The Research Design

According to Cabello and Claro (2017), most studies on digital inclusion have been quantitative, focusing on infrastructures and material access. However, there is a growing need for studies that address “qualitative disparities” and explore the individual, social, and contextual factors that affect the usage of technology (Cabello & Claro, 2017; Correa & Pavez, 2016; Helsper, van Deursen, & Eynon, 2015). The review of related works done in chapter 2 has also signaled the need for works that dig deeper into issues that affect inclusive access to digital information. Therefore, the main purpose of this research was to make an in-depth exploration of factors that determine the access of users with print disabilities to digital content.

There were two main issues considered while designing this research. The first and most important was the research purpose. The second was the anticipated difficulty of conducting research that involves persons with disabilities. Discussing the challenge, Lazar, Feng, & Hochheiser (2017) said:

Difficulty in finding and recruiting qualified participants is a problem frequently faced by many HCI researchers. One typical example is the field of universal usability, which focuses on developing applications usable by diverse user populations. Numerous studies in this field examine how individuals with disabilities interact with computers or computer-related devices. The sample sizes are normally smaller than in studies examining users without disabilities (p. 54).

Moreover, Lazar et al (2017) added:

Recruiting participants with specific disabilities is always a challenging task.... The same problem also occurs when the target population is well-trained, highly experienced, professionals, such as business executives or experienced project managers, simply because they are too busy to be bothered (p.54).

Therefore, it was important to have a research design that 1) allows in-depth exploration of issues and 2) offers flexibility in case the recruitment of participants doesn't go as planned. The review of the available research methodologies showed that the qualitative methodology is well suited for the purpose and anticipations of this research.

Qualitative methods offer an in-depth understanding of a problem “in ways that are impossible to reduce to numbers” (Mortensen, 2019, para.12). Qualitative methods give “the voice” to participants of a research and enable to reveal the user side of a story (Ashby, 2011; Llewellyn, 1995). The qualitative methodology offers “methods and techniques that are less standardized, more flexible, and more respondent-centered, that are capable of adapting to the social actor who is under study and to his/her linguistic, cultural, and social difficulties” (Gobo, 2005, para. 20).

The other advantage of the qualitative methodology is the flexibility it offers. Qualitative research maintain flexible design before and throughout the actual research (Taylor, Bogdan, & DeVault, 2015). It gives flexibility to deal with unforeseen circumstances that may occur during research. For instance, the recruitment of participants may not go as planned. Very few participants may be willing to take part in the study. Qualitative data collection tools such as interviews and observations enable collection of rich data from a small number of participants (Budiu, 2017; Kiernan,2009; King & Horrocks, 2010; Orb, Eisenhauer, & Wynaden, 2004). The other possibility is that, after recruitment, some respondents may be reluctant to speak openly: some could be nonverbal, or the initial research questions may become irrelevant (Taylor et al., 2015). Therefore, a qualitative research may start with some general questions that show what the research is about and what data is to be collected (Agee, 2009). Then, issues can be explored as they emerge during the study (Mortensen, 2019; Taylor et al., 2015).

This research was designed as a qualitative study taking the above into consideration. Agee (2009) said, “Good qualitative questions should invite a process of exploration and discovery” (p.434). Thus, this present research was planned to start with two broad research questions, which are presented at chapter 1, and conduct three types of studies that would answer the questions. As the result, this research was designed as comprising three groups of studies: user perspective, librarians’ perspective, and literature review and documentation analysis.

The studies on the users’ perspective aimed to explore barriers users with print disabilities face when they access digital information. They focused on purposefully recruiting participants with print disabilities who are experienced users of digital library services. That was done believing that those users would provide a deeper insight into the barriers or facilitators of access to information. Data was collecting through semi-structured interviews and user tests. A qualitative data from a survey was added to substantiate the findings from the interviews and user tests.

To identify potential gaps between the needs of users and the offerings of libraries, it was important to incorporate the latter’s perspective. Therefore, another study was required to examine the situation at selected libraries in Oslo which run relatively well-developed digital services. Thus, interviews were made with the librarians who run the digital services.

To compare the findings of the above studies with the state-of-the-art of accessibility and universal/inclusive design, a review of literature and an analysis of documentation were conducted. The documents were blog posts mainly obtained through email correspondences with the IDRC. Finally, a hi-fi prototype of a search interface, which was designed as a proof of concept based on the findings of the research, was designed as additional means of collecting data from users. Fig 4 summarizes the research design.

The results of the studies were published in seven papers (see Table 3). Papers 1, 2, 6, and 7 are on user perspectives; Paper 3 contains the librarians’ perspective; Papers 4 and 5 are literature review and documentation analysis. The overall findings, which are integrated, interpreted, and presented in Chapter 6, are used to answer the two main research questions.

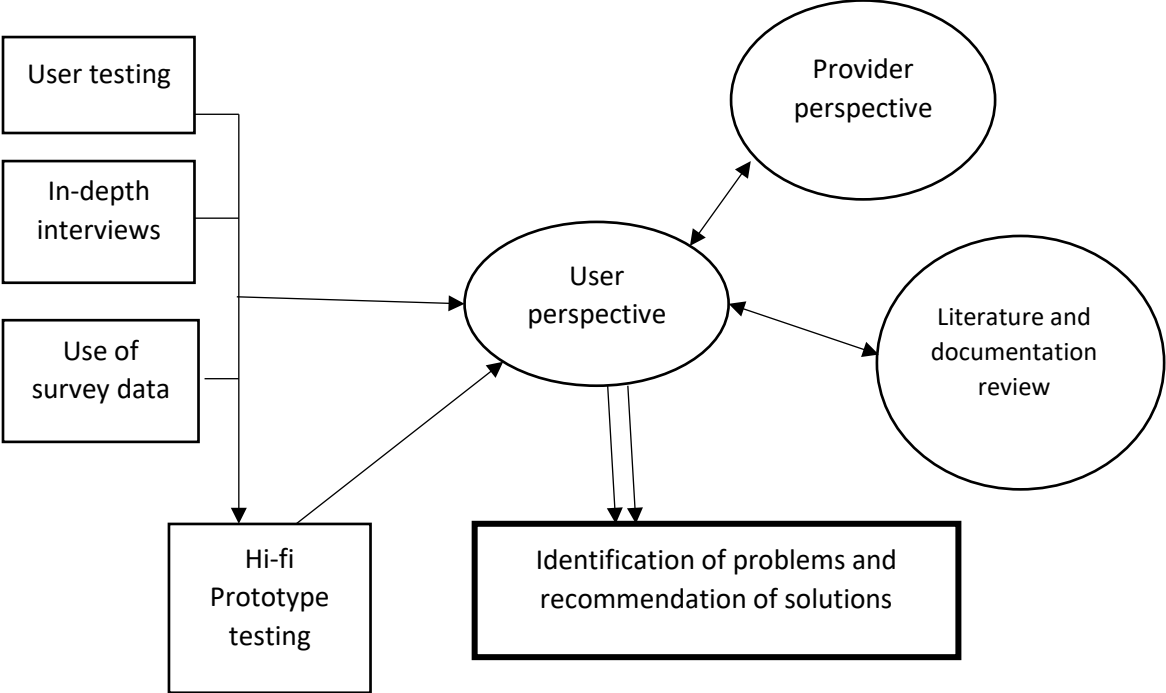


Fig. 5. The research design

Table 3. Methodology

No	Paper title	Method	Data collection technique	Participants	Duration	Data management techniques	Data analysis techniques
1	Resource Discovery and Universal Access: Understanding Enablers and Barriers from the User's Perspective.	User testing	Testing and observation (individual) Interviews (individual)	10 participants (six with dyslexia, four with low vision) Age: 21-51	30-45 minutes	Observation, audio recording, transcription and coding	Thematic analysis
2	Digital Inclusion in Library Context: Perspective from Users with Print Disability	Interviews	Individual in-depth semi-structured interviews	Ten participants (six with dyslexia, four with low vision) Age: 21-51	30 minutes	Audio recording, transcription and coding	Thematic analysis
3	Realizing Inclusive Digital Library Environments: Opportunities and Challenges	Interviews	Individual and group semi-structured interviews	Eight participants	One hour	Audio recording, transcription and coding	Thematic analysis
4	A case for Adaptation to Enhance Usability and Accessibility of Library Resource Discovery Tools	Documentary	Literature review	-	-	coding	Content analysis
5	Metadata and Universal Access in Digital Library Environments.	Documentary	Literature review, emails, blogs, documents	-	-	coding	Content analysis
6	Accessible Search and the Role of Metadata	Survey	survey data (two open-ended questions taken from the data for qualitative analysis)	113 participants (demographic information not included)	Two months	Coding	Thematic analysis
7	Improving Resource Discovery and Access through User-Controlled Adaptation: Exploring the Role of Library Metadata	Prototype testing (user testing)	Observation, interviews	Three (two female, one male) Age (20-80)	30-45 minutes	Observation, audio recording, transcription and coding	Thematic analysis

3.2. Methods of Data Collection

This research is comprised of three groups of studies that have been reported in seven publications shown in Table 3. The methodology used in each paper is presented in Chapter 5 with the summary of each paper. This section presents a general discussion of the methods used in this research. Reflections on the methodological limitations are presented separately in section 3.5

3.2.1. Users' perspective (Papers 1 and 2).

During this research project, different methods were used at different times to collect data from users. The qualitative design of the research allowed the flexibility to follow leads and conduct follow-up studies as needed. There were three times where studies dealing with user perspective were conducted. The first was done around the beginning of the research project and the output was published in Papers 1 and 2. The data collection procedure is discussed next.

Selection Criteria

The first step before recruiting participants is developing a selection or inclusion criteria (Robinson, 2014). That would require developing a classification scheme or adhering to an existing classification to decide what types of respondents to recruit. As defined by Marradi (1990), classification is “an operation whereby the objects or events of a given set are grouped into two or more subsets according to the perceived similarities of their states on one or (more frequently) several properties” (p. 130).

The classification of users with disabilities is “somewhat artificial” (Lazar et al., p.493). People grouped in the same category may have some common traits, but they possess many others that make them different. In addition, there are different degrees of severity within an impairment. (WHO, 2002). Moreover, some disabilities may be temporary, some users may have multiple disabilities, and some may be situationally impaired (W3C, 2017). Due to the difficulty of recruiting persons with disabilities and the diversity within a given category, attaining a representative sample is difficult.

In this research, we utilized the category print disability which is used in libraries to collectively describe the inability to read printed text materials (IFLA, 2017). The scope and extent of this category is not clearly defined (see section 1.3). In this study, we decided to limit our focus to participants with dyslexia and low vision impairment due to 1) the significant overlap of the problems they share despite the different origins of their disabilities (see section

1.4) and, 2) the opportunity they provide to gain insights into accessibility issues that cover wider aspects of digital library environments such as user interfaces (e.g., fonts, background and foreground colors, etc.) and the data behind the interfaces (eBooks, journals, etc.).

Recruitment

Qualitative research is dependent on the individual's experience (Rahman, 2016). Therefore, it was important to recruit users with print disabilities who are experienced users of digital library services. Therefore, the recruitment purposefully targeted participants with college level education and above. This was the toughest part of this research. Explaining such challenge, Lazar et al. (2017) said:

“It's not likely that there are a sufficient number of people with the specific disabilities at your company or government agency (unless you work for a very large company or government agency). Certain offices at a university or a company (e.g., the Disability Student Services office, or the Compliance Office) may have a list of all people with disabilities in an organization, but you can expect that they will be reluctant to share that information with you, and according to the laws of some countries, it may be illegal to share that information. Also, depending on the national or regional laws of a country, an individual may not be required to identify that they have a disability (pp.499-500).

Lazar et al. (2017) also recommended collaborating with advocacy groups as the best way to recruit participants with disability. No such partnership was established in the duration of this research project. Nevertheless, the NLB and the admission offices of the University of Oslo (UiO) and the Oslo and Akershus University College of Applied Sciences (HiOA)⁷ were requested for help recruiting participants. It was possible to recruit ten participants (six with dyslexia and four with low vision impairment) in the period between January 2016 and April 2016. All but one were females and their ages ranged from 21 to 51 years. Their educational level ranged from bachelor's degree students to master's degree graduates. Data was collected from the participants through user tests and semi-structured interviews.

User testing

A user test (task-based evaluation) conducted on Oria. Oria was chosen based on the following assumptions: 1) it is a web-scale discovery tool that provides access to resources in digital

⁷ The Oslo and Akershus University College (HiOA) is currently the Oslo Metropolitan University (OsloMet)

library environments; 2) it is well known to Norwegian users especially those recruited for this research. The purpose of the test was to provide users a walkthrough through the discovery tool and elicit information from them on which aspects of the search tool complicate or facilitate access to information. The participants used their own computers for the tests and they were contacted at the place of their choosing (including their homes and offices). The participants were given four predetermined searching and browsing tasks: 1) search for a book by a certain title and author, check whether a book has Norwegian and English versions; 2) browse the collection by a certain subject and open an item for reading; 3) check for an audiobook; and, 4) check for a recent journal article on a certain topic. These search activities were intended to give the participants a chance to explore Oria and discuss what should be improved to make it more accessible to users with a print disability. The participants were encouraged to think aloud while they were performing the tasks. Finally, the respondents were asked to explain what they liked, what frustrated them, and what they like to see improved. The ICF model was used to classify the problems as personal (impairment related or not) or environmental (related to Oria and/or the digital library environment). The result was published in Paper 1 (see section 5.1.1.).

Interviews

Semi-structured interviews followed the user test discussed above. The interviews were conducted to enrich the data collected in the usability tests to explore the participants' usage of library services. The interviews were recorded with a recording device and later transcribed for thematic analysis. The interviews and user tests took a total of one hour for each participant.

The interview guide was designed using the vocabulary in the ICF framework. The following questions are examples of how the ICF vocabulary was used to prepare the interview guide:

- Which libraries do you use? How often? Why? *Participation*
- How often do you search libraries for digital resources (articles, e-books, etc.?) *Participation*
- Is there any other place other than libraries where you search for books, e-books, etc.? if yes, explain? *Participation*
- Are there problems you encounter while you search for library resources? If yes, what are they? *Barriers/Enablers*
- What frustrates you while searching with library catalogs? *Barriers/Enablers*
- What makes library search tools and libraries in general appealing to you? *Barriers/Enablers*

The user tests and interviews took a total of one hour for each participant. The findings were thematically analyzed using the ICF as a framework. The data collected through the interviews helped to publish Paper. 2 (see section 5.1.2).

3.2.2. User's perspective (Paper 6)

The results of the above studies and the literature reviewed revealed issues that need to be explored in further studies. Then there was a chance to collaborate with another researcher who was doing a research on Lydhør, an audiobook app maintained by the NLB. The aim of that researcher was to explore problems users with print disabilities encounter with the app and propose a better design. The researcher was contacted when he was at the stage of designing a questionnaire. He then agreed to add two open-ended search related questions (which are described in section 5.2.3) to the questionnaire, collect answers for them, and co-author a journal article based on the answers given to those two questions.

The co-author then posted the questionnaire online for two months. He contacted disability organizations in Norway such as Dyslexia Norway, Blinde Akademier (Blind Academics), Norges Blindeforbundet (the Norwegian Association for the Blind), and the NLB for help to have the questionnaire filled. Eventually, the questionnaire was filled by 113 respondents. The co-author then set aside the answers given for those two open-ended questions, translated them from Norwegian to English, and collaborated in analyzing the data and producing the publication. I (The main author) was responsible for designing the manuscript, formulating research questions, analyzing the data and preparing the manuscript for publication.

The co-author had added a paragraph on the questionnaire informing the participants that their participation is voluntary, and they have the right to withdraw from the survey. The co-author has taken the utmost care to avoid collecting personally identifying information. He neither collected nor shared any demographic information that may identify a respondent. That has gone to the extent that he did not know how many of the respondents were with dyslexia, visual impairment, etc. The questions were totally focused on finding what to fix on Lydhør, not on who said what. That was done to limit the questions to the relevant ones, make the questionnaire less taxing (especially to users of screen reader technologies), and increase the response rate. Lack of demographic data made the data weak. Nevertheless, the responses can be understood as reflecting part of the experience of users with print disabilities as they interact with digital library services. The answers given for the two open ended questions (which I contributed) were thematically analyzed, and the result was published as Paper 6 (see section 5.2.3).

3.2.3. Users' Perspective (Paper 7)

The second usability test was conducted on a prototype which was developed at the last stage of the research. Some of the recommendations presented in Paper 6 (represented by Fig 6, p.81) were developed into a prototype as an additional means for collecting data from users. This study was conducted around the end of the research project and it too was done with a co-author. I (the main author) was responsible for the design of the research paper, formulation of the research questions, analysis of the data, and preparation of the manuscript. The co-author was responsible to convert Fig 6 into a hi-fi prototype, recruit participants and conduct prototype tests. He also interviewed the participants, transcribed the interviews, and anonymized the data. Only three participants (two female and one male) with low vision impairment were willing to take part in the study. Each session took around 30 minutes. None of the participants were on the earlier user test which was conducted on Oria. The number of participants is obviously small. Nevertheless, the study has confirmed findings of the earlier studies and has provided some interesting insights that can be tested in the future with an improved prototype. The result was published in Paper 7 (see section 5.2.4). Ethical considerations taken during this and the other studies is discussed in detail in Chapter 4.

3.2.4. Librarians' perspective

It was important to explore the accessibility of digital services in libraries to identify a possible mismatch between users' needs and the libraries' services. Thus, requests were sent to libraries in Oslo that were believed to have well-developed digital services. The University of Oslo (UiO) Library, the library of Oslo and Akershus University College (HiOA), Helsebiblioteket.no, and the National library of Norway were contacted for semi-structured interviews, which were focused on two themes: the digital services available in the libraries and the measures taken to make the services accessible to persons with print disabilities. Eight participants were recruited (three from the UiO library, two from the HiOA (Now OsloMet) library, two from helsebibliotek.no, and one from the National Library). The participants from UiO were interviewed individually, the participants from OsloMet library and helsebiblioteket.no were interviewed in pairs, and the participant from the national library preferred to answer the questions through email correspondence. The interviews were recorded with an audio recording device and later transcribed for use in the thematic analysis. The results were published in Paper 3 (see section 5.1.3).

3.2.5. Documentation and literature review

The third part of this research aimed at exploring the state-of-the-art of research in accessibility and inclusive design and examine their applicability to make digital library services more inclusive. The results of this study were published in Papers 4 and 5 (see sections 5.2.1 and 5.2.2). Paper 5 is a study that attempted to expand on some of the findings reported in Paper 1 (i.e., the accessibility metadata). Thus, the study aimed to explore the state-of-the-art of accessibility metadata and its applicability to libraries. The study involved the review of documentation obtained through email correspondence with the IDRC, which was working on an accessibility metadata project. Paper 4 is a literature review, which aimed to explore accessibility and usability issues identified with library RDTs in previous studies. Based on the findings, recommendations were made to address the issues.

3.3. Reflections on Methodological Limitations

The main limitation of this research is the small number of participants recruited for the interviews and usability tests. That can be attributed to 1) the scope of the research, which was limited to digitally competent users who are experienced users of digital library services, and, 2) the difficulty of finding as many willing participants as possible in the limited time frame. This section discusses this research's limitations in relation to the literature of qualitative research methodology and the experiences of other researchers.

3.3.1. Sample size

There is no clear-cut rule for defining the appropriate sample size for a qualitative research. According to Dworkin (2012), most of the literature recommend from 5 to 50 participants. Others broke that down by research type: Moser & Korstjens (2018) recommended 25-50 participants for ethnographic research, about 10 interviews for phenomenological research, and 20-30 interviews for grounded theory studies. Morse (1994) recommended 30 to 50 participants for ethnographic studies, 6 for phenomenological research, and 30-50 for grounded theory studies.

Others do not concur with the idea of fixing sample sizes. Patton (2002, p. 244) said that sample size of a qualitative study “depends on what you want to know, the purpose of the inquiry, what is at stake, what will be useful, what will be useful, what will have credibility, and what can be done with available time and resources”. Taylor et al. (2015) said that qualitative researchers do not know how many interviews they would have to make before starting a study. The sample size is known rather at the end of the study. Moser & Korstjens (2018) explained that the

sampling procedure in qualitative research is adaptive, starting with a broad sampling plan with the sample emerging during the study. Moser & Korstjens (2018) added that the inclusion and exclusion criteria and the sampling sites may change during the study. Moreover, questions that emerge during the study would decide the need of recruiting more participants. Fusch & Ness (2015) raised the concepts of thick (in quantity) and rich (in quality) data, arguing that quantity does not entail quality and vice versa. Hence, an in-depth inquiry with few participants may yield more data than an inquiry with many participants. In that sense, even a single case (N=1) could be considered depending on the research objective and the depth of inquiry required (Patton, 2002; Taylor et al., 2015). Therefore, scholars agree that the concept “saturation” is an important concept for qualitative researchers to think about while pondering about sample sizes (Malterud, Siersma, & Guassora, 2015; Moser & Korstjens, 2018; Saunders et al., 2018).

Saturation is understood as a point where the collected data is considered sufficient and, as the result, there is no need for additional data (Dworkin, 2012; Saunders et al., 2018). The literature review made by Saunders et al. (2018) revealed four different models of saturation. The first, which they called theoretical saturation, relates to the grounded theory methodology. It is focused on sampling until to the point where no new theoretical category is found for an emergent theory. The second, inductive thematic saturation, is focused on the analysis phase. There, the data collection stops when the researcher finds no new code or theme in the data. The third, a priori thematic saturation, is expressed as the reverse of the former. There, data is collected to exemplify rather than to define or refine a theory. There, saturation occurs when the collected data represents all constructs that formed the theory. The fourth, which Saunders et al. (2018) referred to as data saturation, is reached when the data collected becomes redundant. It is focused on data collection and doesn't have a relation with a theory. Saunders et al. (2018) added that there are authors that interpret saturation by combining two or more of the models described above.

How can one identify the point where saturation is reached? According to Dworkin (2012), it depends on the homogeneity/heterogeneity of the study population, the selection criteria, the budget available for the study, the research timeline, and other different factors that may or may not be under the researcher's control.

Before commenting whether the studies made as part of this research had enough data or had attained some form of saturation, it could be better to present some examples from related studies. A small number of participants is not uncommon in studies involving persons with

disabilities. For instance, Walker & Keenan (2015), recruited just one blind student to explore the accessibility of digitized special collections stored in two institutional repositories (namely CONTENTdm and Digital Commons) . They admitted that their study has several limitations in addition to being a subjective feedback from a single participant. However, they were able to show what vendors must do to improve the accessibility of those two digital repositories. Dermody & Majekodunmi (2011) recruited “ten students with print disabilities who use screen readers” (p. 152) to examine the searching experience of students with print disabilities on three proprietary databases. The authors didn’t provide further clarification on the disabilities of the participants. They mentioned the small number of participants and the lack of control group of non-print-disabled users as the limitations of their study. The comparative evaluation of library and non-library websites conducted by Yoon, Dols, et al.,(2016), which too was mentioned above in 2.5, had only six participants who were screen reader users. Those studies with their limitations were able to contribute knowledge that would improve the accessibility of digital information for persons with print disabilities. Having discussed the experience of other researchers, the next sections discuss limitations of this study.

3.3.2. User Tests and Interviews with Participants

As discussed earlier, the inclusion criteria of this research was to recruit participants with print disabilities who most likely are able provide opinions on wider range of issues related to digital services design. The important matter was not whether the participants are dyslexic or low vision impaired. It is rather whether they struggle to read printed text and whether they face accessibility problems that span different elements (font, font size, color, contrast, digital documents, etc.) of a digital library environment. This could be a point for debate. UD/inclusive design is opposite to specialist design. The focus of specialist designers may be to design something for persons with a specific disability. In the contrary, UD/inclusive design focuses on removing barriers which may exclude some groups of users. Here, we can bring back the argument by IDRC in section 2.3.1 where they said they prefer to focus on diversity of needs rather than on disabilities. That could be a point for further research. In this research, the results were analyzed and presented wholly as issues that need attention to make digital services inclusive of people with print disability.

The user test on Oria had six dyslexic and four participants with low vision impairment. It is difficult to say that that number was adequate. However, it took about three months to get those ten participants. It was then inconvenient to wait for more participants due to time limitation.

The strategy to counter the effect of the small sample size was to make the data richer by compounding the user testing with semi-structured interviews. Was saturation attained? As presented in the following chapter, the findings have identified personal (medical and non-medical) and environmental barriers of access to information, utilizing the theoretical framework presented in section 2.7., and recommended solutions. That may show the direction of the a priori saturation mentioned by Saunders et al. (2018). The data has also identified different types of barriers in digital library environments that may exclude users with print disabilities (see Table 4, p.79). That too may imply the direction of data saturation, which is also mentioned by Saunders et al. (2018). The research timeline didn't allow waiting for more participants. Hence, the research timeline can be seen as a point of saturation (Dworkin, 2012). Nevertheless, the small number of participants remains the major limitation of the research.

3.3.3. User Testing with a Prototype

The number of participants who took part in prototype testing was also small. Like the first user testing, this too took unreasonably long time to find willing participants. Its main contribution to knowledge could be the recommendations it carried for further research. The prototype by itself was an attempt to illustrate some recommendations from Paper 6. Therefore, it could be indicative or informative of further studies that may have to be carried out in the future..

3.3.4. Interviews with Librarians

One of the studies conducted as part of this research was an exploratory study to identify the types of digital services being run in libraries and the measures being taken to make the services inclusive. Here, we can argue that the interviews have provided sufficient information. Redundant information was given by the interviewees contacted at the libraries mentioned in section 3.2.2.

3.3.5. Survey data

The survey data has some problems. First, it lacks basic demographic information which shows how many male and female respondents filled the questionnaire, how many of them were with dyslexia, visual impairment, etc. Given the number of respondents (which is 113), a data with those missing attributes could have helped to make a more in-depth analysis of the data. I had a limited role in the design of the questionnaire, except contributing two open-ended questions. Moreover, the data is limited to the experience of users searching/browsing an audiobook app, which is by far less complicated than mainstream RDTs.

3.3.6. Summary: Reflections on Methodological Limitations

The major limitation of this research was the small number of users that took part for the interviews and user tests. According to qualitative methodology literature, that may or may not be a problem because qualitative studies are done to “garner an in-depth understanding of a phenomenon” under study (Dworkin, 2012, p. 1319). Instead of using statistical procedures to make predictions or generalizations, qualitative researchers seek to use their findings to create a thorough understanding of a phenomenon in a real world setting and extrapolate to similar situations (Golafshani, 2003). That can be done with rich data. Richness of data is not necessarily a factor of sample size.

Despite its limitations, this research has answered the main research questions. The answers may not be regarded as complete, pertaining to wider group of print disability. The data has fallen short of representing users from the other types of print disabilities. For instance, it didn't include participants with visual impairment (blind). It didn't also include participants with physical impairments that affect people's capability to read printed text. Dyslexic and low-vision impaired persons could be affected by the visual aspects of user interface elements. However, it might be totally different with the blind. Nevertheless, this research has contributed answers that can inform accessibility and digital inclusion efforts in libraries. Further studies that would add greater number of participants would be required to affirm, refine or refute the findings and the recommendations presented in this research.

3.4. Generalizability

An important question would be whether the findings and conclusions from this research could be extensible to other similar contexts. Generalizability is “to claim that what is the case in one place or time, will be so elsewhere or in another time ” (Payne and Williams , 2005, p. 296). It is understood by many as an attribute of a good quantitative research where the results of an adequate sample could be regarded as applicable for the study population and other similar populations (Leung, 2015; Morse, 1999; Polit & Beck, 2010). However, there are debates on generalizability of qualitative research because, as discussed by Polit & Beck (2010), the goal of most qualitative studies is rather “to provide a rich, contextualized understanding of human experience through the intensive study of particular cases” rather than making generalizations (Polit & Beck, 2010, p. 1452).

However, scholars argue that qualitative research too is generalizable (Morse, 1999). Gobo (2008) stressed the importance of making distinction between representativeness and generalization, stating that representativeness is the property of the sample whereas generalizability is concerned with the findings of a research. Polit & Beck (2010) discussed three models of generalization: statistical generalization, analytical generalization, and case-to-case translation. Statistical generalization happens when a researcher draws inference from a sample to a population at large. This is a model commonly used in quantitative studies. Analytical generalization is linked to qualitative studies, and is a generalization where qualitative researchers “develop conceptualizations of processes and human experiences through in-depth scrutiny and higher-order abstraction” (Polit & Beck, 2010, p. 1453). Analytic generalization happens at the stage of data analysis and interpretation. Case-to-case translation or transferability entails the use of the findings of a research in a different setting. Polit & Beck (2010) said that transferability is the responsibility of the reader to extend or “transfer” the results of a research to a different setting. The researcher’s job is to provide detailed description and help the readers to do the extrapolation (Moser & Korstjens, 2018; Polit & Beck, 2010)

Beside the assertion that qualitative studies too are generalizable, Payne and Williams (2005) discussed “moderatum generalizations”, which are presented in a form of testable propositions that may be proved or refuted in further studies. These may be alternatives to researchers who are not comfortable with making sweeping statements. In that sense, a qualitative study could be presented as a platform on which generalizations can be made (Payne and Williams, 2005).

To go back to the question presented at the start of this section, is this research generalizable? The interpretation of the results and analysis provided in the form of Table 4 (p.79) and Fig. 7 (p. 88); moreover, the postphenomenological analysis presented at the end in section 6.3 (p. 88) could be taken as attempts of analytical generalization. To be modest, they can also be considered as moderatum generalizations which can be tested in further research.

4. Ethical Considerations

Ethics can be understood as a set of moral principles that shape people’s behavior in a particular context (Wiles, 2012). Such behavior consists of “doing good and avoiding harm” through the application of ethical principles (Orb et al., 2004, p. 93). According to the Norwegian National Committees for Research Ethics (2016), the term research ethics refers to a set of values, standards, and institutional norms that help to maintain the integrity of scientific activity starting

from the formulation of the research topic to the eventual dissemination of the research results. This chapter explains the ethical considerations taken at different stages in this research.

4.1. Handling Participants

In research involving people with disability, extreme care must be taken to avoid making them feel stigmatized. Such measures include developing “emphatic” relationships with them avoiding treating them as “test subjects” (Newell et al., 2011, p. 237). As discussed by Orb et al. (2004), it is possible that some interview questions could evoke painful experiences and distress the participants during the interviews. In this research, the interviews and the tasks in the usability tests were designed to encourage the participants to focus on problems in the system (e.g., Oria, digital resources, and the search interface prototype) rather than their bodily limitations. However, the participants often related the problems to their limitations although the researcher did not intend to elicit such responses. The participants were contacted at a place of their own choosing, where the interviews and the usability tests were conducted.

4.2. Privacy and Personal Data

The Norwegian Center for Research Design (NSD) was notified about this research project at the start of the project. An application form which contained information on the nature of the research, the participants sought, data collection methods, and the data collection period was sent to the NSD. The data collection methods reported to NSD were observation (for the user tests) and audio records (for the interviews). The NSD sent a clearance with instructions on handling personal data (see Appendix I). on the response letter, the NSD sent instructions on how to keep the anonymity of the participants. The instruction defined anonymous information as information that doesn’t directly or indirectly identify a participant through name, email, residence, gender, institution, pictures, video recordings, etc. In this project, the audio records were kept in a separate device, away from computer networks. Precautions were taken during data analysis not to publish any personally identifying information. The NSD was once updated when changes were made on the research design. Their response stated that there is no need for further updates unless the originally reported data collection mechanisms are changed.

The co-authors of Papers 6 and 7 also followed the same precautions. They never transferred a personally identifying information of any participant to the main author (me). The survey data and the transcriptions were anonymized.

This research relied on data collected from human participants through interviews and observations. Thus, a morally acceptable procedure was developed to collect the data while maintaining the privacy of the individuals involved and the confidentiality of the data collected. The Norwegian Personal Data Act section (2000, §8) stipulates that personal data must be processed only after the participant has provided informed consent. Thus, consent forms were prepared with information about the background and purpose of the research, the types of questions to be asked, the manner of data collection, how the collected information will be used, what will be done to safeguard the anonymity of the participants and the confidentiality of the records, and the project's scheduled time of completion. For the studies in which interviews and usability tests were used, consent forms that included all the aforementioned information. (see Appendices II, III, and VI).

4.3. Integrity

Research involves the quest for newer or deeper insights. Its integrity is established by adherence to the truth and by taking precautions against the misinterpretation of the research data (Resnik, 2016). Moreover, ethical research requires respecting and acknowledging the intellectual works of other scholars. All works referenced in this thesis are appropriately acknowledged and cited. The American Psychological Association (APA), Chicago, and Harvard citation and reference styles are used in this thesis and in the published papers. Moreover, care was taken to avoid the misinterpretation and misrepresentation of the data collected.

5. Summaries of the Publications

This study was aimed to answer the following research questions:

RQ1: What are the problems users with a print disability face when they accessing digital services in mainstream libraries?

RQ2: How could advances in accessibility and universal design be harnessed to solve those problems?

This chapter presents summaries of the published studies that were conducted to answer the research questions.

5.1. Identifying Barriers of Access to Information

5.1.1. Paper 1

Beyene, W. (2016). Resource discovery and universal access: understanding enablers and barriers from the user perspective. *Studies in Health Technology and Informatics*, 229, 556–566. IOS Press. Retrieved from <https://doi.org/10.3233/978-1-61499-684-2-556>

Purpose: Library resource discovery tools (RDT) are the new generation of library catalogs that are used to explore, find, and retrieve resources from the collections hosted or subscribed by libraries. These tools present interfaces that include rich functionalities to search, filter, and access resources. The study reported in Paper 1 was aimed to answer the following main questions:

- How do people with print disability search library contents?
- What are the enabling and disabling factors they face in the process?
- How can their experiences inform the design of inclusive RDTs?

Methodology: The aim of the study was to give users the voice to articulate the barriers they face in resource discovery and to encourage them to state their preferences solutions. Thus, it employed a qualitative methodology that involved the task-based evaluation of Oria. Ten participants (six with dyslexia and four with low vision impairment) took part in the study. The respondents were given predetermined searching and browsing tasks, and they were encouraged to think aloud. They were observed as they carried out the tasks. At the end of the sessions, the participants were interviewed to know what they liked, what frustrated them, and what should be done to remove the barriers.

Findings: The data collected in the sessions did not exhibit differences from any typical user in the way the participants conducted their searches. However, the participants identified the following issues that made the RDT uncomfortable.

Interface-related issues: The interface was not comfortable for those who wanted to switch it to high contrast mode. Parts of it became blurry and invisible. The interface had parts that became uncomfortably shiny when it was turned to high contrast. The list of filters presented at the left side of the results list was too compact, which caused some users to click a wrong link and become confused. Moreover, the list was too long. It is important to mention that although Oria is implemented by academic and research libraries in Norway, each institution implements its own CSS related fixes on the interface. Therefore, the foreground and background colors of the interface may differ from institution to institution. The participants did the test on the interface that was implemented by the University of Oslo.

Search results presentation: The search results did not present alternative formats (PDF, HTML, audiobook, etc.) available for each title in the results list. The participants mentioned JSTOR⁸ and the Gutenberg Digital Library Project⁹, which they said were better in presenting search results with alternative formats. There were also complaints about the “excessive number of clicks” required to reach electronic resources in vendor databases. Moreover, faulty link descriptions (e.g., links labeled as link 1, link 2, etc.) were found to be irritating for the participants who use screen readers.

Resource description: There was “too much information” on the search interface, which represented complexity for some participants. The lack of “important information” (e.g., on the accessibility of eBooks and journal articles to screen readers) was also mentioned.

Search box: The search box did not include autocomplete or autosuggest features, which could be important especially for dyslexic users. Some “best examples” to follow for enhancing the capability of the search box were discussed by the participants. These included imitating Amazon’s search box to present autofill suggestions for keywords and faceted searches as well as LivriVox, a free audiobooks app that allows the input of aural queries.

In addition to the system-related issues discussed so far, it was observed that, users’ experience with library catalogs, their low expectation, and their lack of knowledge of the available digital services could play the role of barriers. Using past experiences with library catalogs to judge

⁸ <http://www.jstor.org/>

⁹ <https://www.gutenberg.org/>

that library RDTs are too complex for people with disabilities, judging library RDTs as unfit for full text searches, confusing e-books for audiobooks and articles for e-books were some of the issues identified in the study.

Differences in preferences: The participants with dyslexia expressed their appreciation of the addition of graphic hints, such as icons and cover images, with the search results. However, the participants with low vision impairment regarded the visual cues as nuisances. The preferences were not constrained by the participants' disabilities because people with similar disabilities were observed having contrasting preferences. A solution recommended by participants for accommodating such diversity is emulating Gmail's "standard" and "basic html" views. The standard view could be used by any user, and the simplified basic html view could be used by those who require a simplified interface. This indicate that the inclusive design of RDTs could be more productive if it focuses on accommodating diversity in user needs and preferences. Needs related to disability could be treated under that domain.

In conclusion, removing barriers to resource discovery and access will be best served best by identifying all personal and environmental impediments that might exist between users and information. RDTs must be accessible, usable, informative, and adaptable to users' needs and preferences. Their design should emphasize simplicity (how easy the search tool is to use, including to users of assistive technologies) and efficiency (how fast users can retrieve resources) in order to ascertain their usability and accessibility.

5.1.2. Paper 2

Beyene, W. (2018). Digital inclusion in library context: A perspective from users with print disability. *Journal of Web Librarianship*, 12(2), 1–20. Retrieved from <https://doi.org/10.1080/19322909.2018.1427657>

Purpose: Paper 2 is a continuation of Paper 1 and was focused on exploring the concept of access to digital content. Providing access to digital content is one of the strategies followed by libraries towards digital inclusion. This study aimed to provide an improved conceptualization of what access to digital content entails by exploring the concept from the perspective of people with print disability. The following research questions were formulated:

- What is the experience of people with a print disability in relation to access and use of digital content in libraries?
- How could that information be used to improve the understanding of digital inclusion?

Methodology: In-depth semi-structured interviews were conducted with 10 participants with print disabilities. Six participants were dyslexic, and the remaining four had low vision impairments. The ICF model was used to formulate the interview questions and to analyze the data collected (see section 3.2.1). The participants were asked about the following: their use of libraries and the digital services offered by libraries (participation); what frustrates them (barriers); and what they think would help to eliminate the barriers (facilitators). Depending on their answers, the participants were encouraged to discuss which libraries they used, their motives for using those libraries, how they access the libraries' digital services, and the problems they encounter while using digital resources (e.g., e-books). Moreover, they were encouraged to reflect on their experiences of other web-based information services and offer opinions on what could make libraries more accessible.

Findings: Most participants described themselves as users of different libraries such as their university libraries, the NLB, and the public library. They also mentioned library apps they were using. However, their frequency of usage of a particular library was generally low and that can be partly due to the presence of different alternatives, including the Internet. The other reasons mentioned included the unavailability of a resources in the desired format, the inaccessibility of PDF documents to screen readers, and the complexity of library search tools. The solutions they recommended included simplifying library search tools, enabling sorting search results by resource type, adding audio input capability to library search tools, and offering resources in alternative formats and languages.

The results of the data analysis identified personal and environmental barriers, which were used to formulate the following indicators that could be used for evaluate access and digital inclusion:

Personal factors: In addition to the medical factors that obviously limit the users' ability to read printed text, non-medical personal factors such as users' past experiences and perceptions may affect their inclusion in information services. Based on past experiences, a user could be judgmental to conclude that a library does not have resources suitable for him. Information literacy programs may remedy such gap the non-medical personal factors may create. Libraries may consider providing orientations on the accessibility of their resources to patrons with print disability.

Environmental factors: As defined by the ICF model, the environment can be a source of enabling or disabling factors. The following could affect the access of users with a print disability to information in digital library environments:

Resources and alternatives: Libraries are used by diverse groups of users with varying needs and preferences. Providing content in alternative formats and languages could make information services responsive to the diversity of needs among users. There are instances when people want to use audio and text together (for improved cognition), text only (for academic reading), or audio only (for leisure reading). Such choices may not necessarily be dictated by disabilities. Presenting content in text (e.g., PDF, HTML, EPUB, etc.) and audio alternatives could help to serve the needs of all users to the greatest extent possible. Language is another dimension of alternative content presentation. This study, other studies (e.g., Boldyreff et al., 2001), and the WAI guidelines ascertained that some people with disabilities require resources with “easier expressions.” Such requirements may not be specific to persons with print disabilities. Thus, designing for accessibility benefits all, not only those with disabilities (WAI, 2016a). In addition to alternative formats, users may desire alternative routes for accessing resources. Therefore, making library resources discoverable through search engines such as Google Scholar would benefit users. It may also enhance the exposure of library resources to their potential users.

Decision support: Users have to be empowered to make informed selection of resources. A user may be frustrated when he or she finds out that a resource (e.g. eBook or journal article) is inaccessible to screen readers after going through the process of searching and retrieving it. Therefore, search tools may have to include information on the accessibility of resources in the results list. That could help users to inspect the search results and decide whether to retrieve a resource.

Content delivery format – flexibility and adaptability: Digital text carries the opportunity to meet the visual and aural needs of users, a trait desired to make information accessible to the wider mass. If a digital text is accessible, a user can change the font size, color contrast, and have the content read out loud by screen reader technologies. Moreover, it allows copying and pasting content to directly quote it in a research document. Digital text may be delivered through a variety of formats such as PDF, HTML, and EPUB. Guidelines such as the WCAG 2.0 could be consulted to make digital text accessible.

Access rights: The DRM encryptions used by publishers could unintentionally discriminate against users with a print disability by blocking screen readers from “reading” a text to their users. Hence, it is important to maintain the balance between access rights and intellectual property rights.

In summary, removing barriers of access to digital content requires an elaborated conceptualization of the concept access. The indicators presented in this research could be used to study the state of access in an information environment and to identify and remove barriers.

5.1.3. Paper 3

Beyene, W. M. (2016). Realizing inclusive digital library environments: Opportunities and challenges. In N. Fuhr, L. Kovács, T. Risse, & W. Nejdl (Eds.), *Research and advanced technology for digital libraries* (pp. 3–14). Springer International Publishing. https://doi.org/10.1007/978-3-319-43997-6_1

Purpose: This study aimed at obtaining the libraries’ perspective to examine the context of the problems discussed in Papers 1 and 2. A gap in the previous research was the scarcity of a holistic approach to examine the processes, practices, and policies followed in libraries to ensure universal access to digital content. Thus, this study aimed to answer the following questions:

- What digital services are available through libraries?
- What steps are being taken to make the services accessible for users with disabilities?
- What are the challenges for providing accessible digital services?
- What approaches could be considered to realize inclusive digital library environments?

Methodology: Libraries in Oslo which run relatively advanced digital services were contacted for in-depth interviews. A total of Eight digital service librarians from Oslo and Akershus University College (HiOA), University of Oslo (UiO), the National Library of Norway, and Helsebiblioteket.no (health digital library) were interviewed. The participants at HiOA, UiO and Helsebiblioteket.no were contacted at their libraries, while the librarian at the national library answered the questions through email correspondence.

Findings: The digital services provided by the libraries were categorized as access services, content production, discovery services, and other services. Access to subscribed electronic resources, such as journals and e-books, formed the largest share of the digital services offered by the two academic libraries and the health digital library. The libraries were also engaged in

content production. The academic libraries publish open access journals, maintain institutional repositories, produce educational firms, prepare compendiums, and digitize old books. The health digital library presents translated content (from English to Norwegian) to suit the needs of their user. As per the right granted by the nation's legal deposit act, the national library digitizes the intellectual output of the nation, including books, newspapers, photos, and radio broadcasts. The digitized content is available online through bokhylla.no for users with Norwegian IP addresses.

The need for universal design is well recognized by the librarians interviewed. However, their focus was largely on the universal design of library websites according to the requirements set by the Norwegian Agency for Public Management and eGovernment (Difi). Difi is responsible for monitoring whether the universal design requirements are met as required by the Norwegian law. Difi has specified WCAG 2.0 level AA as the standard for the universal design of websites with some exceptions regarding time-based media, audio description, and media alternatives (prerecorded content), captions (live content), and audio description (prerecorded content) (Difi, 2018).

The librarians acknowledged the need for accessible digital resources. However, that was constrained by intellectual rights ownership issues, which also affected the management of resources. The digitized collections at the national library were not made accessible to screen readers to avoid a potential violation of copyright terms the library has agreed upon with rights holders. The national library has been seeking a mechanism to make the resources accessible to screen readers without endangering intellectual property rights. The academic libraries included in the study said that they try to negotiate with content providers to have access to electronic resources without DRM protections. The health digital library has arranged for all of its users in Norway to easily access online databases without passing through login authentications. The library didn't specifically mention how DRMs are handled. However, contractual agreements with database vendors were mentioned as tools to improve the accessibility of eResources to library users. The academic libraries discussed the production of documents in accessible PDFs, HTML and EPUB alternatives for resources such as the open access journals that are produced by their institutions. Although it was not discussed in relation to accessibility or universal design, one of the academic libraries has attempted to develop apps that locate books on shelves and an e-book library that can be browsed with hand gestures.

All interviewees mentioned NLB as a place where users with a print disability could be better served. This attitude could limit the libraries' effort to be inclusive. The overall findings showed the tendency of associating universal design with WAI guidelines Web design. The study also showed the need for a framework to identify and address universal design needs in the processes and practices related to digital services. The study also recommended that libraries consult process-oriented standards, such as the British standard (BS) 8788, in addition to the W3C/WAI recommendations.

5.1.4. Summary: Barriers of access to information

Papers 1 and 2 explored problems users with print disability encounter while using digital services in libraries. Paper 3 attempted to explore the context of the problems. Identifying barriers is the first step toward eliminating them. Table 4 combines the ICF model with Mathiesen's (2014) conception of access to summarize the barriers of access to digital content as explored in this research. The table may not have provided a complete list of barriers. However, it provides a framework to detect, classify and eliminate them.

Sections 2.3 and 2.5 discussed that the WAI guidelines are not sufficient to address all accessibility issues. Table 4 also confirms limitations of the conformance-based approach and the fact that there is no "one-size-fits-all" solution for digital accessibility. For instance, the problems related to user's attitudes, libraries' policies, resource description and organization are not covered by WAI guidelines.

Table 4 and Paper 3 show that public policies may inadvertently create barriers to access. For instance, Jaeger et al. (2012), said that the way policy makers define digital divide and digital literacy may shape digital inclusion activities in libraries. In this study, the interviewed librarians mentioned Difi's recommendation (conformance to WCAG 2.0 level AA) as a benchmark for the universal design of webpages. Thus, government policies may narrow or widen the understanding and the scope of digital inclusion. If libraries choose to follow the conformance-based approach, then there could be a mismatch between what the libraries offer and what their users want. Therefore, national guidelines in relation to accessibility and universal design shouldn't be taken as "one-size-fits-all" solutions. Libraries are systems with their own peculiarities. Thus, there is a need for an approach/guideline contextualized to digital services in libraries. That is discussed in the next chapter.

Table 4. Barriers of Access to Information

Facets of access	Constraints		
	Personal (body or body part-related)	Contextual	
		Personal	Environmental
Availability	User's impairment limits availability of resources suited to his/her needs e.g., visual impairment, dyslexia ,	User's knowledge about the availability of the resource,	Failure of libraries to collect resources in alternative formats (e.g., braille, audio, captioned video, etc.) which is accessible and usable to the user.
Findability	Impairment (e.g., visual, motor, etc. impairments) may limit the capacity of users to search and retrieve information	Users may lack skills for information search and retrieval	Poor labeling or description of resources (including accessibility metadata) , Poor resource organization, bad information architecture may render a resource unfindable. lack of user education and orientation may affect the resource's findability
Reachability	User's disability would make resource unreachable without the help of assistive technology. User's disability (e.g. low vision) may make it difficult to use a search interface with poor color contrast	The user may not have subscription to access a resource behind a pay wall, copyright protection, etc.	DRM protections, faulty link labels on search interfaces, excessively long navigation affect the resource's reachability. Inaccessible search interface may complicate search and discovery of resources.
Comprehensibility	Users (e.g., those with dyslexia) would struggle to comprehend a text written in "complex language"	Attitudes, culture/norms, level of education, expertise, knowledge of the subject matter, language competence	Failure of the library to have material in the local language, legibility of the document, quality of the document, lack of documents written in "plain language", library jargons for resource description and organization
Usability	User's impairment restricts usability of resources which are not accessible	Information may be irrelevant to the user; information may not be comprehensible.	DRM protections, inaccessible PDF pages render a document unusable by some users with print disability

5.2. Removing Barriers of Access to Information

Table 4 summarized the different types of barriers users face in their quest for information. The personal and environmental barriers which are related to availability, comprehensibility and usability could be addressed through legislative and policy-related fixes. Acquisition and

procurement policies could be developed to collect resources in alternative formats and/or to negotiate with rights holders for accessing resources without DRM protections.

The second research question sought to explore solutions for reachability and findability. Thus, it sought to explore the advances in accessibility and universal design and examine their applicability to improve resource discovery and access in libraries. The papers summarized below aimed to answer this question.

5.2.1. Paper 4

Beyene W. M., & Ferati M. (2017). A case for adaptation to enhance usability and accessibility of library resource discovery tools. In M. Antona & C. Stephanidis (Eds.), *UAHCI 2017. Lecture notes in computer science, vol. 10277*. Cham.: Springer. Retrieved from https://doi.org/10.1007/978-3-319-58706-6_12

Purpose: Library resource discovery tools (RDT) are the latest generation of library catalogs that enable searching across disparate databases and repositories from a single search box. Although the advent of such “Google-like” tools is regarded as a breakthrough that benefits library users, studies report the presence of problems related to accessibility and usability. By definition, universal design includes improving accessibility and usability. Therefore, addressing accessibility and usability issues related to RDTs would contribute to make them universally designed. This paper aimed at reviewing the literature on the issues and explore solutions.

Methodology: Previous works that dealt with usability and accessibility of RDTs (including Papers 1, 2) were reviewed. Keywords and combination of keywords such as “library catalog accessibility”, “library resource discovery tools”, “universal design”, “library search tools”, “search interface usability” were used to search for relevant literature through Google Scholar, EBSCO, and Web of Science databases.

Results: The accessibility and usability issues explored through the literature review were categorized as follows:

- **Interface-related:** These problems included user interface elements such as, fonts, font colors, background colors, link labels, etc. Guidelines such as WCAG 2.0 or the specifications made by Difi could be used to design accessible interfaces. However, users may have different preferences regarding the setup of user interfaces.
- **Information/resource description-related:** The studies showed that users with print disabilities would benefit if search results are presented with more information on the

accessibility status of resources. For instance, a description of whether an e-book or a journal is readable by screen readers could be important for some. However, putting too much information on the interfaces could be overwhelming. RDTs tackled that problem by hiding seemingly less important information behind “view more” links (see Fig. 6). However, which information should be readily visible above the “view more/less” toggles would require a user study. Iconizing some information could be beneficial for some users with dyslexia. However, that may not be liked by users of screen readers. The other problem lies in the vocabulary used by librarians to describe and categorize information resources, which was found to be “too technical” to be understood by some users.

- **Navigation-related:** The number of links users need to navigate to reach to an information resource, missing link labels, poor link descriptions are issues that fall into this column. Faulty links or wrong link labels navigate the users to a wrong place. Clicking excessive links to reach to an electronic resource may be taxing for some, especially for screen reader users.

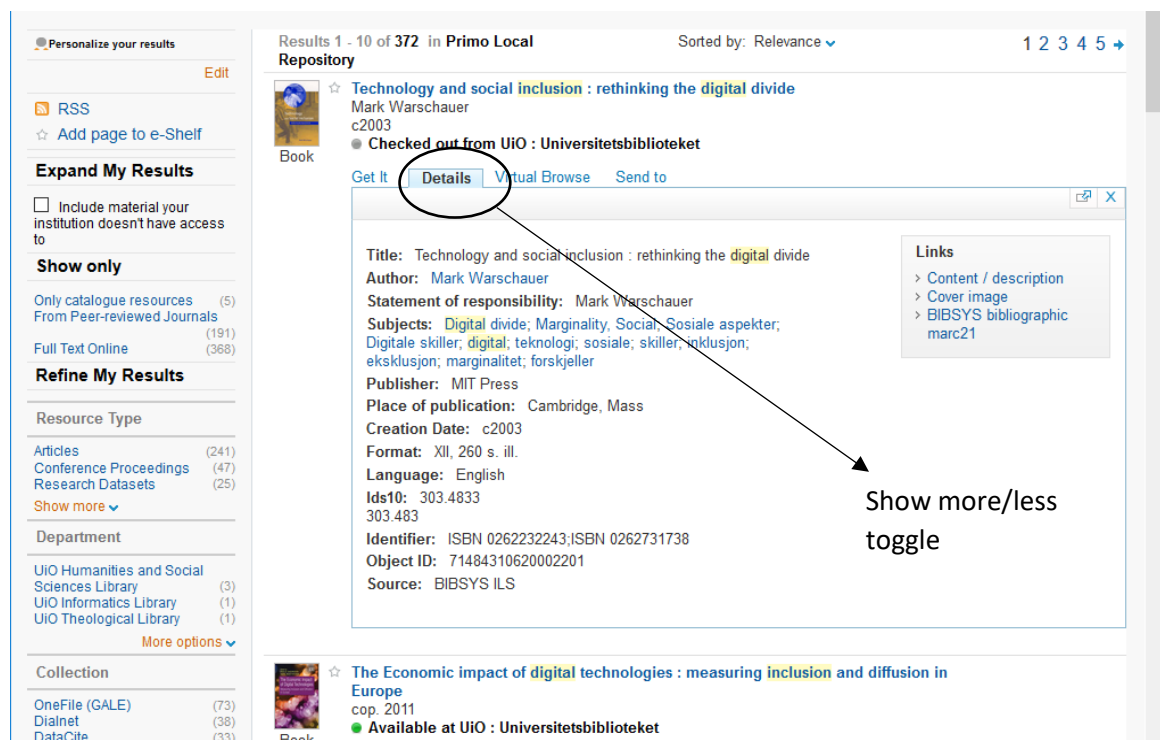


Fig .6. Search Results Presentation on Oria (as implemented at the University of Oslo library)

Because of the diversity in users' needs and preferences as learned from the literature review, this study recommended the adaptation approach (see section 2.3.2.) as the better approach to make RDTs accessible and usable at three levels: interface level, information or resource description level, and navigation level. This conforms to the approach recommended by Paternò and Mancini (2000). The advantages and disadvantages of the automatic and user-controlled adaptation approaches were weighed. Taking the diversity of users' needs into consideration, Paper 4 concluded that giving users control, that is, user-controlled adaptation, is the better option for designing inclusive library RDTs.

As discussed in Chapter 2, the existing literature on universal design of library interfaces highlighted on the use of WCAG and other related guidelines. The adaptation of library search interfaces according to users' needs and preferences could be a subject of future research. The remaining three papers summarized below explored solutions that relate to information/resource description and navigation-related issues.

5.2.2. Paper 5

Beyene, W. (2017). Metadata and universal access in digital library environments. *Library Hi Tech*, 35(2), 210-221. <https://doi.org/10.1108/LHT-06-2016-0074>

Purpose: Accessibility metadata has been a recurring theme in recent efforts to promote the accessibility of ICT solutions to all regardless of their disabilities, cultural differences, languages, and so on. This study was aimed to explore the application of accessibility metadata to improve knowledge discovery and access in digital library environments. It discussed developments in creating accessibility terms for resource description and attempted to relate these developments to the overall purpose of improving resource discovery and access.

Methodology: This exploratory study was based on a review of selected literature and documentation made available by metadata projects. Search for related literature was made on Google Scholar, EBSCO, and Web of Science Databases using terms and combination of terms such as “universal design and metadata,” “accessibility metadata,” “inclusive design,” and “metadata and digital libraries.” Some documentation was obtained through email correspondence with persons linked with an accessibility metadata project that was led by Benetech.¹⁰

¹⁰ <https://benetech.org/our-work/born-accessible/certification/technical-background/>

Findings: Accessibility metadata is not new to libraries although it is not mentioned among the main metadata categories such as descriptive metadata, administrative metadata, and technical metadata. However, accessibility metadata was understood as “the degree to which the institution allows access to people with disabilities” (Corrado & Moulaison, 2014, p. 115). Existing metadata schema include metadata fields that can be used to describe the accessibility qualities of resources. For instance, Dublin Core’s (DC) “audience” and MARC 21’s “reading level” could be used to describe resources that are suitable for users with dyslexia or other forms of impairment. Moreover, DC’s “format” could be used to label a resource as an audiobook, braille, audio, video, and text. However, such descriptions may not be sufficient because it might be important to indicate whether an audio or video has captions, whether a text is accessible to screen readers, and so on.

The Benetech led accessibility metadata project helped to magnify the importance of accessibility metadata for improving digital accessibility. At the time of this study, the set of accessibility metadata recommended by the project included four properties: `accessibilityFeature`, `accessibilityHazard`, `accessibilityAPI`, and `accessibilityControl`. `AccessibilityFeature` was intended to record content features of a resource. Its “expected values” included `alternativeText`, `caption`, `tactileGraphic`, `taggedPDF`, and others. The property `accessibilityHazard` is intended to describe whether a resource is physiologically dangerous, that is, whether it contains sound and/or flash hazards, to some users. The property `accessibilityControl` describes the input method (keyboard, mouse, touch, etc.) that allows access to an application’s functionality. The examination of the proposed metadata elements revealed the intention to crystallize WCAG 2.0 guidelines into metadata elements that label resources by their accessibility attributes. The work on this accessibility metadata project is described as ongoing (W3C, 2018c).

The above accessibility metadata recommendations were picked up by some digital libraries with the intention of improving the findability of accessible resources by their intended users. However, the applicability of the accessibility metadata properties to libraries requires further research. It would require studying which properties could be relevant to a particular library. There are different metadata schemas devised to be used by libraries. However, a single metadata schema might not be sufficient to serve the purpose of a particular library. Therefore, information professionals might need to creatively mix and match metadata schemas to suit the purpose of their libraries, the nature of their collections, and the needs of their users (Corrado

& Moulaison, 2014; Coyle & Baker, 2016). Therefore, librarians are advised to maintain an application profile, which is a document showing a set of metadata elements, policies, and guidelines defined for their library (Corrado & Moulaison, 2014). If libraries plan to make their services inclusive to people with disabilities, one of their functions could be to plan what accessibility metadata elements their application profiles should include.

This study concluded that accessibility metadata may be used to augment library RDTs for the benefit of users with disabilities. Accessibility metadata would make accessible resources easily discoverable through library RDTs and search engines. Accessibility metadata elements could inform users whether a resource is suitable for them before they decided to retrieve it. However, the notion of indexing resources by their accessibility attributes remains an area that needs further exploration. Moreover, user studies would be required to determine the extent of the need.

5.2.3. Paper 6

Beyene, W., & Godwin, T. (2018). Accessible search and the role of metadata. *Library Hi Tech*, 36(1). <https://doi.org/10.1108/LHT-08-2017-0170>

Purpose: Some of the usability and accessibility problems of search interfaces emanate from poorly organized search results. Metadata is important to make well-informed selection of resources. However, putting too much of it on search interfaces could be counterproductive. Moreover, what is relevant to some users could be irrelevant to others. Therefore, previous studies suggested supporting metadata-related decisions by user requirements. The purpose of this study was to explore library metadata from usability and accessibility perspectives. It attempted to identify the search-related problems encountered by users with a print disability and to explore how metadata-related decisions could be tailored to solve those problems.

Methodology: Part of a survey data that was collected to study the audiobook app Lydhør was used in this study. The data was collected through a questionnaire that was posted online for two months. The questionnaire was targeted at people with print disabilities who use Lydhør. The cooperation of disability organizations (see section 3.2.2) was sought to collect the data. Responses from 113 respondents were obtained. Responses given to two open-ended questions dealing with search and metadata were chosen for qualitative analysis. The questions were:

- Have you encountered problems while using Lydhør search interface? If “Yes,” please list them.

- When you are searching for or selecting a book, is there any information you want to see in addition to the title? If “Yes”, please specify.

Findings: 44 respondents said that they have encountered problems while searching on Lydhør’s interface. Among them, 21 respondents mentioned Lydhør’s intolerance of spelling errors. Eight respondents mentioned faulty search results and the difficulty of finding some books, and the rest ten of them mentioned problems related to the app’s design including the small size of the search box and the obscurity of advanced search options. Some participants suggested potential solutions to make searching easier. Four of them recommended enhancing the search box with autocomplete suggestions to help with typing queries. Others recommended the use of shortcuts, such as “newly added books,” “favorites,” “popular books,” and the use of genres as alternative ways for reaching to their favorite collections. The answers given to this question suggest that designing search interfaces as shown in Fig 6 would make the design more inclusive and convenient for users with print disabilities. In addition to augmenting the search box to provide instant suggestions, allowing users to create their own shortcuts on their search interfaces could be beneficial for users with print disabilities.

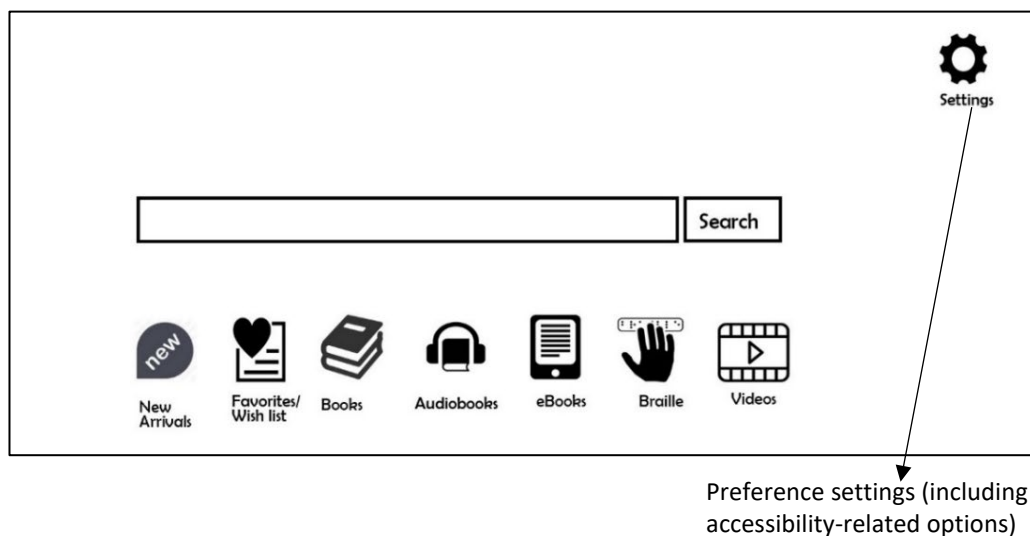


Fig. 7. Giving users control to add shortcuts to library search interfaces

The second question was related to the metadata shown in the search results list. Metadata is important for informed selection or abandonment of resources. However, the paradox of “too much information” and “lack of important information” was mentioned in Papers 1 and 2. The respondents of this survey were therefore asked whether they like to see additional information in the results list beside the book title information. More than half of the respondents (64 of

them) indicated that they want to see more information. Those respondents were asked to list metadata information which would be more relevant for them. The term “more relevant” referred to the information that should be always visible beyond the “view more/less” toggles. 26 of them mentioned book summaries or abstracts, four participants mentioned audio summaries, 13 participants mentioned genre, eight participants mentioned date of publication, six participants mentioned audience (whom or which age group the book was intended for), and seven participants indicated the need for technical metadata, which could also be seen as accessibility metadata. The technical metadata included narrator information for audiobooks (whether the narrator is human or a voice synthesizer), chapter information and book length. These metadata elements were not included in the accessibility metadata proposal discussed in Paper 5. The fact that the majority of respondents prefer to see summaries or abstracts implies their desire to be well informed of an item before proceeding to retrieve it. The need for audio summaries also shows the importance of making the summaries accessible.

The study was conducted with the belief that what users want to see on small screens such as mobile apps is transferable to desktop applications (Wroblewski, 2011). Limited screen space demands a wise usage of the available space. A user requirement analysis as performed in this study could be important to rearrange metadata in search results to display the most relevant ones and hide the rest under view more/less toggles. Library RDTs already possess this functionality. However, the difference of opinions regarding which metadata is more important may suggest the need for a mechanism that allows users to customize the way search results are presented to them.

The findings of this study showed the importance of augmenting some metadata properties to entertain the needs of users with print disabilities. As demonstrated in Table 5, some elements of existing metadata schema such as the DC could be augmented to better describe resources according to their accessibility attributes.

Table 5. Example of Augmenting the DC Metadata Element *Format*

DC metadata property	Expected value	Accessibility attributes
Format	Audio	Narrator information: human/voice synthesizer Audio hazard :yes/no
	text	Screen reader: supported/not supported Format: PDF, HTML, EPUB...
	image	Has Alternative text: yes/no Tactile: yes/no
	Video	Has Caption: yes/no Flashing hazard: Yes/No

In summary, accessible search is not only the product of accessible search interfaces. It is also the result of a well-planned use of metadata to simplify resource discovery and access. This study demonstrated how metadata could be used to relieve some navigation and information-related problems mentioned in Paper 4.

5.2.4. Paper 7

Beyene, W. M., & Aasheim, M. W. (2018). Improving resource discovery and access through user-controlled adaptation: Exploring the role of library metadata. In M. Antona & C. Stephanidis (Eds.), *Universal access in human–computer interaction: Design and development approaches and methods*. UAHCI 2017. *Lecture Notes in Computer Science*, vol. 10908 (pp. 397–408). Cham.: Springer. <https://doi.org/10.1007/978-3-319-92052-8>

Purpose: library search tools are used by diverse groups of users with diverse needs and preferences. For the average user, they could be about finding a particular resource. However, for people with print disability, they could be about finding accessible resources. This makes library metadata an object of study in library accessibility. This study was an attempt to translate the recommendations presented in Paper 6 into a hi-fi prototype and test the idea of allowing users to control how search results are presented to them. The following research questions were formulated: Which metadata fields are more relevant to people with a visual impairment? How could metadata be harnessed to enhance user experience in resource discovery and access?

Methodology: Fig 6 from Paper 6 was translated to a hi-fi prototype. The prototype had three components. The first was the search interface with a search box and predefined shortcuts to browse some types of resources such as braille, PDF, audiobook, eBooks and “new books”. The second was a searchable list of resources with fields such as author, language, format, genre, subject, description, and accessibility. The choice of metadata fields did not follow any particular schema used in libraries. The third component was a preferences settings module that allows users to specify which metadata information should be visible in search results page and which should be hidden behind the show more/less toggle. The aim was to use the tests to elicit conversations with the participants regarding the need for user-controlled adaptation of library search tools.

Disability organizations (see section 3.2.2) were asked once again to help with the recruitment of participants. Only three participants were willing to take part in the study. Two of whom were females, and one was male. One participant was a retiree, one was a student with part-time employment, and the other was an employee at an institution. Neither of them took part in

the other studies conducted as part of this research. The participants were given predefined search tasks and were encouraged to experiment with the preferences settings to control the search results presentation. The sessions took place on a laptop presented to the participants and lasted from 30 to 60 minutes. Two participants used the magnification tool available on the browser whereas one of them used a screen reader. As they walk through the prototype, the participants were asked for their opinions.

Findings: The study confirmed the findings reported in Papers 1 and 6. Users do not want search interfaces to be overwhelmed by too much information, but they do not want important information to be absent. The participants generally liked the idea of allowing users to control the visibility of metadata information. However, they also mentioned that the solution presented by the prototype could be more appealing to frequent users than to “one-time” users.

It is known that search engines such as Google and library RDTs incorporate preference settings to allow customization of some features. It would require further research to see how well those functionalities are used by users. However, the preference settings are there for whomever who wishes to use them. Similarly, the concept of adding accessibility and usability options to library RDTs as part of preference settings could be an object of interest for future studies.

Recommendations for future work: This study could be seen as a demonstration of a future work that should to be studied in more depth with greater number of participants. Nevertheless, the sessions have provided valuable input for improving the prototype for the next iteration. The suggestions included giving users the option to change the visual aspects of the search interface, such as fonts, foreground and background colors; employing filters such as subgenres to further narrow search results, and labeling contents or content clusters with vocabulary that could easily be understood by a regular user.

5.2.5. Summary: Removing barriers

Papers 1, 2, and 3 showed that removing barriers of access requires addressing a wide spectrum of technical and non-technical issues. Papers 4, 5, and 6 attempted to explore technical approaches that could help to remove the barriers by grouping them as interface-related, information-related, and navigation-related issues. The interface-related issues could be resolved by following established accessibility guidelines or by allowing users to customize their own search interfaces. However, more research is needed to address information and navigation related barriers, and that is what Papers 4, 5, 6, and 7 tried to do.

Ensuring accessibility in digital library environments involves simplifying resource discovery and access. That can be done through the presentation of informative search results in library search tools. Tagging resources with accessibility metadata would allow search results to include information on the accessibility of resources. That would empower users with a print disability to decide which materials suits their needs. However, in the context of digital library environments, there is the possibility of using vendor-supplied metadata (Register et al., 2009). Therefore, it is worth asking where labeling resources with accessibility metadata should begin. Should it be done by libraries or by publishers? It may require the collaboration of libraries, vendors, and publishers and others in the information industry. Although all metadata are important, all may not be relevant (Resnick & Vaughan, 2006). Therefore, the application profiles maintained by libraries should be informed by user requirements.

Metadata could be instrumental in shortening navigation to resources in internal and external databases. Allowing users to have shortcuts to their favorite resources through the use of genres or some faceted metadata would make navigation less taxing. The summaries of Papers 4, 5, 6, and 7 showed that a well-planned usage of metadata could improve the accessibility of RDTs for the benefit of all users.

6. Discussion

This research started by acknowledging the need for a study that gives users a voice in identification and removal of barriers of access to information. It thus attempted to involve users with a print disability in order to understand what includes and excludes them from mainstream library digital services. The research was thus designed as a qualitative study that used different methods of data collection, such as user testing, interviews, use of a survey data, document analysis, and literature reviews. The following main research questions were formulated to guide the research:

- What are the problems users with a print disability face while accessing digital services in mainstream libraries?
- How could advances in accessibility and universal design be harnessed to solve those problems?

6.1. Barriers of Access to Digital Content

The barriers of access to information, which are identified in this research, are categorized as personal (medical), personal (non-medical), and environmental. The medical personal barriers relate to an individual's physical or cognitive impairments. The non-medical personal barriers originate from the individual's lack of knowledge of the available digital services, his/her negative experiences with libraries in the past and other related factors. Environmental barriers are caused by the poor design of RDTs and the organizational practices and policies implemented in the management of digital resources. Table 4 (p. 79) presented the barriers in detail. Table 4 not only identifies the sources of barriers but also defines the phrase, "access to digital content."

6.2. A Framework for Inclusion in Information Services

The second main research question was on how developments in accessibility and universal design could be employed to remove the barriers. As depicted in Fig 7, the overall research showed that focusing on the barriers is not enough. It is important to acknowledge the presence of diversity in needs and preferences and the varying patterns of participation and usage. Some users are first-timers while others are advanced users. Some are occasional users while others are frequent users. The frequency of use may also define users' accessibility and usability needs. As shown in the summaries presented in Chapter 5, users' needs range from simple accessibility

fixes, such as changing fonts and colors, to advanced adaptability options that include the options for “standard” and “simplified” views of library RDTs.

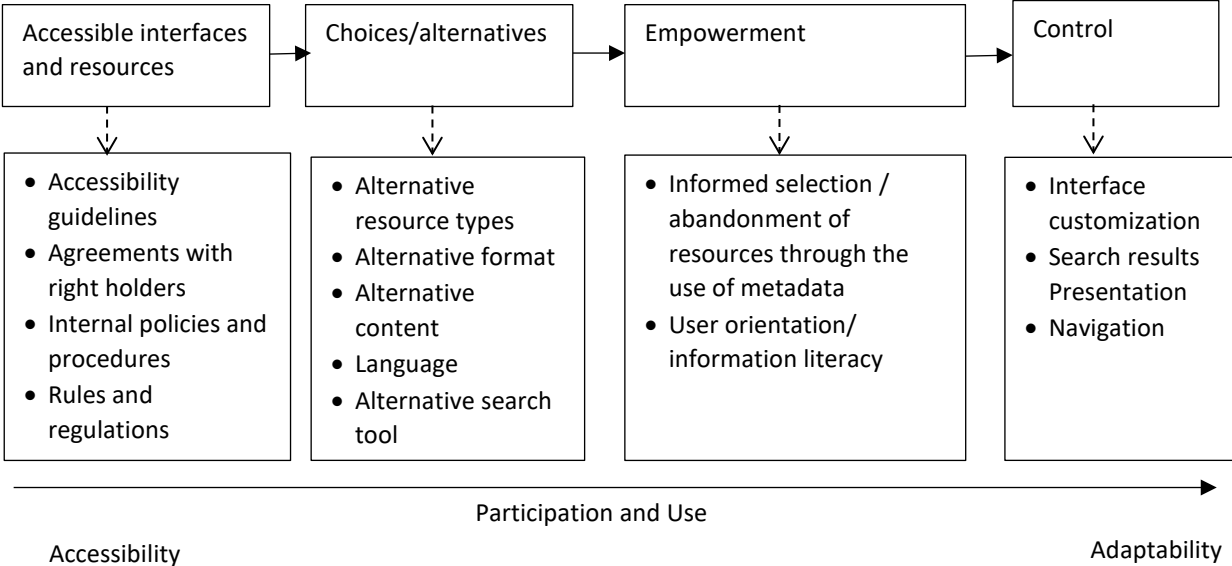


Fig. 8. A framework for inclusive and adaptable information services

Thus, a digital inclusion strategy may have to envisage adherence to accessibility guidelines just as a minimum requirement and gradually progress toward satisfying the needs of advanced and frequent users. Based on the analysis of the findings, this research has presented a framework (Fig 7) that can be used to plan and run inclusive and diversity-resilient information services. The framework includes the following components:

Accessible interfaces and resources: The first step could include designing websites and search interfaces according to established accessibility guidelines, developing in-house digital content that is accessible to screen reader users, negotiating with content providers or right holders to make resources accessible to screen reader users, and devising policy instruments to ensure universal design across processes and practices in the information environment.

Alternatives: A key concept in universal design is the concept of alternatives: alternative text, alternative format, alternative content, alternative ways for resource discovery, and so on (See Table 1). providing audio alternatives to text documents, preparing html, PDF, and EPUB alternatives to an article, and making resources discoverable via library RDTs as well as Internet search engines could be parts of the second step to incrementally improve access to information resources.

Empowerment: libraries give access to both accessible and inaccessible resources. A well-planned use of metadata could empower users to make informed selection or abandonment of resources. A well-planned use of metadata may save users time and energy as they search for resources that fit their needs. It may be impractical to expect that every digital resource could be accessible for persons with print disabilities. However, it is possible to inform users whether a resource is accessible or not (see Paper 5). This would involve augmenting the existing metadata schemas to handle description of resources by their accessibility attribute. The need for some accessibility-related metadata was reported in Papers 2, and 6. An application profile could be planned to handle the management and use of metadata. This, however, could be complicated since libraries are not responsible for the management of the digital content provided by online content providers. The other aspect of empowering users could relate to library orientations and information literacy programs.

Control: The results of this study and the literature reviewed showed differences in preferences even between people sharing similar impairments. For instance McCarthy & Swierenga, (2010) mentioned iconization or use of images instead of texts as appealing for users with dyslexia. The study by Berget and Sandnes (2015b) showed that replacing text with images on search interfaces may not present a special advantage for improving the information seeking performance of dyslexic users. Our study (Paper 1) has also shown differences of opinions between persons sharing the same disability: some like autofill suggestions, others are annoyed by them. Some may already have developed coping mechanisms which freed themselves from the limitations imposed by their impairments. To accommodate such varied needs, digital library environments may need to consider allowing their users to customize their search interfaces according to their needs and preferences.

Accessibility and usability options could be included in preference settings of RDTs. The preference settings may be designed to include options that allow users to customize search tools. Users may consider creating shortcuts to their favorite clusters of resources, specifying which metadata information should not be hidden behind view more/less toggles (see Papers 6 and 7), and customizing user interface elements. Previous studies have noted the challenge of addressing user's diversity. This research has also confirmed that it is not always productive to prescribe accessibility fixes based on disabilities. The discussion in section 2.3 has shown overlaps of accessibility needs, for instance, between users with dyslexia and low vision impairments. Studies referenced in section 1.5. have recommended customizable interfaces as

a solution to satisfy the diverse needs of the print-disabled users. Therefore, creating customizable search interfaces or RDTs could be thought as part of a strategy to ensure digital inclusion. In summary, digital library environments may consider developing a framework like Fig 7 to formulate a digital inclusion strategy that considers not only users' disabilities, but also the diversity of needs and the varying patterns of participation and use.

6.3. Rethinking Human- Technology-Information Relation from Inclusive Design Perspective

In digital library environments, users interact with librarians and/or search interfaces in their quest for information. This study showed that despite the introduction of anti-discrimination laws and accessibility guidelines, barriers remain. The framework introduced above could be a way to ensure universal access to digital content. The presence of access problems, however, would require reexamination of the broader context, that is, the role of technology in helping people access information. In this section, Verbeek's (2015) and Idhe's (2009) analyses of human–technology relationship are used to give an account of the context in which the solutions presented in Fig. 7 could be applied.

6.3.1. Approaches

Verbeek (2015) identified three approaches to human–technology relations: extension, dialectic, and hybrid. These approaches are utilized to interpret the state in digital library environments.

Extension: Approaching technologies in terms of extensions portrays them simply as tools or instruments. For instance, RDTs are tools for users to search and retrieve information. Accessibility guidelines enhance RDTs accessibility. Assistive technologies extend the capabilities of people with disabilities to use the tools. For example, screen readers decipher content for users with a print disability, screen magnifiers extend the visual perception of users with low vision impairment.

Dialectic: The dialectic relation refers to antagonistic relationships between users and technology. People with a disability may not like to use assistive technologies in public for fear of stigmatization (Seale, 2013). As discussed in Paper 1, some users would refuse to accept their limitations and prefer to find their ways to using any mainstream design as everybody else. Hence, designing an interface catering to their disability, such as a search interface with dark background and text with larger font sizes could be interpreted as emphasizing the user's disability.

Hybrid: According to Verbeek (2015), this approach is based on the weaknesses of the previous two approaches, that is, the oversimplification of the human–technology interaction. According to Verbeek, the above approaches locate humans and technologies in different spheres, which would result in the failure to understand the intertwined relationship between humans and technologies. The hybrid approach acknowledges that humans and technologies shape each other.

This thesis, especially Paper 1, showed that achieving accessibility is not as simple as tailoring solutions based on users’ disabilities. A dyslexic user who grew up using computers could develop coping mechanisms that others with a similar disability may lack. Visual cues could be clutters for users with visual impairments but could be appreciated by those with dyslexia. Some people with a visual impairment would prefer to have a simplified view of the RDT used in their library. That may also be preferred by others without disability. These examples indicate that accessibility in human–technology relation is too complex to be reduced to compliance with some norm of accessibility. Analyzing the relationship as done next could improve the understanding of such complex relationship.

6.3.2. User-technology-information mediation

The theory of technological mediation has three dimensions (Verbeek, 2015). The first deals with the types of relationships between humans, technology, and the world. That include Ihde’s (1990) four types of human-technology relationship discussed in section 3.1.2. The second deals with the identification of the points in applications where technologies influence humans. The points of contact are described as belonging to four zones around the human body: “to the hand,” “before the eye,” “behind the back,” and “above the head.” The third dimension is concerned with different types of influences technologies have on human actions. The influences are described as “hidden,” “apparent,” “weak,” and “strong.”

This paper utilized only the first dimension of the theory, i.e., types of relationships, to analyze the user-technology relationship in the context of digital library environments and to put the recommendation proposed in Fig. 7 into context.

Embodiment: According to Ihde (1990), this type of user–technology relationship is the condition in which the user’s experience is reshaped through technology, and the technology itself is taken “into the user’s bodily awareness”. (Rosenberger & Verbeek, 2015, p. 14). the analogy given for this type of relationship is the role of eyeglasses. Users experience aspects of

the embodiment relationship with digital resources in libraries. Some users rely on assistive devices (e.g., screen readers) to interact with a search interface. These technologies play the role of “eyeglasses” for some users to use search interfaces and subsequently access the digital content behind the interfaces. The performance of assistive technologies (and the embodiment relationship) could be affected by RDTs which have features users might not desire: faulty link descriptions, excessive links per search result, and related issues explored in this research. Accessibility guidelines could improve the embodiment relationship. For instance, WCAG 2.0 Guideline 1.1 recommends providing alternative text to non-text media. That would tell a screen reader whether a graphic is an illustration or a decoration to ignore. That way, search interfaces become less taxing.

A concept related to embodiment, which is introduced by Ihde (1990), is “transparency”. Transparency refers to “the degree to which a device (or an aspect of that device) fades into the background of a user’s awareness as it is used” (Rosenberger & Verbeek, 2015, p. 14). This concept could be related to human information interaction (HII), a term coined to stress that computers are just the means to reach to information (Jones et al., 2006). As elaborated by Jones et al. (2006), “Trends towards a ubiquity of computing, an increasing transparency of user interfaces and the overall integration of computing technologies into our everyday lives may push computers into the background as a basic service – like electricity or heating. If our computers disappear we are left with our information” (p. 66). This research described instances in which the user interface may “melt” in the background while users interact with information. As discussed in Paper 3, the UiO library was working on an e-book library that can be browsed with gestures. In such cases, the users see digital objects, such as e-books, select them, and flip through the pages using hand gestures. This functionality echoes the analogy of eyeglasses described above. As discussed in Paper 1, a user with low vision impairment recommended the addition of voice input capability to RDTs. The voice input enables the search interface to be more “transparent” and less “visible.” Improving the embodiment relation or transparency of interfaces could be regarded as part of improving accessibility of interfaces as depicted in Fig.7.

Hermeneutics: Ihde (1990) related hermeneutics to visual readouts and the user’s ability to “read” and understand the readout on the interface of the mediating technology (Rosenberger & Verbeek, 2015). Library search interfaces are not only “gates” to books and other resources. They are also sources of information about whether the material that users want is in the library, whether there are other related materials, whether a particular e-book is accessible to screen readers, and so on. Chapman (2007) said that rich metadata information could be beneficial for

people with visual impairment to make well-informed selections of resources. Stamou and Efthimiadis (2010) indicated that rich metadata presented with search results enables the accomplishment of some tasks without the need to click through the links (i.e., positive search abandonment). Thus, the embodiment type of relationship may not be desirable at times. The users may not want the interface to melt away or to be completely transparent. Users, at times, would want to be informed about a resource (eBook, journal article, etc.) in the results list. As depicted in Fig. 7, rich metadata may empower the user to make informed choice of resources.

The visual and aural cues on RDTs show whether a material, in a certain form, is available in a library. When users see an icon, they see the material the icon represents: book, e-book, audiobooks, etc. When they see a green icon next to a book title, they know that it is available. When they see a lock sign beside it, they know that the content is not accessible without a subscription. Users with dyslexia would prefer to quickly check the icons rather than read textual descriptions (See Paper 1). Those with a visual impairment would appreciate having an aural alternative to the visual cues.

Issues that affect the hermeneutic relationship include “faulty” language and its role in mistaken perceptions of a representation. Moreover, user’s failure to differentiate between an eBook and an audiobook, their unfamiliarity with the vocabulary used in librarians to annotate resources, their inability to understand what some icons stand for may affect the quality of the hermeneutic relation (see papers 1 and 4).

Improving the hermeneutic relationship could be complicated because of users’ diverse needs and preferences. Not all persons with print disability love icons or visual cues. Not all of them desire search results list inundated with metadata information. All of this has been shown in Papers 1, 6, and 7. A solution could be to give users control to customize search tools according to their needs (see Fig 7).

Alterity: According to Ihde (1990), alterity refers to the type of human–technology relation in which interfaces are designed to emulate the style of person-to-person relationship (Rosenberger & Verbeek, 2015). A typical example given was user’s interaction with ATM machines. As discussed by Morrone and Witt (2013), self-checking machines are being installed in libraries so that users borrow and return books without the involvement of librarians. This is one example of the replacement of the traditional user-librarian interaction by the user-machine interaction. In the digital setting, users interact with library RDTs to download, borrow, and reserve materials. This transaction involves some type of “dialog” in which users

input their request, and the system provides a results list. The user would opt to filter the search results and eventually access the resources that best serve his or her needs. This type of relationship could be taxing for some users with disabilities if they must go through excessive steps. Paper 6 discussed some solutions, such as shortening the path to a cluster of resources by providing a shortcut on the home page of search interfaces. Moreover, the possibility of inputting aural queries would facilitate the dialog between users and search interfaces (see Paper 1).

Background: Ihde (1990) described background relations as users' relationship with technologies that form the users' environmental context. The technologies may affect user's experience without the user directly interacting with them.

As users interact with a library RDT, design elements such as the interface's background and foreground color may affect their experience. For example, searching on an interface with a bright background color is painful for some print-disabled users (see Paper 1). A main problem with library RDTs is their complexity when compared to search tools such as Google. For instance, a participant of this research said that she prefers searching on Google because it is easy to use in high contrast when compared with library catalogs (see Paper 1). This shows that users' previous bad experiences with library search tools could positively or negatively affect impact their perception and usage of libraries.

There are some processes that run on the sidelines as users search on library RDTs. A search box may produce list of autofill or spelling suggestions when a user inputs queries. These suggestions may be liked by some and hated by others (see Paper 1). As users search, their search history may be processed to generate recommenders. Users with print disabilities would require those features to quickly find related materials (Paper 6). Such features could reduce the need for typing keywords, which some users struggle to spell correctly. Users who love reading novels may be interested to get recommenders containing list of new books. In general, the processes that run in the background could help or annoy a user. That too may require giving users control over the behavior of some background processes (see Papers 6 and 7).

The background relation in user-information interaction is also affected by the policies followed by libraries and content providers. Paper 3 showed that the largest share of digital services in the selected libraries was subscription-based. As discussed in Papers 1, 2, and 3, publishers employ DRMs which, inadvertently, block users of assistive technologies from

accessing an electronic content. Libraries that use proprietary RDTs have little control over the behavior of the tools. They also have a reduced role in description and organization of most of their digital resources. Such issues could be deemed “wicked problems,” which are difficult to solve without the involvement of other stakeholders.

In summary, one of the functions of libraries is to make their resources accessible to their users. That can be helped by the analysis of users’ relationship with libraries. In digital library environments, that relationship can be described in terms of resource discovery and access: users interact with library RDTs in search of an information resource. The foregoing postphenomenological analysis presented different aspects of that relationship such as the embodiment, hermeneutic, alterity and background relations. It also utilized the findings of this research to pinpoint where accessibility problems may happen. The problems may reside in the assistive technologies users use, in inaccessible documents, and in the context of use. The context of use includes the “background processes” which may be of technical or non-technical nature. The technical impediments may reside in the user interface elements users don’t directly interact with. The non-technical impediments manifest in policies, rules, practices, and procedures that are used in the procurement and management of information resources.

The accessibility/inclusion traditions discussed in section 2.3 (pp.23-35) have recommended solutions that can be grouped into two: conformance to laws/principles/guidelines and employment of an approach that matches resources with user’s needs and preferences. None of the approaches discounted the importance of accessibility guidelines. The argument was that the use of guidelines should be compounded with a more user-responsive approach. The data collected from the research participants has revealed some problems which can be fixed by accessibility guidelines. The data has also showed diversity in needs and preferences. Therefore, this research recommended an approach that has elements from both traditions and that emphasizes focus on user needs and the varying patterns of use. The postphenomenological analysis attempted to pinpoint areas where the proposed solution could be applicable in the wider context of user-library relationship.

6.4. Recommendations for Future Research

Future researchers could follow the theoretical and technical leads presented in this research. One direction could be to study the effects of barriers on users’ information behavior. There is a potential for information behavior research to support works related to universal design (Beyene and Byström, 2017). Another direction could be to build on the initial prototype

presented in this research to experiment the idea adaptable RDTs. Future research could also expand on the theoretical and practical accounts reported in this research.

6.5. Significance of the Research

This research is an important reminder to information workers that they should make their services inclusive of all users to the greatest extent possible. There is a trend of associating accessibility and universal design with the conformance to the WAI accessibility guidelines. The postphenomenological analysis presented in this study may help information workers to understand the scale and scope of user-information relation and identify areas that require intervention. The framework for inclusive and adaptable information services proposed in this study could also be applied for planning such interventions.

Libraries have a strong tradition of user-oriented collection development. This findings of this research should encourage them to plan user-oriented measures to ensure accessibility and inclusion. The findings could also encourage researchers and practitioners to go beyond user interfaces to examine the effects of knowledge acquisition, organization, and representation on the accessibility of information resources.

7. Conclusion

The purpose of this research was to identify the barriers of access to digital content in mainstream libraries and to explore how the advances in accessibility and universal design could be utilized to remove the barriers. The findings of this study showed that the barriers of access may relate to both individual and environmental factors. The personal barriers included the individual's bodily or non-bodily limitations, whereas the environmental barriers were attributed to the failure of libraries to provide accessible digital content and /or accessible search tools. The barriers were also interpreted as the indirect result of policy makers who influence the understandings of accessibility, inclusion and universal design.

Users have diverse needs and preferences which are not necessarily dictated by their bodily limitations. Users with similar disabilities can have different and contrasting preferences. Users' requirements may range from simple accessibility fixes to more advanced functionalities that enable them to control some search interface features, such as fonts, color schemes, and the presentation of search results. Users have different patterns of use of libraries, and their requirements may differ accordingly. Thus, designing for inclusion goes beyond removing barriers. It includes designing digital services that can be adaptable to the user's needs and preferences. Therefore, inclusive/universal design needs to incorporate strategies for addressing not only impairment-related needs, but also the diversity in needs and preferences.

Human-technology-information relation is complex. Thus, prescribing solutions in terms of conformance to accessibility guidelines would be oversimplification of the relationship. The postphenomenological analysis conducted at the end of the research showed the types of relations that can exist between an information seeker and a technology which mediates access to information. This knowledge could be used in diagnosing potential barriers in each type of relation, thus contributing to the inclusive design of digital library environments. The postphenomenological analysis done at the end not only describes barriers in user -information relationship, but also recommends an approach for removing barriers.

In conclusion, this research has contributed an approach for identifying the various sources of barriers of access to information, a framework for planning an inclusion information environment; and a theoretical analysis that may help not only to understand the wider context of human information interaction, but also to plan strategies for making it inclusive.

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Project Registration Confirmation (APPENDIX I)

Norsk samfunnsvitenskapelig datatjeneste AS

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Postboks 4 St. Olavs plass
0130 OSLO

Vår dato: 22.01.2016

Vår ref: 46354 / 3 / ASF

Deres dato:

Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 31.12.2015. Meldingen gjelder prosjektet:

46354	<i>Towards Inclusive and Adaptive Information Services in Digital Library Environments</i>
<i>Behandlingsansvarlig</i>	<i>Høgskolen i Oslo og Akershus, ved institusjonens øverste leder</i>
<i>Daglig ansvarlig</i>	<i>Wondwossen Beyene</i>

Etter gjennomgang av opplysninger gitt i meldeskjemaet og øvrig dokumentasjon, finner vi at prosjektet ikke medfører meldeplikt eller konsesjonsplikt etter personopplysningslovens §§ 31 og 33.

Dersom prosjektopplegget endres i forhold til de opplysninger som ligger til grunn for vår vurdering, skal prosjektet meldes på nytt. Endringsmeldinger gis via et eget skjema, <http://www.nsd.uib.no/personvern/meldeplikt/skjema.html>.

Vedlagt følger vår begrunnelse for hvorfor prosjektet ikke er meldepliktig.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Amalie Statland Fantoft

Kontaktperson: Amalie Statland Fantoft tlf: 55 58 36 41

Vedlegg: Prosjektvurdering

Dokumentet er elektronisk produsert og godkjent ved NSDs rutiner for elektronisk godkjenning.

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Personvernombudet for forskning



Prosjektvurdering - Kommentar

Prosjektnr: 46354

Based on the information you have given us about the project, the Data Protection Official cannot see that your project will entail a processing of personal data by electronic means, or an establishment of a manual personal data filing system containing sensitive data. Therefore, the project will not be subject to notification according to the Personal Data Act.

You have informed us that you will do a situated interview where the informants are asked to demonstrate how they search for a resource using any library searching tool they normally use. Also, you have notified us that you will use audio recording device to record the conversation during the interview and take notes as the informants interact with the search tools. The Data Protection Official presupposes that all information processed using electronic equipment in the project is anonymous.

Anonymous information is defined as information that cannot identify individuals in the data set in any of the following ways:

- directly, through uniquely identifiable characteristic (such as name, social security number, email address, etc.)

- indirectly, through a combination of background variables (such as residence/institution, gender, age, etc.)
- through a list of names referring to an encryption formula or code, or
- through recognizable faces on photographs or video recordings.

Furthermore, the Data Protection Official presupposes that names and consent forms are not linked to sensitive personal data.

Consent Form for User Participants (APPENDIX II)

APPENDIX II: Consent form for user participants (Papers 1 and 2)

Request for participation in research project Toward Adaptable and Inclusive Information Services in Digital Library Environments

Background and Purpose

This PhD project envisions identification and dismantling of barriers that exclude people with different types of impairments from mainstream information services, in light of anti-discrimination laws and advances in universal design. One of the research tasks is to study users experience in searching and finding materials suitable for their needs, identify the problems they faced in the process, and present recommendations for improving the search tools/catalogs.

You are requested to participate believing your perspective as a user and your experience of using library services would provide much valuable input for accomplishment of the research's objectives

What does participation in the project imply?

Situated interview will be the method of data collection. The questions include how often you use electronic library services, how you perform searches and which tools (catalogs) you use, what problems you experienced while conducting search, what problems you encountered after retrieving the resource to use it, what discourages from using library search tools and what you think would improve them. It would also involve observing you while you perform some searches. The conversation will be recorded with audio recorder. The overall process takes up to 60 minutes.

What will happen to the information about you?

All data will be treated confidentially. The collected data will be accessed only by the researcher. Identity of the participants will remain anonymous. This phase of the project is scheduled for completion by April 30/2016. The recording will be deleted after the project completion.

Voluntary participation

It is voluntary to participate in the project, and you can at any time choose to withdraw your consent without stating any reason. If you have any questions concerning the project, please contact Wondwossen Beyene, cell no. 48661880

The study has been notified to the Data Protection Official for Research, Norwegian Social Science Data Services (Project Number 46354)

Researcher: Wondwossen Beyene _____ Date _____

Consent for participation in the study

I have received information about the project and am willing to participate

(Signed by participant, date)

Consent Form for User Participants (APPENDIX III)

APPENDIX III Consent form for Participants (prototype testing)

Hello participant,

Thank you so much for agreeing to participate in this user study! The purpose of this study is to show whether granting users control of the presentation level will improve accessibility of search interfaces. What this means is that we wish to give you, the participant, the possibility to alter settings on the prototype website that will allow you to choose what sort of filters you would like to use on the site. In future iterations of this prototype, it is also possible that we will include settings that will allow you to alter colors (such as text and background colors, to create the contrast you want) and what kind of text, or how big it is, you would want. This is to test if this is an approach that would make search interfaces in general more accessible to users without the need for assistive technology.

What we need from you:

We will gather some basic personal information (age, occupation and information about any impairments you might have). We will also ask you about your experience with the user test, and about your other experiences with some sites. You should feel free to respond in any way you wish, as everything you say and mean is of importance, and there are no “wrong answers” to any of the questions. The data gathered will be anonymised if it is not already anonymous, and it will also be encrypted. When the data is successfully analyzed and the project has been completed, the data will be safely and securely deleted. We will not share this data, or your personal information, nor contact information or participation in this subject with any other party.

You can of course choose whether you wish to answer these questions or not, and should you at any point regret your decision to answer, you can withdraw your consent at a moment’s notice by informing us. We will then proceed to delete any data gathered from you, and you will be thanked for your participation. There will be no repercussions towards you as a result of this.

We would also like to record the audio of the user test, purely for transcribing it later, thus allowing the researcher to focus entirely on the user test.

I consent to the following:

- Gathering of information
- The recording of audio during the user test
- I have fully read and understood this form
- I am aware that I can at any time retract my consent and that there will be no repercussion for doing so.

Date

Sign. participant

Sign. researcher

Consent form for Librarians (APPENDIX IV)

APPENDIX IV: Consent form for librarian participants

Request for participation in research project

Background and Purpose

This PhD project envisions identification and dismantling of barriers that exclude people with disabilities from mainstream information services, in light of anti-discrimination laws and advances in universal design. One of the research tasks is to study the present scenario of digital services in libraries (and also associated tasks of indexing/cataloging) and see how they are built/can be built to accommodate the needs of potential users with print-related impairments.

We would highly appreciate your participation believing that your perspective and experience as a person involved in digital services would provide much valuable input for accomplishment of the research objectives.

What does participation in the project imply?

Semi structured interview will be the main type of data collection method. The questions are related to digital services available through your library, the nature of the collection, users and users with impairments, digital documents and related copyright and accessibility issues, and resource discovery tools. The conversation will be recorded with audio recorder. The overall process takes from 30 to 60 minutes.

What will happen to the information about you?

All data will be treated confidentially. The collected data will be accessed only by the researcher. Identity of the participants will not be recognizable in the publication. This phase of the project is scheduled for completion by February 29/2016. The collected data will be deleted after the project completion

Voluntary participation

It is voluntary to participate in the project, and you can at any time choose to withdraw your consent without stating any reason. If you have any questions concerning the project, please contact Wondwossen Beyene, cell no. 48661880

The study has been notified to the Data Protection Official for Research, Norwegian Social Science Data Services. (Project Number 46354)

Researcher: Wondwossen Beyene

Date:

Consent for participation in the study

I have received information about the project and am willing to participate

(Signed by participant, date)

Papers

Paper 1

Beyene, W. (2016). Resource discovery and universal access: understanding enablers and barriers from the user perspective. *Studies in Health Technology and Informatics*, 229, 556–566. IOS Press. Retrieved from <https://doi.org/10.3233/978-1-61499-684-2-556>

Resource Discovery and Universal Access: Understanding Enablers and Barriers from the User Perspective

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Abstract. Resource discovery tools are keys to explore, find, and retrieve resources from multitudes of collections hosted by library and information systems. Modern resource discovery tools provide facet-rich interfaces that provide multiple alternatives to expose resources for their potential users and help them navigate to the resources they need. This paper examines one of those tools from the perspective of universal access, utilizing the experience of users with print disability. It aimed at exploring the way print disabled users use library search tools, the barriers they might face in the process, and what needs to be considered in order to implement discovery tools that incorporate the needs of users with print disability. Interviews that involved user testing were made with selected group of users. The data obtained in the process was analyzed and compared against the existing body of knowledge to forward design recommendations for future endeavors.

Keywords. Universal Design, inclusive design, library accessibility, resource discovery tools, digital library accessibility

1. Introduction

The right to seek receive and access information is enshrined as a human right by Article 19 of the Universal Declaration of Human rights². Moreover, Article 9 of the United Nations (UN) Convention on the Rights of Persons with Disabilities³ requires state parties to “*Promote appropriate forms of assistance and support to persons with disabilities to ensure their access to information*”. Beside such international conventions and country specific anti-discrimination laws, the long-standing tradition of libraries and their commitment to equally serving their communities [1] provides them the rationale for incorporating the needs of people with disabilities in their day-to-day activities.

The goal of Universal Design, also called inclusive design, is to ultimately ensure that all content is designed to be accessible to all to the possible extent [2]. However, the reality in libraries is that they collect and organize resources in various formats targeting the needs of various groups of users. Resources may be accessible for some

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² <http://www.un.org/en/universal-declaration-human-rights/>

³ <http://www.un.org/disabilities/convention/conventionfull.shtml>

but inaccessible for others. The discoverability of the right resource by the right person is determined by the quality of the discovery tools used.

This study aimed at identifying issues that need to be addressed for implementing inclusive resource discovery tools (RDTs) taking the case of Oria, a Primo-based discovery tool implemented in Norwegian academic and research libraries, and users with print disability. The term “print disability” is generally understood as the difficulty associated with effectively utilizing print text due to visual impairment, physical disabilities, and some forms of learning disabilities^{4,5}. This paper considers universal design as *user sensitive* design [3] and attempts to present perspectives from real users. Therefore, it attempted answering the following main questions: how do people with print disability search library contents? What are the enabling and disabling factors they face in the process? How can their experience be taken to inform design of inclusive RDTs? To answer the questions, qualitative study that involved task-based interviews and observations with ten participants (four with low vision impairment and six with dyslexia) was conducted.

The rest of the paper is organized as follows: review of related works is presented next, followed by explanation of the research design and the methodology used. Then follow results and discussions of the findings. Finally, the paper closes with the conclusion section.

2. Literature Review

Since the introduction of online catalogs, there have been notable efforts to expose library materials to their potential users through provision of searching options by author, title, subject (topic) and other bibliographic information. Serendipitous features like “those who have read this also read...” incorporated on some library catalogs [4, 5] and features for faceted browsing [6, 7] have been some of the developments.

Libraries are increasingly adopting RDTs to provide single point of access to all materials in their holdings as well as digital archives, eBooks, and subscription databases [8]. Those RDTs are dubbed as the “new generation catalogs” libraries use to make their collections discoverable and accessible to the communities they serve [6, 7] with presumed advantage of richer, intuitive, and more improved user experience [9]. They simply can be understood as search engines of libraries though they may fail to cover all online resources, as they tend to rely on metadata taken from vendor-supplied databases [8]. RDTs have different components depending whether they are proprietary or built in-house. List of commonly known commercial tools include Primo from Ex Libris group, EBSCO Discovery Service from EBSCO Information Services, Summon® from ProQuest and WorldCat® Discovery Service from OCLC® [6]. These tools include features such as relevance-ranked keyword search results, facet metadata, tag cloud, and other features that help to enhance browsing, searching and filtering of search results [10]. The development of those tools is said to have leveraged best practices of successful websites such as Google and Amazon including user behaviors that are “assumed to have developed using those same sites”, in order to provide better user experience than that can be offered by traditional web based library catalogs [9].

⁴ <https://www.ahead.org/resources/e-text/position-statement>

⁵ <http://printdisability.org/>

There have been studies that looked into usability and related issues of these tools. A usability test done on Primo discovery system showed that the search interface posed challenges for new and inexperienced users [11]. New users would need time to get acquainted with the way resources are presented in the result list, the terminologies used to describe resource types, and the mechanisms put for filtering search results. Another study made on EBSCO Discovery Service [12] also identified some issues. One of the problems was the inconsistency in the use of icons which led participants to confuse material types. For instance, it was mentioned that participants mistook book reviews for books or periodicals for academic journals. The other problems mentioned were spelling errors, participants' failure to use spelling suggestions the system provides during and after search, and their unwillingness to go past the first page of the results. A study that explored challenges faced by libraries using RDT presented an array of problems including incomplete coverage of resources, difficulties in managing addition or removal of titles, reliance on metadata from external resources and the inconsistency observed in the metadata, non-standardized assignment of ISBN codes, etc. [8].

There have also been works aimed at augmenting library catalogs to suit the needs of people with disabilities. For instance, there has been a suggestion that users with visual impairment could be helped if the search results come along with more information [13]. For instance, a user with visual impairment would like to know whether an item is a book or an audio alternative, whether it is a tactile map or regular map, etc. Therefore, if a search tool could provide more information per hit such as summaries, target audience information, filters by format, genre, etc., that would help visually impaired users to know whether a material could be accessible or suitable for them [13]. It has been also noted that users with dyslexia would benefit if resources are described by their reading level or intended audience for that would help them to easily discover materials suitable for them [14]. Studies show that there are search goals which are met by search results without the need of clicking through them (positive abandonment), showing contents or snippets displayed with search results have the potential of addressing some of the information needs of the user [15]. A research that examined the searching experience of students with a print disability on three proprietary databases identified barriers such as erroneous formulation of Boolean search; inaccessible, untagged or image-based PDFs; unreadable links and too many links [16]. It was mentioned that those "rich" links were in fact impediments for the participants. A study that addressed the effect of dyslexia on information searching behavior on a university library catalog [17] showed that dyslexic users struggle if search tools are not error tolerant or don't include query building aids. The researchers recommended search systems to incorporate spelling suggestions, tolerate errors, provide feedback for queries that don't have match, allow users to replace difficult terms, and incorporate autocomplete feature.

In conclusion, the studies discussed so far show that designing inclusive library resource discovery tools presents a multifaceted challenge that requires addressing not only interface design issues, but also others including presentation of results, resource description and related matters. Our study aimed at building upon those previous works. The following section provides explanation of the methodology used in the study.

3. Methodology

The “crucial source of evidence” for the experience of people with impairments in relation to their participation in some activity is their views and opinions [18]. This research therefore aimed at offering the ‘voice’ of end-users a place in evaluating or shaping designs of information systems. Therefore, qualitative methodology that involved task-based interviews and observations was chosen for the study.

The study aimed at including as much user experience as possible. Therefore, effort was made to purposefully select participants who could have used different library systems and who would contribute much information. Therefore, the Norwegian Library of Braille and Talking Books (NLB) were contacted to help recruit some from their members. In addition to that, the cooperation was sought from university admission offices. Finally ten participants, four with low vision and seven with dyslexia, were included in the study. All but one of the participants were female. The age range was between 21 to 51. Seven of them were university students, one of them was a recent master’s graduate and the rest two were employees at different institutions. The respondents were briefed about the intent of the research and all of them have given informed consent to participate in the study.

At first, the participants were asked more general questions on their disability, their use of technology, their use of library services and other relevant questions. Then they were asked to perform selected searching and browsing tasks on Oria and express their experiences in terms of what they liked, what was difficult for them, and what they would like to see changed to make the discovery tool more user friendly. The respondents used their own devices and they were contacted at their place of choosing, including their houses. The tasks were presented to them one by one and they were encouraged to think aloud in the process. They were being observed as they worked on the tasks and notes were being taken. The design of the interview guide was inspired by studies that utilized the International Classification of Functioning, Disability and health (ICF) as a framework for interpreting barriers and inclusion [18, 19]. The ICF links the biological and social conceptualizations of disability and offers vocabularies for people with disabilities to describe their lives in terms of participation and potential barriers for inclusion [18]. The interview questions before, during, and after the tasks were formulated using ICF as a framework and revolved around issues such as participant’s use of library search tools, what frustrates them (barriers) and what would remove those barriers (enablers). The data collected in this manner was transcribed, coded, and analyzed to present answers to the research questions.

4. Results

Participants were asked to perform searching and browsing tasks on Oria and explain features they liked and features that made their tasks difficult. As shown in Fig. 1, Oria incorporates different features including the search box, search refining /filtering options in the left pane, and the area to display search results. For each title in the search result, information on the resource such as title, author, material type (presented with icons or thumbnails with labels describing the material type), availability (online or in the physical library) etc. is available. Moreover, links to read online and/or to locate in a physical library are included.

Most (six) of the respondents were from the University of Oslo. Therefore, the activities were carried out via the university's library website.

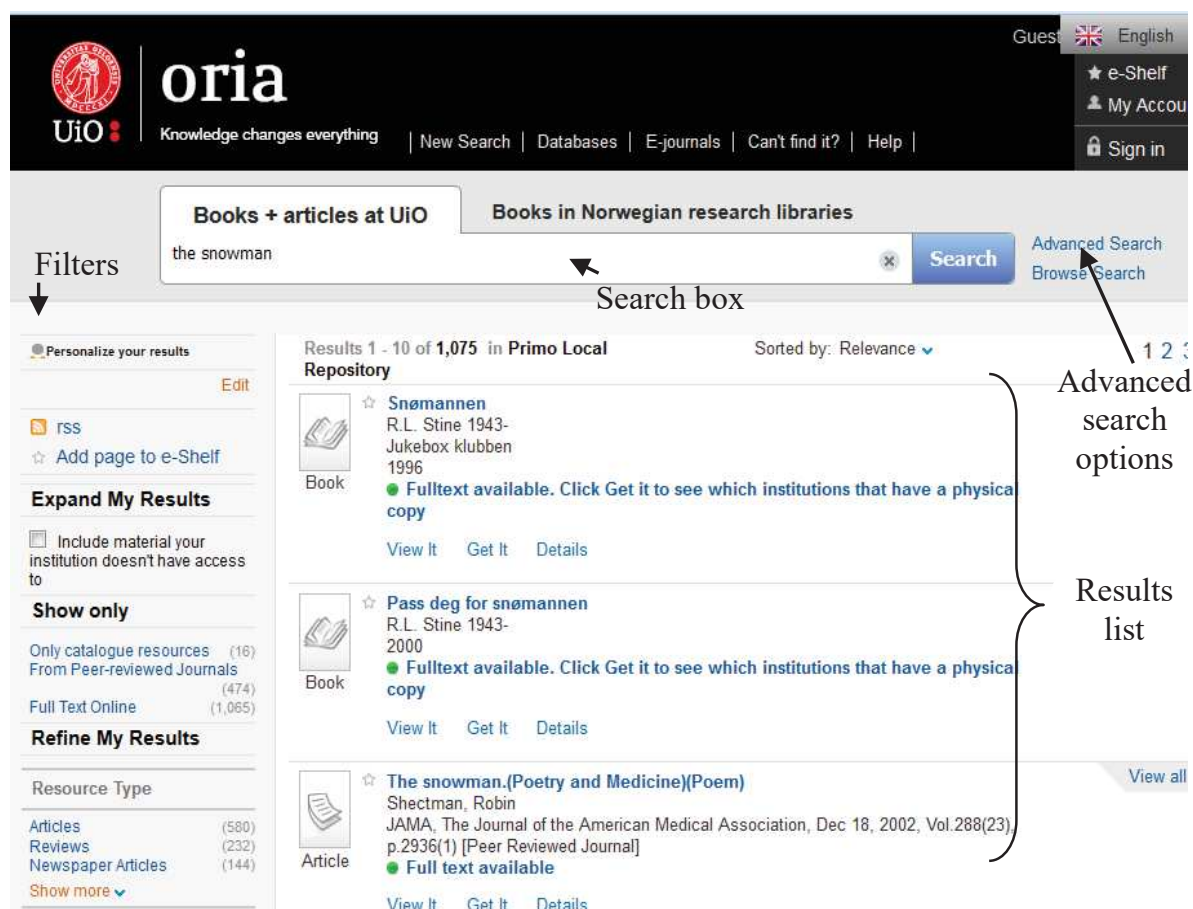


Figure 1. The Oria discovery tool as implemented by University of Oslo library

The primary purpose of the exercise was to give the participants a chance to explore the search tool so that they can speak about enabling or disabling elements of the discovery tool and secondly, to observe some of the difficulties they face. Literature on library search tools show that users primarily perform searching and browsing tasks: the searching tasks involving searching for specific resources by author or by title while browsing conducted with keywords or subject headings [20, 21]. Therefore, four tasks that involve searching and browsing tasks were presented to the participants.

Table 1. Searching and browsing tasks

Task 1. Check if the library has the book <i>The Snowman</i> written by Jo Nesbø. See if there are Norwegian and English versions
Task 2. Search for an ebook on business ethics. Try to open one of them for reading
Task 3. Is there any audio book for a book “ <i>The Count of Monte Cristo</i> ”?
Task 4. Find some recent journal article on universal design of ICT

All of the users were able to perform the first task though users with JAWS had difficulty at the beginning to find the search box because, at the beginning, they were using the library homepage where there were two search boxes. The one at the top is

for searching within the website while the other down around the middle was for searching in the library. Seven of the respondents typed the title “the snow man” with some of them typing it in Norwegian “Snømannen”. In either of the cases, the search result presented both the English and Norwegian titles related to the work. One of the respondents chose to search by author’s name saying that would be the fastest way to find versions of works by the same author. Two other respondents typed the author name and the book title together in the search box. In all of the cases, the respondents navigated from the search box to the first page of the results list to decide whether the item is present or not. One of the JAWS users used the voice over functionality to have the results read out for her while the other one asked the researcher to read out the results for him.

The second task required participants to search an eBook and try opening it for reading. Six of them typed the keyword and begun to inspect the results list. They took the link “full text available” as a hint for the material being an eBook and clicked on it, which, in some cases, took them to the publishers’ site. It was noted that some respondents confused ebooks and articles. One JAWS user tried to use advanced search options to limit the result list to eBooks but JAWS couldn’t show her the advanced search boxes. She said such inconsistency is usual with JAWS as, at times, it fails to recognize some parts of a page. She had to quit the task. The other participant using the same screen reader also quit the task saying, “*This is not designed for me*”. He said he was usually assisted by librarians when he searches for materials and this task was too complicated for him. Three of the respondents used the filters to narrow the results to ebooks, and then clicked the “full text available” link which took them to publishers’ websites. One of them was assisted to locate the filters.

There were some reactions from the participants in relation to the second activity. Three of the participants with dyslexia said there is too much information included under each search result and too many links to reach to the publishers’ site. One of them clicked the *Details* tab and said of the information there, “*I don’t need all this information to read this book*”. One of them spoke of the navigation and said it makes her unsure as the number of navigations increases. She said, “*too many steps make me unsure, and take a lot of time. I don’t often have that much time.*” Three of the respondents (two low vision, one dyslexia) said the text is too small to read. One respondent said she expected a pdf to show up underneath the “fulltext available” link, not to navigate to somewhere else. Two of the visually impaired participants using JAWS didn’t complete the task. Three respondents said they expected to find the filters underneath the search box, as it is with other library catalogs they are familiar with.

For the third task, six participants used filters to narrow search results for the audio versions related to the title but most of them required assistance in locating the audio filter option. Oria shows some of the filters while hiding the others under the “show more” link. Two participants tried full text search typing “Count of Monte Cristo audio” and the system was able provide audio books at the top of search results. It was noted that the expression “audio file” was added among titles presented at the top. One of the JAWS users tried to navigate using link lists generated by the software but was not able to complete the task. JAWS generated numerous link lists and some of them were labeled as 1,2, 3, without proper link labels. She was able to see a link labeled “material type” but couldn’t locate the one for filtering audio. She saw multiple links labeled as “view more” and asked, “*View more of what?*” The problem with JAWS as she said is that it picks every link on the page and every link is taken out of its context. Her comment was “*you have to be stubborn to use it, I rather ask someone because*

that is a more effective way to find the material". The other respondent using this tool didn't perform this task at all. Some participants were observed confusing audio books for ebooks and audio books for text-to-speech enabled PDF documents.

For the last task that required users to browse recent journal articles, two of them typed "universal design of ICT" and used the date and the material type filters for narrowing the search result to articles. Two of them typed "universal design of ICT, article", four others used the filter to narrow the result to articles and inspect the list for the dates to see which one might be recent. Participants with JAWS didn't perform this task. One of them made an effort to navigate to advanced search options, which at this time JAWS was able to recognize. At this point, she asked the difference between filters and advanced search options. She was later frustrated by the number of search boxes presented for advanced search and quit the task. It was noted that the participants were gradually getting more familiarized with the system as they work on the tasks.

After the completion of the search tasks, the participants were asked to express their experience regarding what they liked, what frustrated them, and what they think should be done so that the tool can incorporate their needs. As shown below, features liked by respondents have been presented as enablers while those posing challenges have been presented as barriers.

4.1. Users Opinion

4.1.1. Enablers

The first question respondents were asked after completing the tasks was on what they liked of the system. The respondents with dyslexia mentioned the thumbnails and icons which are shown among titles in the result list. Icons and thumbnails are used in Oria to show the material type of a title. Moreover, icons are used to show availability of resources either online or in the physical library with green color showing availability and yellow showing unavailability. Experienced users can combine the icons to quickly check whether a material is available for access. However, two of the respondents with dyslexia commented that there is inconsistency in the use of those images as some titles come up with thumbnails of cover pages while others come up with gray icons. Three of them mentioned other libraries they browse (two of them citing NLB) and said those libraries set a good example on consistent use of icons. The other feature favored by the respondents was the possibility offered for performing searches by author, title, keyword, or full text using a single search box.

4.1.2. Barriers

Participants were asked to reflect on the difficulties they faced while working on the tasks. Their responses were mostly repetitions of their reactions during the activities. Their responses are categorized and presented in the following manner.

Interface Design: Five of the respondents said there is too much on the interface. One of them said the links are too compact which creates a possibility of jumping lines and clicking wrong links. All but two participants commented that fonts are too small and difficult to read. A participant with low-vision impairment who cannot read unless in high contrast said the fonts have weak intensity which makes them harder for her to read. The two JAWS users were at first confused because there were two search boxes at the home page of the library search interface. The one at the top was for searching within the website while the second one was for searching within the library.

There is a lengthy list of filtering options on the left side. Though some in each category are hidden with “view more” links, one participant said the need of scrolling down to look at more options discourages her from using that part of the interface. The other problem noted with filters is that they don’t allow selection of multiple filtering options on the first page. Two respondents noted the difficulty posed to “unfilter” the search results. Once a filter is performed, Oria takes that out of the filters list and puts it at the top of the results list with a label “refined by:”. The x button there must be clicked to unfilter the results and see the filter back at its normal place. The respondents said that is not convenient.

The other complaint was on the number of clicks it takes to get an electronic resource, which makes some of them uncertain and feel that they are wasting time. A respondent said she expected a PDF to show up underneath the “full text available” link, not another link to navigate to somewhere else. Poor or faulty link descriptions are also mentioned as problems affecting those depend on JAWS for navigation.

When the interface is viewed in high contrast, the upper part of the page containing menus and logo of the discovery tool turns to white. A respondent with visual impairment and who can not read unless in high contrast said “*it painful for me. I cannot change it. It is very uncomfortable for me because it is like the sun on my face. I don’t know how to avoid it. I just prefer just to go to Google again because everything can be black there*”. The same respondent said she cannot see the book icons because they will become unrecognizable in high contrast. She added, though, the presence of alternative text for the icons helps to recognize what they stand for. Two respondents with dyslexia noted the color similarity between the titles, their links, and their status descriptors which might confuse some users. They suggested the color of the titles to be different from others details of the title.

Search Results Presentation. Most of the respondents said there is too much information per title. However one respondent hinted lack of “important” information. She said she uses kindle books and there, there are descriptions on whether a book is text-to-speech enabled. She said she missed that information on Oria. She added that that could have helped her to save her time from trying inaccessible PDFs. There were two incidents where participants clicked the “Full text available” links but the resources were not available. There have been comments regarding the yellow highlights seen in the in the results list. A participant with dyslexia said she does not like those highlights because they distract her. Another participant with the same impairment said she likes the yellow highlights because they help her to quickly see whether what she is looking for is available.

Lack of Spell-check and search suggestions: the other problem mentioned the by majority of the respondents, especially by the dyslectic respondents, was the lack of those functionalities on Oria. A respondent with visual impairment explained her experience on other library catalogs and said, “*Whenever I am not sure of what I want, I type the first two or three letters in the search box and see if something interesting comes along the drop down suggestions*”. However, another respondent with the same impairment said the search suggestions would be annoying if they cannot be read correctly by screen reader software.

Users’ perception: The interviews and the experiments show that one of the factors excluding users with print disability is their own perception of library search tools. While working on task 1 mentioned in table 1 above, one of the respondents thought of using advanced search because she was “*not confident enough on this system to write author and title together*” in the search box. A respondent with visual

impairment tried to solve the same problem by typing the title of the book and then check the search results. When he was asked what he normally does, he went to Google and typed both author name and title of the book together.

User devices: The difficulties faced by the two JAWS users indicate that problems could be related to the technologies used by users. One of them explained that there are times JAWS fail to work properly. That was noted during the user testing session. She said that she uses the combination of assistive devices including JAWS, braille display, speech synthesis, and screen magnifier and guessed perhaps that mix makes the system busy.

4.1.3. Recommendations

The last question the respondents were asked was on what they think would make Oria appealing for users with print disabilities. Some of the comments were directed at the search interface. A respondent with visual impairment suggested Oria would be accessible and usable to all if it emulates Gmail by providing standard and basic html views saying, “*The standard view will be good for you, the html view will be suitable for me*”. He also recommended voice input technology to be added to aid search. The other respondent commented the filters can emulate finn.no. to make them collapsible and expandable and also enable selection of multiple filtering options. There were also recommendations regarding presentation of search results. Two of the respondents described the need for a filtering option by file types (PDF, HTML, etc.) or presenting alternative formats available for each resource. Gutenberg Digital Library and JSTOR were mentioned as possible inspirations on how to present search results in that manner. There was also a suggestion to present search results sorted by material type.

5. Discussion

This study aimed at identifying issues that need to be addressed while implementing RDTs which could be inclusive of the needs of people with disabilities. It took the case of Oria and the experience of people with print disability and asked: how do people with print disability search library contents? What are the enabling and disabling factors they face in the process? How can their experience be taken to inform design of inclusive RDTs? The overall analysis shows that users with print disability use author, title or keywords like anyone else while searching for a resource. However, they have needs that RDTs have to accommodate in order to enhance their experience. That can be done by focusing on the following themes that stood out in the course of the study.

5.1. Simplicity and Minimal Effort

The overall study shows that users with print disability prefer if RDTs offer them the simplicity to get what they want with minimal effort. It was observed that participants prefer if their activities are limited between the search box and the results list. In sessions that involved searching resources by material type (audio, article, etc.), The pattern observed among the participants with dyslexia was that, after they typed in their queries, they quickly go to the results list and check for the thumbnail(icon) of the media type they were asked to look for. Then they check the titles. They were mostly reluctant to use filters.

The participants showed their preference if each title in the result list includes information on availability of alternative content (PDF, HTML, etc.). That would help them to know whether that title is available in formats suitable for them.

It was possible to observe full text search formulations incorporating descriptions of material types. That can be seen as the users' desire to get materials quickly without the need of using the filter options. As explained in the above section, there were occasions where titles incorporating labels such as 'audio file', 'brief article', etc. coming at the top of the results list, depending on the formulation of the query. However, the results (number of hits) were different when done using the search filters. That would lead to say that, if annotation by material type is done consistently to all of the resources, that could enable users to perform faceted search as they type in the search box. The study also confirmed that automatic search and spelling suggestions could provide the simplicity users want while searching for a resource.

There is a hint for the need of accessibility-related information, for instance, on whether an ebook/pdf file is accessible for text-to-speech tools. The overall essence is to make search interfaces more informative and to save time of users. This confirms previous studies that indicated search tools could help to address some information needs without the need for clicking through. However, it is also noted that "too much information" would frustrate some users.

The studies reviewed in this paper as well as this study have highlighted the importance of icons in simplifying information search if used properly. Studies have shown that inconsistent use of icons would confuse users and lead them to confuse material types. This study also confirmed that if used consistently, icons could help in simplifying resource discovery and access.

The type of problem faced by JAWS users demonstrates the difficulty posed by poor or faulty link descriptions. Links need labels that describe their function. It was however possible to note that too much links per page increase navigational strain for people using screen reader software. Addressing this and other issues mentioned above would contribute to offering users the simplicity they desire.

5.2. Needs and Preferences

The study showed that it might perhaps be unproductive to profile users by their disabilities. Two users with similar impairment would have opposing preferences on the same thing. Some users like icons, the others see them as clutters. There are different color, font, etc. preferences. This shows that RDTs need to have features that capture user needs and preferences and provide adaptations in terms of display and content presentation.

6. Conclusion

Library discovery tools are gateways to the wealth of content hosted by libraries for their diverse groups of users. As noted in related works and as confirmed in this study, their implementation should be sensitive to the needs of users with disabilities. This paper attempted to present users' perspective on barriers people with print disability might face while using library discovery tools. The findings from this study show that RDTs need to be designed emphasizing simplicity and flexibility for addressing the needs of various groups of users. The paper discussed issues related to searching,

search results presentation, resource description, use of icons, fonts, etc. to raise points that could be important to inform better design of RDTs to suit the needs of people with disabilities. As part of further work, investigating features of commercial or in-house developed RDTs and their potentials in managing user needs and preferences would be an area worth exploring.

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Paper 2

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Digital Inclusion in Library Context: A Perspective from Users with Print Disability

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ABSTRACT

Digital inclusion is a strategy pursued to foster social inclusion of those who have been sidelined from the mainstream of information society due to lack of access to digital technologies and the skills to use them. Libraries have been working to close the gap by providing access to computers, the Internet, digital content, and digital literacy programs. However, research reveals a new type of divide where digitally competent people could be digitally excluded. This shows the need for a better conceptualization of access and literacy. This paper commits to exploring the concept of access to digital content from the perspective of people with print disability. It involved in-depth interviews with ten participants with print disability where the International Classification of Functioning, Disability, and Health was used as a framework for data analysis. The overall analysis shows that digital inclusion would be more meaningful if it involved providing content in alternative formats and empowering users to make informed choices. Issues such as flexibility and adaptability in content presentation and design of content discovery tools are among those discussed.

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Introduction

Universal access of information envisages the accessibility and usability of information resources to all regardless of their dis/abilities, social status, gender, age, context, etc. (Queirós et al. 2015; Stephanidis and Savidis 2001). Its ideals are enshrined in international treaties and conventions as well as country-specific anti-discrimination laws. For instance, the United Nations Declaration of Human Rights frames access to information as part of human rights.¹ The UN Convention on the Rights of Persons with Disabilities (CRPD) demands state parties provide appropriate forms of assistance to people with disabilities to ensure their access to information.² Similarly, the Marrakesh Treaty to Facilitate Access to Published Works for Persons who are Blind, Visually Impaired, or otherwise Print Disabled

(Marrakesh Treaty)³ requires state parties to take measures for ensuring production and distribution of published works in accessible formats. Moreover, the Americans with Disabilities Act (ADA) and other country-specific anti-discrimination laws aim to ensure the equality of people with disability in many aspects of societal life (Bertot and Jaeger 2015; Beyene 2016b).

Libraries have a long record of working for all-inclusive information services. This service ethic can be exemplified by their longstanding tradition of acquiring audio and braille books for the benefit of users with visual impairments long before the introduction of antidiscrimination laws (Bertot and Jaeger 2015). The emergence of special libraries dedicated to serving people with print disabilities promoted the notion of special service (Bonnici et al. 2015; Brazier 2007; Kavanagh 2005), which seemed to contradict the ideals of inclusive service. Therefore, there have been debates on the need of maintaining specialized libraries rather than transforming the mainstream ones to be more inclusive (Brazier 2007). However, the advent of digital technology and the production of information in electronic formats, coupled with the introduction of accessibility guidelines, have created a favorable ground for pursuing the ideals of all-inclusive information services (Beyene 2016b; Lazar et al. 2014).

Digital inclusion is not a new concept to libraries—they have been working as “digital inclusion and social inclusion actors” or “eInclusion intermediaries” along with others such as public Internet access points, non-governmental organizations, and social workers (Misuraca, Centeno, and Torrecillas 2014). Libraries’ key roles include providing public access to computers, Internet connectivity, digital content, and digital literacy programs (Bertot et al. 2015). Part of the drive for promoting digital literacy has been the fact that technological advances have limited librarians’ interactions with patrons as patrons themselves need to “check out their books, reserve their own computers, print out their own documents, and pay their own fines at a machine” (Morrone and Witt 2013, 4).

A look into related literature reveals that libraries have largely focused on expanding physical access to digital technologies and promoting digital literacy (Seale, Draffan, and Wald 2010; Selwyn and Facer 2007). However, it is evident that people can be privileged in terms of access and skills, but remain digitally excluded for different reasons. For instance, video content may exclude people with hearing impairment if subtitles are not included. Similarly, blind people may not be able to access a digital text that cannot be read by screen reader technologies. In such cases, digital inclusion may need to go beyond access and skills to address participation and usage (Jaeger et al. 2012).

This paper seeks to explore access to digital content in relation to participation and usage. Specifically, the issue of access will be examined from the perspective of digitally competent users with print disability. Print disability is a term used to refer to people who have difficulties in reading printed text due to visual, cognitive, and motor impairments (Blansett 2008). This paper utilizes the International Classification of Functioning, Disability, and Health (ICF) as a framework to analyze

the data collected through interviews. By doing so, it attempts to contribute to a better conceptualization of digital inclusion that can inform further research. Thus, the paper attempts to answer the following questions: What is the experience of people with print disability in relation to access and use of digital content through libraries? How could that information be used to improve the understanding of digital inclusion?

Literature review

Digital inclusion: A conceptual background

Inclusion is a concept rooted in the acknowledgment that there are segments in a society that are excluded from mainstream society due to poverty, disability, race, or cultural differences (Alam and Imran 2015; Peters and Besley 2014). The goal is thus to ensure equal participation of all in social, economic, and community affairs of their society (Lloyd, Lipu, and Kennan 2016; Warschauer 2004). With the advent of the information society and the growing role of technology in everyday life, access to technology and the skills to use it have become crucial for people to integrate into a new society, communicate effectively, understand the new society, and express their own cultural identity (Andrade and Doolin 2016). Technology thus became a key component of equality and social justice (Mendonça, Crespo, and Simões 2015; Thompson and Paul 2016). Digital inclusion also became a defining factor for social inclusion (Alam and Imran 2015; Andrade and Doolin 2016; Helsper 2012; Ragnedda 2017; Warschauer 2002).

Digital inclusion is explained as a “policy developed to close the digital divide and promote digital literacy.” and an “outreach to unserved and underserved populations” (Jaeger et al. 2012, 3). The term digital divide is, in turn, defined as the gap between the technology “haves” and “have-nots”, which could be a result of socioeconomic status, education, skills, language, or other factors (Real, Bertot, and Jaeger 2014).

Studies aligned with the positivist tradition attempted to measure the digital divide in a society by analyzing statistics related to poverty, income, broadband connectivity, public access points, and literacy (Misuraca, Centeno, and Torrecillas 2014). Others, however, implied that such an approach could be overly simplistic. For instance, Helsper (2012) explained that people’s behavior toward technology may be shaped by “social scripts” in religion and culture. Seale, Draffan, and Wald (2010) stated that fear of stigmatization would prevent people with disability from using assistive technologies in public. A study by Thompson and Paul (2016) showed that individuals’ concerns for their privacy and security, the amount of leisure time they have, and their expectations would influence their use of technology. Burgstahler (2008) also explained that people with disability could be technologically proficient but digitally excluded due to inaccessible web-based systems—experiencing what some call the “second digital divide.”

Some scholars proposed a shift from the digital divide to “digital inequality,” arguing that inclusion goes beyond addressing the dichotomy of haves and have nots (Blank and Groselj 2015; DiMaggio and Hargittai 2001; Stiakakis, Kariotellis, and Vlachopoulou 2009). They, for instance, refer to Weber’s theory of social stratification to explain that inequality is not only an issue of economic status but also a factor of social class, status, and power (Ragnedda and Muschert 2015). Such studies applied this theory to study digital inequality between countries (Schroeder 2015) and across societal and economic layers of a given country (Nemer and Hakken 2016; Ragnedda 2017; Ragnedda and Muschert 2015).

Digital inclusion in libraries

Literature on inclusion related to libraries have been largely focused on physical access to information and communication technologies (ICT) and digital literacy (Andrade and Doolin 2016; Jaeger et al. 2012; Kinney 2010; Misuraca, Centeno, and Torrecillas 2014; Morrone and Witt 2013). For instance, Real, Bertot, and Jaeger (2014) discussed the barriers rural libraries face in promoting digital inclusion. They listed issues such as inadequate budgeting, staffing, and staff training as problems that need to be resolved. Jaeger et al. (2012) illustrated how public policy could affect digital inclusion activities in public libraries. They explained that the way digital divide, digital literacy, and digital inclusion are defined by policy makers could affect the funding and support libraries can get from government entities. As a solution, the researchers recommended librarians take up the role of advocacy—to present a strong, public case for the support they need. Tripp (2011) discussed the potential of recreating libraries as digital media centers and mentioned the importance of training librarians. The other notable works include digital inclusion surveys that assess libraries for their Internet and Wi-Fi connectivity, the trainings they run, and the staffing they have to run the trainings (Bertot et al. 2015).

Access to digital content

Expanding access to digital content is an important undertaking in bridging the digital divide. However, as the discussion made so far implies, access is a layered concept. First, it refers to the availability of a resource when it is needed. Second, it refers to its accessibility—whether the resource carries features that complicate its access by some groups of users.

There are studies on library accessibility that could be interpreted as efforts to bridge the second digital divide. Most of these studies evaluated the conformance of library websites and databases to established accessibility guidelines (Hill 2013). For example, the longitudinal study by Comeaux and Schmetzke (2013) used Web Content Accessibility Guidelines (WCAG 2.0) to evaluate the accessibility of 56 North American libraries. The study made use of Bobby 3.1.1., an automatic accessibility testing tool, and showed an improving trend in accessibility of library

websites. Charbonneau (2014) sought to test the adherence of public library websites to senior-friendly guidelines. The author utilized guidelines developed by the National Institute on Aging and the National Library of Medicine (USA) to evaluate 104 public library websites. The study claimed that none of those websites fulfilled all the guidelines.

Tatomir and Durrance (2010) evaluated the accessibility of 32 library databases and stated that the majority of them showed low levels of compliance to federal web accessibility legislation and international web accessibility standards. Borchard et al. (2015) tested 21 individual pages from Public Knowledge Project Open Journal Systems with automatic testing tools such as WAVE, Fangs, and the Functional Accessibility Evaluator. The study concluded that the tested pages did not pass the minimum level of accessibility specified by WCAG 2.0.

The above-mentioned examples show a trend of using accessibility standards to improve or evaluate the accessibility of digital resources. Some used automatic testing tools and others conducted heuristic evaluations. However, it would be difficult to conclude that such methods are sufficient to dismantle barriers or, in other words, remove the second digital divide. Such studies need to be complemented by user-centered studies to explore other personal, environmental, and contextual factors that can influence people's access to information (Mathieson et al. 2008).

Inclusion of people with print disability

Though there is a shortage of studies that discuss digital inclusion in relation to people with print disability, there are some that identified barriers of access to the digital content. Dyslexia, for instance, is understood as a neurobiological disability that affects a person's ability to read and write (Vellutino et al. 2004). Studies show that fonts would affect accessibility of a textual content to people with dyslexia. For example, Rello and Baeza-Yates (2013) claimed that "Sans serif," "mono-spaced," and "Roman" font styles make text more accessible for people with dyslexia than "Serif," "proportional," and "italic" fonts. Wery and Diliberto (2016) studied the effect of "OpenDyslexic," a specialized font, on improving the reading performance of people with dyslexia, but concluded that the font did not make any difference. There are assumptions that visual representations such as icons and images would make search interfaces more appealing to dyslexic users (Ismail and Jaafar 2015). However, other studies state that there may be no advantage gained by replacing text with icons (Berget and Sandnes 2015).

People with low-vision impairment are among those categorized as print disabled. According to a working draft by the World Wide Web Consortium (W3C 2016a), this group includes people with low visual acuity, light and contrast sensitivity, loss of field of vision, and color blindness. This group represents users with diverse needs in terms of brightness, color, text contrast, font type, font style, line spacing, etc. Past studies show that these and others with print disability could avoid using library search interfaces if they feel the tools are too complex (Beyene 2016a; Beyene and

Ferati 2017; Fagan et al. 2012). Moreover, users with print disability who rely on screen reader technologies could effectively be excluded from digital services if the search interfaces are not easily navigable, or if resources such as ebooks cannot be “read” by screen readers (Beyene 2016a; Yoon et al. 2016).

Digital inclusion, in general, is a multilayered concept that requires addressing different issues at different levels. Works discussed so far mostly reflect the top-to-bottom approach, that is, implementing what experts, policy makers, or librarians think is best to realize inclusive digital services. However, as presented in this study, a bottom-up approach that incorporates the voices of actual users might be helpful to better understand what digital inclusion should entail.

Methodology

Theoretical framework

There are different models of disability that can be used to frame studies in digital inclusion. The medical model, for instance, interprets disability as biological or physiological limitations of individuals. The social model, on the other hand conceptualizes disability as the failure of the environment to accommodate the needs of its users with disabilities (Toboso 2010). The ICF combines the medical and social models to explain disability as a construct of health conditions and/or contextual factors. The contextual factors are further divided as personal factors and environmental factors. The personal factors include age, gender, coping styles, social background, education, profession, overall behavior pattern, and others; whereas, the environmental factors include social attitudes, legal and social structures, climate, and terrain (World Health Organization 2002). This study utilized the ICF model for the reasons discussed below.

As explained by Douglas, Corcoran, and Pavey (2007), the ICF was developed with “more emphasis on developing an inclusive agenda and on social participation,” with “useful structure and vocabulary for examining the physical restrictions of impairment whilst simultaneously acknowledging the barriers that lead to social exclusion” (37). Some of those key terms (Douglas, Corcoran, and Pavey 2007; World Health Organization 2002) are:

- *Activity*—The execution of a task or action by an individual
- *Participation*—Involvement in a life situation
- *Participation restriction*—Problems an individual may experience in involvement in life situations
- *Impairment*—Problems in body function and structure such as significant deviation or loss
- *Environmental factors*—The physical, social, and attitudinal environment in which people live and conduct their lives
- *Barriers*—Environmental factors that limit activities or restrict participation
- *Facilitators*—Those that may remove the barriers or the restrictions

As a contextual study that explores digital inclusion in relation to participation and usage, it was believed that the ICF is the best framework to use in this study.

The participants

Finding a representative sample is one of the main problems of research involving people with disabilities (Newell et al. 2011). For that reason, scholars recommend the use of creative methods such as the theatrical technique and personas (Newell et al. 2006, Newell et al. 2011). Difficulty in recruiting participants was also experienced in this particular study. Therefore, the study was designed as an exploratory qualitative study.

In this study, efforts were made to recruit participants with print disability who have access to ICT and who have experience in using digital library services. Therefore, the Norwegian Library of Braille and Talking Books (NLB) and admission offices of the University of Oslo (UiO) and the Oslo and Akershus University College of Applied Sciences (HiOA) were approached for help in recruiting participants. Ultimately, ten participants (six with dyslexia and four with low-vision impairments) came forward to take part in the study. All but one of them were females. All of them were from the Oslo area. The majority (eight of them) were university students, whereas the remaining two were employees of different institutions. Their education status ranged from first year university students to graduates with master's degrees. The age range was between 21 and 51.

The participants were contacted individually at the place of their choice: three of them at their residences, one at her office, and the rest at either of the universities mentioned above. Making appointments and collecting data from each participant was a challenging task, which started at the end of February 2016 and ended in April 2016. All the participants provided written informed consent to take part in the study.

Data collection and analysis

Users views and opinions remain the most important evidence regarding their inclusion or exclusion in a certain activity in life (Douglas, Corcoran, and Pavey 2007). Therefore, the semi-structured interview technique was the principal method of data collection used in the study. The users also took part in a usability test of a library discovery tool. The results of the usability test are presented in a separate publication in Beyene (2016a).

The participants were asked about their use of libraries and digital services offered by libraries (participation), what frustrates them (barriers), and what they think would help to eliminate the barriers (facilitators). Based on those main questions, the participants were encouraged to discuss which libraries they use, their motives for using those libraries, how they access the digital services available through the libraries, and the problems they face while using digital resources (e.g., eBooks). Moreover, they reflected upon their experience of other web-based information services and offered opinions on what could improve accessibility in digital library environments.

Then the ICF was used as the framework for deductive thematic analysis of the collected data. The findings were further compared with existing literature to address the research questions.

Results

Activities and participation

The respondents were first asked to discuss their use of libraries. Except for one participant who said she uses only the NLB, all of them cited two or more libraries including university libraries, public libraries, digital libraries, and library apps. Four respondents (three low vision and one dyslectic) stated they use library apps. Two of them mentioned Lydhør, which is an app from the NLB. One of them said she uses BARD (Braille and Audio Reading), an app from the American Library of Congress, in addition to Lydhør. The other mentioned LibriVox, which is a freely available app available on the Internet. Two participants said that they use Amazon's Kindle eBooks too. This shows that the participants' choice of libraries was not necessarily bound by their disabilities, confirming the need for inclusive design of mainstream as well as specialized information services.

The participants also discussed their motivations for using libraries. Eight of them (all of the students) explained their motives for using their university libraries as: "to check my mandatory reading lists," "to work on my thesis," and "to check the status of my loans." A respondent stated her motivation as her love of reading books for pleasure. The NLB was the only library she mentioned where she checks the catalog "maybe once in a month or less." Based on her registered needs, the library sends her audiobooks (on a CD) once every two weeks. Another respondent said she uses NLB and the public library because of her job (which is storytelling) and checks the libraries "at least once in a week."

Restrictions and barriers

Access to digital content

Users' low frequency of usage of a specific library is attributed to the presence of alternatives, the task at hand, and inaccessibility of the information resources in the library. For instance, a participant with low-vision impairment said she usually searches the public library catalog for printed books and the NLB for audio and some braille books. Three respondents with dyslexia said they are getting the materials they need from somewhere else. One of them said she can get the materials from a public library where she works as an assistant. Another said she gets them via audio from the NLB. She also added:

"The university library has only text materials. I can't listen to that [there is no audio version]. If I have the books for my studies, I think that is enough and I don't have time to read anything else."

The other respondent said she is “not using libraries this semester” because she already has the books she needs. Moreover, she stated there are Internet forums that could be more helpful for the “practical courses” she was taking that semester.

A respondent with low-vision impairment said she is light sensitive. Therefore, she cannot read anything unless it is in the high contrast mode (black background). Therefore, she prefers electronic documents in PDF or HTML formats, which can be read by her screen reader tools, or which can be switched to high contrast mode. Speaking of her university library, she said:

“Unfortunately, there are no PDF materials [from her mandatory reading list] among them. What I can do is to have them [physical books] scanned but it is only allowed to scan them as JPEG images, which I cannot read with my VoiceOver tool. So the first thing I do is to check whether those materials are available on Google for free.”

She also added that she tried to attend library orientation sessions to learn about the available services. However, it was difficult for her to follow the sessions because the presentations were made on PowerPoint slides with white background.

Resource discovery and access

In addition to the issues related to content and its formats, problems related to library search tools were raised. They can be categorized as general interface issues (e.g., fonts, colors) and search results presentation (e.g., resource description and the use of visual cues such as icons and cover images). It has become common for library search tools to present visual cues along with titles in the results list (e.g., to show whether a material is a book, eBook, audiobook, etc.). Two of the dyslexic participants said that the visual cues help them to quickly spot whether a material is available in a format suitable for them. Another respondent stated, “The important thing in the life of a dyslexic person is saving time.” Therefore, the visual cues are regarded as time savers by some.

However, three participants with low-vision impairment regarded the visual cues as “clutters” that complicate the search process. For example, two of them use JAWS, a screen reader tool that generates link lists that are navigable with key-strokes. They feel that the “clutters” make the link list longer, and as a result, make navigation more taxing. Library search tools are described as more complicated when compared with Google. One of them said,

“Typing keywords, navigating through tabs for refining search, then pressing Enter is not convenient for me. It is painful. That is not for me. There should be another way... but it should be customized... there should be a way to simplify that tool. The autofill suggestions (in some other systems) are disturbing because sometimes they are not accessible by JAWS”.

He also said that he usually asks librarians to conduct searches on his behalf. He added,

“The first thing I do is search Google [to see] if the book is freely available online. If I can find it there, that is fantastic. If I cannot find it, then I will borrow it from the library. I often use Google Scholar as a tool and as a resource.”

All the dyslexic participants concur that library search tools like the one used at universities,⁴ look complex. One of them said she uses Google Scholar instead as a tool to get journal articles subscribed by her library, focusing on the hits displaying @HiOA- her university’s initials. Another participant said,

“Make it as simple as possible. If someone sees it for the first time, he might run away. I prefer if books, articles, etc. presented (sorted) together, rather than the mix-ups. The icons, some of them are colorful and some are not. That is distracting.”

Facilitators/Enablers

Alternative formats and contents

The respondents were asked about their format preference for digital content. In Norway, the NLB is responsible for reproducing books in audio or braille formats for people with print disability. The purpose of this question was to see whether the users’ alternative format preferences are constrained by their conditions (see [Table 1](#)).

All respondents mentioned text as part of their format preferences. For two of those with low-vision impairment, text means a resource either in PDF, HTML, or other electronic format that can be rendered by screen readers. One participant said she also uses audiobooks. However, they “annoy” her because they do not give her the freedom to select part of a content to be read. She also added that audiobooks are not as convenient as textual documents when the need to copy and paste, for example, to quote, arises. She added, “I am not blind, so I want to see and memorize.” The other respondent said his vision is declining. Therefore, for him text means a document in PDF, Word, or HTML format, which can be accessible by screen reader software. Another participant with low vision said she has an OCR scanner for scanning and reading print books on her computer (apparently creating a digital text version). She would be obliged to use them at times because,

“Sometimes, I need books right now and I can’t wait until audiobooks are shipped to me from NLB in two days’ time.”

All but one dyslexic participant said they use text and audio formats. That one participant said she does not use audio books, though she has access to them, because she is determined to find her own way to read and comprehend textual

Table 1. Participants’ preference of material types.

Preference of formats	No. of participants
Audio	7
Braille	1
Text	10

contents as any typical user does. Another participant said her choice of media depends on her task. If she reads books on facts, then she prefers audio and text versions at the same time. However, she also added that the audio market is not big, and the NLB does not have many audiobooks in English. She also noted that one must apply and enroll to get audiobooks from the NLB and that process can take a long time. Two respondents with dyslexia and ADHD (Attention Deficit and Hyperactivity Disorder) conditions said they prefer to use the audio and text versions of a resource together. One of them explained:

“I prefer the text because with text-to-speech technology, I can heighten my recognition and comprehension by hearing it and also by seeing it, because I can minimize the amount of mistakes I make. Because I can listen wrong too.”

She also added that her choice of format depends on the types of materials she reads. For novels or for materials that require page-to-page reading, she prefers audio. If it is related to her study, she prefers text.

There was a hint for the need of alternative contents prepared with easier expression for users with dyslexia. For instance, one of them said she heard about the possibility of asking the librarians:

“If they have easier book on the same subject and on the same thing. If it is in English, and if you are not sure that you can read in English, then you can ask them if they have a Norwegian book on the same topic”.

Another respondent with a similar impairment also mentioned the difficulties involved in understanding the academic language used in some research papers saying, “Sometimes I think it could be said in a different way, so much easier to understand.” Thus, presenting content in alternative formats and alternative expressions (e.g., simpler language) could improve accessibility and usability of digital content for those with print disability.

Benefits of digital text format

During the interviews, most participants indicated the preference of digital text format as the ultimate inclusive media in digital library environments. The following excerpts from the interviews help to illustrate that preference:

Participant 1: Dyslexia—when discussing her experience of searching books in the physical library bookshelves, she said she often forgets where the book is on the shelf.

Participant 2: Low vision impairment—Referring to her experience with physical libraries in relation to her light sensitivity, she said:

“I cannot see the numbers on the book spines because they are again on white background. I cannot go to shelves and check books because once again the shelf numbers are written on white background”. She also said that, “I cannot read paper books so I use electronic books or articles I get on website. She also added, “I prefer PDF because I can choose where my VoiceOver tool starts to read, that also helps me when I decide to quote.”

Participant 3: Low vision impairment—reflecting on her experience getting loans from libraries she said:

“I know I can get audiobooks from NLB in two days. But due to the nature of my work, which is storytelling, sometimes I need materials right now.”

Participant 4: Speaking of the need for flexibility in choice said:

“I have a double condition of Dyslexia and ADHD, and an advanced level ADD, which is attention deficit. So at times, I need to read and listen simultaneously.”

Participant 5: Low vision impairment—when thinking about the use of magnification tools (which are also among the physical resources made available by libraries), he said:

“My eyesight is gradually declining, and I have lost 80 percent of my sight. I want to be pragmatic, so I don’t use magnification tools if I am not forced to do so.”

As can be understood from the excerpts presented above, the participants are cognizant of the potential of the digital text format to accommodate many of their needs and preferences. They mentioned the possibilities it offers to change font color and size, to change the background color as needed, to use screen reader tools to read the text aloud, and to copy and paste text for quoting purposes.

Flexibility in resource discovery and access

Some participants offered ways to make library search tools more inclusive. A participant recommended libraries emulate Gmail by providing “Standard” and “basic HTML” views. He said:

“Gmail has this very fancy look right now. But if I just click this [the button for basic html view], you see, every clutter is gone now. The graphic here is gone. It is so simple. People may not like it. But if you ask any blind person, they will love it.”

He also recommended the addition of voice input functionality, which is already available on the LibriVox app, saying,

“The technology is already there... I often ask my iPhone the best pizza place so it gives me hits on top ten pizza place according to my geographical location. If they can do it there, it would be much easier to have that here [with the library catalog]. For instance, if I read the name of the book “crime and punishment” and the links for the book pop up. Once that happens, I can use either the mouse or the keyboard to access the book.”

There were also recommendations regarding fonts and colors. A participant said the fonts used on her library’s search interface make reading difficult for those with dyslexia. Therefore, she recommended the search interfaces accommodate changing fonts. She said, “From designers’ perspective, comic sans is horrible font. For a dyslexic, it is good for reading”.

In addition to the library search tools, three users (one with dyslexia and two with low vision impairment) indicated their preference for accessing digital resources through Google and Google Scholar. One of them specifically mentioned Google Scholar as a shortcut to access digital resources from her library. This finding suggests that libraries may have to make their resources accessible through Internet search engines to provide their users alternative access points. Moreover, the Gmail analogy mentioned above illustrates how adaptability could be a way to inclusively design library search interfaces.

Discussion

This study explored the experiences of people with print disability in relation to access and use of digital content through libraries, and how information about those experiences could be used to improve the understanding of digital inclusion. As shown in the results, barriers and facilitators exist that affect the experience of users in a digital library environment. Moreover, the data analysis revealed some indicators that can be used to inform digital inclusion efforts in future endeavors.

Personal factors

Personal factors can be medical or non-medical. In addition to the medical factors that obviously limit users' ability to read printed text, the non-medical personal factors such as users' past experiences and perceptions can affect users' inclusion to information services. As presented in the findings, a user could conclude that a library doesn't have resources accessible to him. Beyene (2016a) mentioned a person with visual impairment who didn't think that it was possible to conduct a full-text search on a library discovery tool. That particular person mentioned his experience with other library catalogs where he had to enter keywords in boxes connected with Boolean operators. As accessibility guidelines are used to design information services (e.g., websites, search tools) and cater to users' physiological needs, information literacy programs could help to remove the other types of personal barriers.

Environmental factors

Resources and alternatives

A single library might be insufficient to satisfy a user's single information need. For instance, a student may log in to his university library's system to check his mandatory reading list and check the availability of the materials in formats suitable to him. If the resources are not available, the user might opt to check the Internet for freely downloadable resources, or contact libraries like the NLB to request the material in an alternative format.

The main theme that stood out in this study was the need for alternatives: alternative formats, alternative content, and alternative modes for resource discovery and

access. Users may have different choices of formats or content presentation technologies. There are instances when people want to use audio and text together (for improved cognition), text only (for academic reading), or audio (for leisure reading). Those choices may not necessarily be dictated by their disabilities.

In addition to format, language is another dimension to alternative content presentation. The need for resources with “easier expressions” was mentioned above in the findings. That solution would entail producing textual documents in plain language, that is, making them understandable and readable to the intended audience (Boldyreff et al. 2001). Studies show that people with reading disabilities such as dyslexia struggle to understand difficult and complex texts (McCarthy and Swierenga 2010). This problem is not unique to dyslexic readers as there are others, such as second-language readers, who may encounter the same problem (Morozumi, Nevile, and Sugimoto 2007). In that sense, addressing the needs of the print disabled helps to redress problems encountered by other non-disabled readers (McCarthy and Swierenga 2010). Measures libraries can take include the use of the metadata field “audience” to indicate the intended audience or the reading level of a document (W3C 2016c). The other alternative, as discussed earlier, is to help users “improve their own cognition” by offering them audio and textual alternatives.

It is important to recognize that two people with similar disabilities could have opposing preferences regarding a feature on a library search interface (Beyene 2016a). As discussed in the literature review and as learned from the interviews, users can have different preferences regarding the design of search interfaces. They may avoid library catalogs and use tools like Google Scholar to access some electronic resources from their libraries. For example, Beyene (2016a) mentioned a user with low vision impairment who prefers Google because of the poor color contrast on her library’s search interface. The same study also showed that search interface features such as icons, filters, and others could frustrate screen reader users as they have to make extra efforts to skip those features. Google and Google Scholar’s attraction emanates from the simplicity it offers.

The trend of switching to Google is not unique to users with print disability. Studies by Cothran (2011) and Wu and Chen (2014), for instance, confirm that non-disabled users also have preferences for using Google. In the context of this study, the preference for Google stems from a desire to avoid navigational overload and interface complications presented by library search tools, which are more strenuous to users with print disability. Libraries can work to make their resources discoverable through their search tools as well as through Google Scholar. Thus, one way to inclusion could be to offer users such alternatives and empower them to make informed choices.

Decision support

Decisions can be generally classified as “empowered” and “non-empowered” (Seale, Draffan, and Wald 2010; Selwyn and Facer 2007). If the decisions are based on informed choices, they can be signs of empowerment. If they are based on fears or

wrong perceptions, then they are non-empowered decisions. As discussed in the findings, there are users who may refuse or dislike special treatment. For instance, recommending audiobooks to someone because they are dyslexic could be regarded as patronizing.

Libraries host both accessible and inaccessible resources. As a result, users often need help to make an informed selection of resources. Metadata could be used to label alternate versions of content so the user can decide which version is suitable for them (W3C 2016b). Therefore, in addition to the regular metadata such as author, title, or subject, information on the accessibility quality of resources could help the decision making process (Beyene, 2017).

Content delivery formats: Flexibility and adaptability

Physical libraries store audio and braille books targeting the needs of users with print disability. The digital text format offers the opportunity for combining visual and aural needs of users, a trait that can make information accessible to a larger audience. For those with cognitive impairment, digital text supports the use of screen reader technologies so they can read and hear at the same time to enhance their cognition. For those with low vision impairment, digital text provides the flexibility to change the color contrast, font, and font size. Moreover, copying part of text to directly quote it in a research paper, and magnifying text without the need for external devices are among the advantages of the digital text format. The text format carries the potential for being accessible to all users regardless of their disabilities.

Access rights

Participants in this study mentioned problems such as inaccessible PDF files that cannot be rendered by text-to-speech tools. A study done on digital services of selected libraries (Beyene 2016b) showed that Digital Rights Management tools (DRMs) used by publishers could block text-to-speech tools from “reading” the text to their users. Therefore, one challenge lies in harmonizing the access rights of people with disabilities with the intellectual property protection rights of content providers (Giannoumis et al. 2017).

Limitations of the study

This research study was designed to involve participants who are digitally competent, who have extensive experience of digital library services, and who are print disabled. The intent was to gain as much insight as possible into what causes the second digital divide. Therefore, the research design may be partly responsible for the limited number of participants. Another limitation could be the lack of gender balance. However, studies show there is no significant difference between males and females when it comes to digital competence (Hatlevik and Christophersen 2013; He et al. 2016). Nevertheless, this paper has provided starting points that could be explored in more detail in further studies.

Conclusion

Inclusion is a multifaceted concept difficult to interpret without context. This paper attempted to explore this idea in the context of digital library environments. Libraries have been playing an important role in expanding access to digital resources. However, a newer form of divide, dubbed by some as “the second digital divide,” presents accessibility and usability challenges that threaten access to information by some, even though they are digitally competent. Improved conceptualization of this phenomenon is needed in order to address it properly. This paper focused on access to digital content, a strand of digital inclusion, so as to explore it from the perspective of users with print disability.

Analysis of different personal and environmental factors highlighted some ways to help articulate the state of digital inclusion in a library. Some suggestions include availability of a content in alternative formats and accessibility of text-based content in different formats such as PDF and HTML. Moreover, the possibility of using screen readers, providing the flexibility and adaptability so text formats can be read with different color and font adjustments, and the accessibility of content discovery tools are other options to consider.

Prescribing solutions to users based on their disabilities may not be productive as users are diverse in their needs and preferences. Therefore, one way to ensure inclusion could be to present options so users are empowered to make their own informed choices. One way library search tools can support users’ ability to make quality decisions is by supplying relevant metadata information about the content presented. That approach would include supplying accessibility related metadata, which should be explored in further studies.

In summary, a comprehensive understanding of digital inclusion requires a thorough examination of issues related to access, skills, participation, and usage in context. In this study that examination was done through an in-depth analysis using the ICF model. The information gained in this study helps to fulfill the ideals of universal access, which seeks to ensure accessibility and usability of information resources to all, to the extent possible.

Notes

1. <http://www.un.org/en/universal-declaration-human-rights/>
2. <http://www.un.org/disabilities/convention/conventionfull.shtml>
3. http://www.wipo.int/pressroom/en/articles/2013/article_0017.html
4. the universities use a resource discovery tool built on the Ex Libris® platform

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Paper 3

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Realizing Inclusive digital library environments: Opportunities and Challenges

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Abstract. Universal design, also known as inclusive design, envisions the design of products and services to be accessible and usable to all irrespective of their disability status, cultural background, age, etc. Libraries have been benefiting from the breakthroughs in accessibility research to design their environments as friendly as possible for all groups of users. However, the present scenario of digital library environments characterized by different types of resources acquired or subscribed from different vendors operating with different rules, and who would maintain some form of control over the collections shows that adherence to guidelines by itself won't ensure inclusive digital library environments. The paper attempts to explore the matter taking the case of digital services run in selected libraries to identify trends that favor universal design and point challenges that need to be dealt with as part of further endeavors.

Keywords: universal design, inclusive design, digital library, accessibility, digital services

1 Introduction

One of the features of the information society is the proliferation of digital technology in production of information in text, audio, video and graphics formats. As the result, we are witnessing growing volumes of electronic books, journals and other information resources as well as mass digitization of already existing print materials. However, increased digital presence of information resources did not translate well into accessibility of them by all users [1]. Therefore, ensuring the accessibility of born-digital and newly digitized materials to *all* users remains the inescapable and important challenge libraries face nowadays.

Expanding the scope of accessibility to include the needs of *all* puts the focus on universal design [2], also referred as inclusive design, which envisions the design of products and services to be accessible and usable to all regardless of their disability status, cultural background, age, etc. [3]. The ideals of universal design have been enshrined in international conventions such as Article 9 of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), which requires state parties to promote “appropriate forms of assistance and support to persons with disabilities to

ensure their access to information”¹. They are also supported by country-specific anti-discrimination laws such as the Americans with Disabilities Act (ADA)² and the Norwegian Anti-Discrimination and Accessibility Act³. These acts promote inclusion and equal participation of people with disabilities in education, government, entertainment, and other aspects of societal life.

Conventions and laws like those mentioned above help to frame accessibility as part of responsibilities of libraries. However, libraries credit themselves for being cognizant of the needs of people for disabilities long before the introduction of anti-discrimination laws, as can be exemplified by the reading rooms they setup for the blind or the effort they make to collect materials in alternative formats. [4]. Therefore, the laws or conventions simply embolden their traditional responsibility. As the digital content and technology keep infiltrating the library world, libraries began to utilize guidelines and design specifications which mostly represent the state of knowledge in computer and information accessibility design [5]. As the result, library websites are being designed utilizing the Web Content Accessibility Guidelines (WCAG) and other accessibility standards and guidelines [6]. WCAG 2.0, approved as ISO/IEC 40500:2012, is part of guidelines produced by the World Wide Web Consortium (W3C)’s Web Accessibility Initiative (WAI) to guide development of web content including text, images, sounds and others so that they can be more accessible to people with disabilities [7].

There have been studies evaluating the conformance of library websites, databases, etc., to established accessibility criteria. The studies, like those discussed in the next section, employed a variety of methods including heuristic evaluation, automated accessibility testing, and user testing. However, the present scenario of digital library environments which is characterized by strong links with publishers, commercial indexing services, open access services, resource discovery tool providers and others makes accessibility a complex challenge that may not be achieved by merely following certain types of guidelines. Therefore, one way for ensuring accessibility of knowledge could be to address the technical as well as non-technical issues surrounding its creation, organization, dissemination, and the retrieval mechanisms put in place for its end users.

Therefore, instead of following the common product-based approach for evaluating accessibility of digital resources, this study chose to make an “environmental scan” of existing digital services that can be available through libraries. The purpose is to explore how the concerns of universal design are being addressed and to pinpoint the challenges that should be met. Its value could be interpreted as encouraging libraries to make inventory or self-assessment of their services and strategize on how to proceed in incorporating the needs of *all* of their users. To that end, this paper attempts to answer the following questions: “What digital services are available through libraries? What steps are being taken to make the services accessible for users with disabilities? What are the challenges for providing accessible digital services? What approaches could be considered to realize inclusive digital library environments? A case study of digital services at four libraries with relatively developed digital services was made to answer

¹ <http://www.un.org/disabilities/convention/conventionfull.shtml>

² <http://www.disabled-world.com/disability/ada/>

³ <http://app.uio.no/ub/ujur/oversatte-lover/data/lov-20130621-061-eng.pdf>

the questions. In-depth interviews involving eight people working in the digital services (with one of them communicated via email) were used to collect the required data.

The rest of this paper is organized as follows: review of related literature is presented next followed by explanation of the methodology used in the study. Then follow findings of the study, discussion on the findings, and recommendations for further research. Finally, the paper closes with the conclusion section.

2 Literature Review

Digital inclusion has been a concept used as a framework to ensure that individuals have access to digital technologies and the skills to use them [8]. Literature shows that the concept is hard to clearly define, but has been used in libraries to formulate policies and actions aimed at solving problems related to digital divide and digital literacy [8, 9]. The early conception of digital divide was used to connote unequal ownership of computational technology and access to Internet [8]. The proliferation of those technologies in people's daily lives introduced yet another layer of digital divide that alienated people with different types of disabilities from enjoying the benefits of the technologies [10]. Inaccessibility of technology creates digital exclusion, which also relates to social exclusion [11]. In this sense, inclusive/universal design in libraries can be considered as an outgrowth of their efforts in digital inclusion.

In the world of information services, we see two different models such as special access and universal access [12]. Users who have difficulties in reading printed text were traditionally referred to special libraries where they can be served with braille or talking book versions of the materials they want. However, the introduction of digital content in libraries has created an opportunity for including the print disabled users in any mainstream information service [13]. This coupled with advancements in assistive technologies and developments in universal design paves the way for digital services to be inclusively designed.

There have been studies made for evaluating accessibility of library websites for their compliance to established guidelines [14 15,16], accessibility and usability of online library databases [17], accessibility of digitized special collections [1], accessibility of academic eBook libraries [16], and accessibility of library content management systems [18]. These studies identified problems such as failure of library websites to fully comply with WCAG guidelines, inaccessibility of book pages to assistive devices, CAPTCHAs that complicate logon for users with visual impairment, thumbnails without alternative text, poorly described links, excessive navigation links, inaccuracy of some automatic testing tools, etc. Studies also showed that copyright protection measures that involve application of Digital Rights Management tools (DRMs) could cause accessibility problems as they may have the undesired effect of preventing assistive devices from rendering content to, users of screen reader technologies [19].

A content analysis of literature in library and information science (LIS) from 2000 to 2010 [20] shows that the "strongest theme" of accessibility research was related to web, database and software. The research added that the majority of those studies were accessibility testing. To sum up, this and the other papers reviewed in this study have

presented results one can expect, i.e., mixed results showing some parts accessible while some other parts inaccessible, while evaluating accessibility of digital resources. Here, we tried to adopt a different approach that allows exploring the whole scenario in current digital library environments from a broader perspective. The following section explains the methodology used in the research.

3 Methodology

The study adopted exploratory research design as its main purpose was to understand the state of the art as much as possible, identify developments that favor universal design, and highlight challenges that need to be tackled. The exploratory design was favored because of the flexibility it provides for tackling problems which are not much explored in previous research [21]. The idea was to find libraries with well-developed digital services, which would provide a good case for identifying and discussing issues that determine inclusiveness in digital services. The scope of the study was limited to libraries in Oslo and four libraries with relatively developed digital services such as the University of Oslo (UiO) library, Oslo and Akershus University College (HiOA) library, the National Library of Norway, and Helsebiblioteket.no (which is an electronic health library) were included in the study. The selection of the libraries was judgmental primarily based on the scale of their digital services. However, the fact that they represent different types of libraries (academic, national, and special) could be taken as a plus. Semi-structured in-depth interviews were made with the personnel running the services. The questions were related to the research questions presented at the start of this paper. The study included a total of eight respondents. Four of them were interviewed in pairs, three individuals were interviewed individually and one other respondent chose to communicate via email. Demonstration of the digital services was made in some of the sessions. The responses were categorized into themes for analysis to finally provide answers for the research questions.

4 Results

4.1 Digital Services

The respondents were first asked to enumerate what they refer as digital services available through their libraries. Though it might not be an exhaustive list, the following were those raised during the discussions.

Access Services. Access to electronic resources including ebooks and subscribed electronic journals constitute the biggest share of digital services in the two academic (UiO and HiOA) and one special libraries. Access to institutional repositories was among the digital services mentioned. The UiO library added that they maintain special databases including a database of papyrus images, a collection of digitized old books, a database of Norwegian translation of literature in Spanish, a bibliography of Norwegian literary

criticism, a database of Norwegian laws translated to other languages, and a database of Non-Norwegian literature before 1966. HiOA included ezproxy, which is an authentication software that provides remote access to licensed electronic resources, and link resolvers as part of their digital services.

Helsebiblioteket.no said they were setup to provide health information service to professionals and practitioners in healthcare, as part of evidence-based practice. As the result, their digital services include access to point of care tools, links to published and unpublished national and international guidelines, medical procedure catalogs, and patient leaflets translated to Norwegian from British Medical Journal (BMJ) best practices. They mentioned that they have access to ebooks and videos through the databases they have subscribed, though most of the videos are not relevant to the Norwegian practice. The other digital resources include meta collection of openly available resources relevant to Norwegian practice, commentaries on contents of their resources, and the digitized version of the Norwegian Handbook for Emergency Medicine available online and as a mobile app.

The Norwegian National Library maintains a digitized collection of books, newspapers, photo and radio. As the respondent from the library said, the legal deposit act grants them permission to digitize for preservation purposes. These resources are available for their users as part of digital services. Some items have been restricted to use within the national library, whereas others (for instance newer newspapers) are also available in public libraries. There are solutions for browsers and mobile devices alike.

Content Production. Currently, UiO and HiOA libraries publish 12 and 11 open access journals respectively. They also maintain institutional repositories. HiOA reproduce educational films that shall be published on Vimeo, YouTube, and on film service called film.hioa.no. They also produce and present compendiums with PDF/A format to students. Helsebiblioteket.no mentioned presentation of translated contents from English to Norwegian to suit the needs of their users.

Discovery Service. Oria, a discovery tool based on Ex Libris's Primo, is the principal tool used in in the academic libraries. The UiO said they have developed additional tools. There is an app developed to locate and find a book in a shelf in their science library. This app shows map of the library with a pointer where the book is located on the shelf. The other application is called Book Motion and it is based on motion sensor LeapMotion technology. Documentation on the library website⁴ shows that this application enables users to browse through ebooks using hand gestures, without the need of using mouse or screen.

Other Services. Other services mentioned as part of digital services by the academic libraries include resource pages where a student can find databases and journals tailored to their field of studies; guides on reference styles, how to write a paper, etc. HiOA

⁴ <http://www.ub.uio.no/om/prosjekter/brukerdrevet-innovasjon/utviklingsprosjekter/bookmotion/>

mentioned they run MOOC (Massive Online Open Course) page with information and instruction on how to use the library, how to search in the catalog etc. Facebook pages set for communicating with users were among those raised in the discussions.

4.2 Accessibility of Digital Services

The next question posed to the respondents was on what they have done to make their digital services inclusive of the needs of people with disabilities. The steps taken were largely described either as plans or measures taken to improve accessibility of the websites according to WCAG guidelines, in a bid to meet universal design requirements set by the Norwegian Agency for Public Management and eGovernment (Difi). Universal design has been legislated as requirement by the Norwegian Anti-Discrimination and Accessibility Act § 14⁵ and Difi is responsible for monitoring whether the regulations are being met⁶. Difi states WCAG 2.0 level AA as a standard for universal design of websites with some exceptions regarding time-based media, audio description or media alternative (Prerecorded content), captions (live content) and audio description (prerecorded content).

The national library stated that their web pages comply with W3C CSS validation standards and are accessible for screen readers. They mentioned, though, the use of screen readers in connection to the text viewer used to view digitized materials like books has not found optimal solution partly due to the agreement between the National library and the rights holders. This agreement grants the National library the right to expose books within the framework of “bokhylla.no” (their digital library) for anyone in Norway, but as the respondent said, “the OCR text must not be exposed to the users, to prevent it from being downloaded, copied or modified. The book viewer therefore shows the scanned pages as they are, and suppresses the hidden text that is bundled with the photos of book pages”. He also added that the library has prototyped solutions for activating the text behind paragraphs or pages, making it accessible for text readers or text-to-speech, but the solutions have not been deployed so far. However, it might be worth to add that the agreement between the library and representative of the right holders, which is found on the library’s website⁷, didn’t exhibit a clause carrying provisions for users with disability.

The UiO library said the books they digitized (books whose copyright periods have expired) are OCR-treated, but added the difficulty posed by fonts used in the old books which were confused for pictures-which makes them difficult to be rendered by screen readers. They said these resources are made available for users but admitted that accessibility concerns were not well addressed. HiOA said they don’t do digitization except producing compendiums. The compendiums are scanned, OCR treated and presented as PDF/A for students. The two academic libraries have discussed presentation of materials in alternative formats. For instance, HiOA publish one of their open access journals in PDF, HTML, mobile and EPUB formats. The UiO library said they are working

⁵ <http://app.uio.no/ub/ujur/oversatte-lover/data/lov-20130621-061-eng.pdf>

⁶ <http://uu.difi.no/om-oss/english>

⁷ http://www.nb.no/pressebilder/Contract_NationalLibraryandKopinor.pdf

to make their electronic resources, including the new discovery tool Oria, available through mobile devices.

Though it might not form part of their digital services, it is worth mentioning that both academic libraries have rooms equipped with tools such as adjustable tables, braille printer, braille keyboards, scanner mouse, screen magnifiers and other physical utilities for users with impairments. Users who require more help would be directed to the Norwegian Library of Braille and Talking Books (NLB) where they can have resources they want either audio or braille forms, depending on their request. A respondent acknowledged that that could have affected the state of accessibility in their digital services saying, “Sometimes also we rely too much on this room that if people have to use we send them down there but it will be difficult if they want to use our services from home”.. The other respondent added, “... we don’t offer more services in that regard because they (NLB) handle everything in Norway”.

Helsebiblioteket.no said they have not been involved in digitizing documents except for the Norwegian Handbook for Emergency Medicine (Legevakt boka), a book very popular among students and anyone involved in emergency medicine. The digitization was done by the publisher and made available via browser and mobile platforms. When asked whether they have considered people with disability as potential consumers of their services, they said their mandate is to serve healthcare practitioners. However, they acknowledged their user could be anyone in Norway saying, “A lot of traffic comes from Google so we have a reason to believe that, especially out of the traffic on the patient leaflets, [it] comes from patients, their caregivers or family and friends”. They said they are in the process of redesigning their entire system emphasizing the demands within the law regarding universal design citing Difi’s WCAG recommendations as “our toolbox”. During the discussion, they raised the possibility of presenting content in PDF, HTML and other alternatives but said they prefer HTML over PDF. The reason as they explained was HTML’s mobile friendliness and the ease it provides for navigation through pages. They specifically mentioned ease of access to information for health professionals using mobile devices. Therefore, they have converted the national health guidelines from PDF to HTML and plan to do the same with their other local collections.

Accessibility of Subscribed Resources. As discussed in the first section, libraries are involved in reproduction as well as subscription of electronic resources. Respondents were asked if there are measures they have taken to ensure that materials they subscribe to are universally accessible to all of their users, including users with disabilities. Respondents from HiOA said that there had been a case where a user with screen reader couldn’t access an ebook because of Digital Rights Management (DRM) tools restriction. The library had to buy the version of the ebook without DRM. They explained their policy of buying ebooks from vendors without DRM to the possible extent. However, they mentioned the difficulty of signing hundreds of agreements with small vendors, where there is a possibility of buying ebooks without DRM and the ease of signing agreements with big vendors but which usually use DRMs.

Helsebiblioteket.no said that most of their resources can be accessed by anyone in Norway without the need for logging in and that is part of their agreement with vendors.

The whole point for this national IP access was the availability of the resources for their users and the ease of access. For instance as they said, “a doctor shouldn’t be required to enter password every time he wants to access a resource”.

All of the respondents acknowledged the agreement they make with publishers dictates the manner the resources are retrieved and used. For instance a respondent from one of the academic libraries said “in each agreement you have different kinds of solutions for access, some allow you only to view, the others allow download”. However, they didn’t specifically mention whether they insert in those agreements clauses that protect the right of access of users with disabilities.

Accessibility of Resource Discovery Tools. Resource discovery tools were among the list of digital services mentioned by the respondents from the academic libraries. Therefore, they were asked what they have done to make those tools accessible and usable by users with disabilities. As mentioned above, the academic libraries use Oria. The respondents said there is little they can change on Oria except some “font and small CSS changes”. They need to contact the company if more changes are required. Oria is thought to provide a single point of search for all resources either owned or subscribed by libraries. The interface carries multiple search options by author, title, etc. and filters by media type, creation date, language, etc. The information on the company website states that the product meets international accessibility standards [22]. However, whether its feature-rich interface poses problem for people with disabilities, for example for low vision and dyslectic users, would require further research.

Helsebibioteket.no explained that they didn’t start up as a traditional library so at this time they don’t have yet a unified catalog for all of their contents. They started up as a website, a service providing research information to healthcare professionals based on the paradigm of evidence-based healthcare, and evolving. There are two types of search systems their users can use: the one provided by journal databases and the other for local collections setup with the IBM Watson Data Explorer. It allows users to search by a term then filter by source, information type, language, and other facets.

Resource Description. The respondents were asked about the metadata schema they use and whether they have used elements in the schemas to describe resources by their accessibility qualities. This question was inspired by the study [23] that suggested Dublin Core’s “Audience” and MARC 21’s “Reading Level or Interest Grade level” could be used, for example, to describe resources suitable for dyslexic users or users with low English language skill. The academic libraries use both MARC 21 and Dublin Core but the respondents couldn’t confirm whether they have used the metadata schemas to that extent. One of the reasons as two of the respondents said is that, mainstream libraries are not expected to have resources that require such special descriptions, as that is the task of NLB. The other reason is the increasing reliance on metadata generated by vendors of the electronic resources which makes it difficult to track the level and scale of metadata usage. The other respondent noted that perhaps annotation of resources by their formats as audio, video, etc. could be taken as describing them by their accessibility attributes.

5 Discussion

This paper aimed at making environmental scan of digital services that can be available through different types of libraries and asked, “What digital services are available through libraries? What steps are being taken to make them accessible for users with disabilities? What are the challenges for providing accessible digital services? What approaches could be considered to realize inclusive digital library environments?”

The case of libraries included in this study showed that libraries could be involved in content production and presentation. List of digital services possible through today’s libraries include access to locally produced resources, presentation of translated content, access to subscribed eResources, resource discovery tools, ezproxy, link resolvers, production of movies; maintenance of movie archives, digital repositories, open access journals; user-tailored resource pages, MOOC pages, digitization of resources, etc.

The case of libraries being involved in production of electronic resources gives them the opportunity to consider approaches that make the resources accessible to all. Their recognition of universal design at least as a requirement under the country’s law; the startups to present textual content in PDF or PDF/A, EPUB, and HTML alternatives; and efforts on making digitized content accessible to screen readers could be taken as steps towards the right direction.

The study on the selected libraries, however, identified the tendency of relating universal design to fulfillment of WCAG guidelines and limiting the role of those guidelines to development of accessible websites. If utilized, WCAG 2.0 could help libraries in designing accessible digital products. For example, it can offer them guidelines for making text content readable and understandable to all users including users with assistive technologies. It may also help to present content in different ways, produce movies in a way that won’t cause seizures on some users, and provide alternative text to videos or non-text formats so that the content can be available in forms such as large text, braille, symbols etc. However, the question is whether WCAG would be sufficient to serve as a framework to ensure inclusive digital library environments. As a matter of fact, the guidelines from WAI (including WCAG) has been critiqued for their emphasis on technical or design elements of accessibility, prompting others to fill the gap by putting more focus on organizational elements that impact digital inclusion[24]. A prominent example is the British Standard (BS) 8878, a process oriented standard aimed at helping organizations to embed inclusion strategically across key job-roles, policies, and decisions⁸.

As shown in this paper, the state of digital services in libraries presents a complicated scenario. First, today’s libraries host different types of resources acquired or subscribed from different vendors operating with different rules, and who would maintain some form of control over the collections. The fact that libraries negotiate access with vendors or copyrights holders shows that adherence to technical guidelines by itself won’t ensure accessibility of the resources to all users. Digitization of books could be taken as a good trend that promotes digital services. However, the measures being taken to safeguard intellectual rights could have the effect of excluding users who depend on

⁸ <https://www.access8878.co.uk/bs8878-overview.aspx>

text-to-speech technologies, presenting a tug-of-war situation between protecting the right of access and the right of intellectual property protection. This underlines the need of including demands of universal design in the negotiations. Therefore, activities related to accessibility evaluation need to extend to evaluating the relationships between libraries and content providers. Second, the issue related to resource discovery tools could extend to the use of metadata to describe resources by their accessibility features so that they can be easily discovered by their users. Third, the fact that digital services are run on different technological platforms and managed by different groups of professionals such as librarians, IT Experts, and others adds up to the complexity of the environment. To sum up, the scenario of digital services in libraries calls for development of a framework that identifies all activities, processes, job roles and responsibilities, and provides a template for evaluating accessibility of the technical as well as non-technical aspects of the services. Therefore, in addition to WCAG 2.0 guidelines, libraries need to be open for inspirations from other standards such as BS 8878.

This study showed the trend where libraries support users with special needs through setup of physical facilities and referring them to the NLB for further assistance. However, this may need to change, at least in digital services, for at least two reasons. First, the Norwegian Discrimination and Accessibility act §12 states that “Breach of the duty to ensure universal design pursuant to section 13 or the duty to ensure individual accommodation in sections 16, 17 and 26 shall constitute discrimination.”⁹ The law itself requires the services to be inclusive. Second, as a paper on higher education in Norway¹⁰ showed, there is a model under development for production of talking books at a local higher education institute library, as part of the effort for making higher education accessible. This shows that the duties and responsibilities of NLB would be shared by academic libraries. Such developments entail the acceptance of the need of inclusive services at organizational level and strive to make services accessible and usable to all to the extent possible.

6 Directions for Further Research

Issues that might be interesting research directions for further studies have been identified during the course of this research. For instance, the utilization of LeapMotion or related technologies in gesture-based interactions can be extended as developments that help, for instance people with motor impairments, to browse through library catalogs. Use of apps to locate and find books has also the potential to help any user to navigate to the place where a book is shelved. Development of applications that allow users to access digitized content with or without assistive devices, but at the same time protect the intellectual right of the creator, could be perused as an endeavor that benefits both the user and the content creator. The issue of resource discovery and access in library systems is the other challenging area. The way resource discovery tools are being designed can simplify or complicate the process of information search and retrieval for users with different types of impairments. Research and development to help these

⁹ <http://app.uio.no/ub/ujur/oversatte-lover/data/lov-20130621-061-eng.pdf>

¹⁰ <http://www.universell.no/english/>

groups of users to easily discover and access resource that fit their needs can be an important direction.

Beside the technical issues, the need for a holistic approach or framework that helps to ensure inclusive information resources has been highlighted in this paper. There has been a recommendation from past research that the Functional Requirements of Bibliographic Records (FRBR), which was first developed by International Federation of Library Associations, could be grown as a model for inclusive information environment [25]. Re-examination of this model or development of a better model could yet be another direction for further research.

7 Conclusion

This paper showed that there are potentials, opportunities, and also challenges to realize inclusive digital services. Startups and future considerations regarding production of local contents in alternative formats and utilization of WCAG guidelines to design accessible websites, as well as works on application of technology in libraries provide the basis for promoting the agenda of universal design in libraries. However as mentioned at the start of the paper, the best way for realizing inclusive digital library environments could be to address the technical and non-technical processes surrounding creation, acquisition, organization, and presentation of information resources to their potential users. The case of libraries discussed in this paper shows a trend of associating universal design with fulfillment of WCAG 2.0 guidelines which may not help in addressing organizational and policy related issues that need to be considered.

The scenario of current digital services is characterized by different types of resources managed on different technological platforms, controlled directly or indirectly by different actors involved in the production and organization of information, and run by diverse human resources. This calls for a holistic approach that helps to incorporate concerns of universal design in tasks, processes, activities, procedures, policies, rules and regulations involved in running digital services.

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Paper 4

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A Case for Adaptation to Enhance Usability and Accessibility of Library Resource Discovery Tools

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Abstract. Library resource discovery tools (RDTs) are the latest generation of library catalogs that enable searching across disparate databases and repositories from a single search box. Although such “Google-like” experience has been applauded as a benefit for library users, there still exist usability and accessibility problems related to the diversity of user goals, needs, and preferences. To better understand these problems, we conducted an extensive literature review and in this process, we initially grouped issues into three categories: interface, resource description, and navigation. Based on these categories, we propose adaptation as an alternative approach to enhance the usability and accessibility of RDTs. The adaptations could be conducted on three levels pertaining to categories of issues found, namely: interface, information, and navigation level. The goal of this paper is to suggest how the process of adaptation could be considered in order to mitigate usability and accessibility issues of RDT interfaces.

Keywords: Digital library accessibility · Usability · Web accessibility · Digital libraries · Universal access of information · Adaptation

1 Introduction

The advent of the digital technology has caused the proliferation of information resources in digital formats. As a result, we see libraries engaged in the presentation of digital content, management of institutional repositories and open access journals, production and management of educational movies, provision of access to online resources, and mass digitization of print resources [1]. Moreover, presentation of books in eBook, audiobook and braille versions and production of text in PDF, HTML, and EPUB alternatives are among the notable activities observed in digital library environments [1]. All those efforts contribute to libraries’ tradition of collecting and organizing information for supporting research, development, and other activities in their parent organizations.

As libraries continue to embrace technology, user’s interaction with libraries is also becoming increasingly reliant on library search tools. Driven by the apparent motive of improving the user experience, the tools have evolved from simple card catalogs to web-based catalogs, web-based catalogs augmented with recommenders, metasearch

tools, and eventually to web scale resource discovery tools (henceforth referred to as RDTs) [2].

RDTs are referred to as the “new generation library catalogs” which offer a single point of access to library resources as well as databases that libraries have subscribed to [3, 4]. They provide users with “simple, fast and easy “Google-like” search experience,” present librarians with statistics on the usage of their holdings, and offer content providers an alternative channel to increase usage of their resources [5, 6]. The “Google-like” experience is explained as the possibility of using a single search box to simultaneously search across in-house and remote databases in a manner suitable even to inexperienced users [6].

RDTs are available as commercial and as open source products [2]. Depending on their design, their interfaces could include advanced search options, options for filtering search results, results ranking, cloud of search terms, resource descriptions (resource overview), cover images or thumbnails of titles, icons, push technologies such as RSS feeds, recommenders and other features [7, 8]. Figure 1 provides an example of an RDT, which is currently being used by Norwegian academic and research libraries.

Apparently, developments in library search tools are fueled by the need to improve their usability. However, the demands of universal design and the subsequent need for reaching all users, make accessibility an important issue to consider along with usability.

The screenshot displays the Oria discovery tool interface. At the top, the header includes the UiO logo, the text "Knowledge changes everything", and navigation links: "New Search", "Databases", "E-journals", "Can't find it?", and "Help". On the right side of the header, there are links for "Guest", "English", "e-Shelf", "My Account", and "Sign in".

The main search area features a search box containing the text "the snowman" and a "Search" button. To the right of the search box are links for "Advanced Search" and "Browse Search". Below the search box, the results are displayed as "Results 1 - 10 of 1,075 in Primo Local Repository". The results are sorted by "Relevance".

On the left side, there are several filter sections: "Personalize your results" (with an "Edit" link), "Expand My Results" (with options like "Include material your institution doesn't have access to" and "Show only"), and "Refine My Results" (with a "Resource Type" section listing "Articles (580)", "Reviews (232)", and "Newspaper Articles (144)").

The search results list includes three items:

- Snømannen**: R.L. Stine 1943- Jukebox klubben 1996. Fulltext available. Click Get it to see which institutions that have a physical copy. Links: View It, Get It, Details.
- Pass deg for snømannen**: R.L. Stine 1943- 2000. Fulltext available. Click Get it to see which institutions that have a physical copy. Links: View It, Get It, Details.
- The snowman.(Poetry and Medicine)(Poem)**: Shectman, Robin. JAMA, The Journal of the American Medical Association, Dec 18, 2002, Vol.288(23), p.2936(1) [Peer Reviewed Journal]. Full text available. Links: View It, Get It, Details.

Annotations with arrows point to the search box, the filters section, the "Advanced search options" link, and the "Results list" section.

Fig. 1. The Oria discovery tool as implemented by the University of Oslo (UiO) library.

Libraries have been working to comply with accessibility requirements through the adoption of technical guidelines such as the Web Content Accessibility Guidelines (WCAG) [1]. Research shows that such activities have been largely limited to library websites and the studies have been mostly evaluative – examining to what extent the websites meet accessibility standards [1, 9]. However, research also shows instances where a website can be designed to pass the maximum AAA level accessibility test according to WCAG 2.0, but remain unusable to those it was intended for [10]. Therefore, researchers recommend to consider the adaptability approach, which builds on the guidelines-based approach, but emphasizes on matching resources with users' needs and preferences [11]. The fact that different types of users, with different goals and needs, use libraries would provide a justification for exploring this approach.

Therefore, this paper aims at exploring how usability and accessibility of RDTs could be improved through the adaptability approach. First, it discusses usability issues uncovered in different studies. Then, it presents accessibility issues as discussed in the literature, with a particular emphasis on a prior study that examined the accessibility of a library RDT from the user perspective. In relation to this, it discusses adaptability approaches from literature and attempts to show how they could be used to improve the accessibility and usability of library RDTs. Finally, the paper closes with conclusion and pointers for future work.

2 Usability of Library Discovery Tools

Usability studies on library RDTs have discussed advantages as well as weaknesses of the tools. For instance, Prommann and Zhang [12] evaluated Ex Libris® Primo¹ and said that the tool is suitable for groups of users with different goals and helps the users to conduct many tasks with a minimum amount of steps. They added that Primo allows filtering search results in different ways without the need of re-entering the search keywords. Moreover, they noted that Primo enables comparing search results via the *details* tabs found under each title, and offers “smooth transition” to external websites when needed [12]. A usability test made on EBSCO discovery service (EDS)² mentioned the ease of use and the possibility to narrow search results as its benefits [13].

RDT interfaces are rich with functionalities that offer alternative ways for searching and filtering. However, this could be a source of problem for some users. For instance, the study made on EDS found that the many features of the interface were found to be “overwhelming” or “confusing” for some users [13]. Studies hint that users might give little attention to end-user features other than the search box [14–16]. Users would also face confusion regarding the location of filters/facets (e.g., whether to look for “music” under *format* or *topic*) [13, 15]. Some would confuse resource types (e.g., eBooks with audio books) and face difficulty in choosing the right filter that helps to narrow the search down to the resource type they want [17]. Other problems include the ‘excessive’ number of clicks it takes to access electronic resources, irrelevant search results,

¹ <http://www.exlibrisgroup.com/category/PrimoOverview>.

² <https://www.ebscohost.com/discovery>.

difficulty in understanding jargons (for instance, mistaking “reviews” for peer-reviewed journals), and librarians’ limitations in providing an “understandable language” [12, 18]. Moreover, inconsistent metadata, inability to save search results, and RDT’s failure to distinguish eBooks from journal articles constitute a list of usability problems [12, 19].

Studies that noted the complexity involved in using library search tools quote Nielsen [20] suggesting that simple interfaces are the most effective ones [14]. Moreover, they showed that the selection and positioning of end-user features could affect the usability of resources behind the interfaces. For instance, Teague-Rector et al. [21] found that presenting search alternatives such as articles, books and journal titles with tabs instead of drop-down menus resulted in better exposure of resources stored in disparate silos. The experiment by Teague-Rector et al. [14] also showed that moving the search box from left to the center of the interface increased the number of searches conducted. Some attribute this to Google, which could have shaped users’ expectation to see the search box at the center [22, 23].

A solution raised in connection with simple search interfaces is the ‘progressive disclosure’ approach, where the interface is designed to show some of the most important features at startup and supply the more advanced ones later as required by the user [14, 24]. Differentiating less and more important features, however, would require considering different factors. First, users’ information needs, information seeking behavior, tasks and task models, goals and their experience of other search systems would need to be factored in [14, 22]. Paternò and Mancini [25] claimed that this could be tackled through the adaptation approach. Second, libraries require RDTs to expose resources to the right users and help to increase usage of library collections, in order to justify the cost of maintaining them [26]. Hence, the design of RDTs would require balancing the needs, preferences, and behaviors of users with the interest of the libraries. In addition to that, it could be important to note that libraries are increasingly adopting commercial discovery tools that won’t leave much room for customization [1]. This could limit their ability to influence the interface design.

In general, usability issues involving RDTs are related to interface level issues (e.g., simplicity vs comprehensibility), end-user features (e.g., search box, filters, results list presentation) and resource description and organization (e.g., language/jargon used to label features, metadata, and resource description). The next section compares these with accessibility issues explored mainly through a prior study made on a library RDT.

3 Accessibility of Resource Discovery Tools

Accessibility is a concept often discussed along with disability. It can have different meanings based on the model of disability used. For instance, the medical model interprets disability as a mental or physical limitation of an individual, whereas the social model treats it as a failure of the environment to accommodate the needs of people with disability [27]. This paper adopts the conceptualization as presented by the International Classification of Functionality, Disability and Health (ICF) model, which interprets disability as a result of medical and/or contextual (personal and environmental) factors [28]. Therefore, accessibility could be seen as a way of identifying and

dealing with sources of impediments, either personal or environmental, in human computer interaction.

Most studies conducted regarding the accessibility of digital library services were related to library websites [29, 30]. Many of them used automatic testing tools to check conformance of library websites to WCAG guidelines [9, 29]. Though studies related to library RDTs are few, some of them identified the needs people with disabilities could have during their interaction with library search tools. For instance, Berget and Sandnes [31] stated that people with dyslexia are prone to making spelling errors while typing search terms. Therefore, they recommended search tools to be error tolerant and support autocomplete features in order to reduce the effects of dyslexia. Another study by Berget and Sandnes [32] found that users with dyslexia formulate more queries and spend much time while searching on databases which lack query support features. Therefore, they claimed that such tools are not accessible for users with dyslexia. Similarly, Habib et al. [33] found that users with dyslexia shun search functions of virtual learning environments which do not tolerate typographical or spelling mistakes.

A study conducted by Beyene [17] on Oria, a library RDT used in Norwegian research and academic libraries (as shown in Fig. 1), confirmed the findings of the studies mentioned above. However, it also provided a glimpse into the challenge associated with diversity in needs and preferences. For instance, two participants with dyslexia had different reactions regarding the colors highlighting the search terms in the results list: one of them saying that the highlights are distracting, while the other saying they are helpful (see Fig. 2). A user with low vision impairment liked the autofill suggestions, while another participant with the same impairment said the suggestions are annoying if cannot be read correctly by his screen reader software. Participants with dyslexia generally liked the use of icons among resource descriptions, while some users with low-vision impairment did not find them helpful. Such examples were many, but in general, the accessibility issues explored in this study could be broadly classified as interface level issues, search results presentation, and navigation related. Next, we compare issues discussed in Sect. 2 with accessibility problems explored mainly in Beyene [17], to recommend an approach that could be used to address the combined concerns of usability and accessibility.

3.1 Interface

A typical interface design issue that causes usability problems for users is the tendency of “overpopulating” the interface with different features [13]. This is also identified as an accessibility problem that could cause strain to users with dyslexia and visual impairments who might use various assistive technologies [17]. In addition to that, the suitability of background and foreground colors; font type, size and intensity have been among accessibility issues identified by participants in the aforementioned study. Moreover, the blurring or disappearance of text and icons when the interface is changed to high contrast was a problem for some users with low vision impairment [17].

Libraries using the same discovery product could follow different styles regarding background and foreground colors of the interface. For example, libraries at University of Oslo and Oslo and Akershus University College use Oria, a discovery tool built

upon Ex Libris® Primo. However, CSS-related differences are quite noticeable on their respective search interfaces. This shows that some accessibility problems could emanate not only from the product, but also from the implementation of the product.

3.2 Search Results Presentation

RDTs typically present search results supported with metaphors and visual cues. For example, in Oria, each resource title is complemented with an icon or cover image to show whether the material is an eBook, article, audio book or any other type of resource. Visual cues are also used to indicate the availability of a material in the library system; green for availability and yellow for unavailability.

The “details” link included with each title leads to detailed information, such as the publisher, date of publication, series, and other descriptions about the resource. Usability studies regard these as important for comparing search results, but they mention metadata inconsistency as a problem [22]. On the other hand, these could be “too much information” for users with cognitive and other forms of print disability [17].

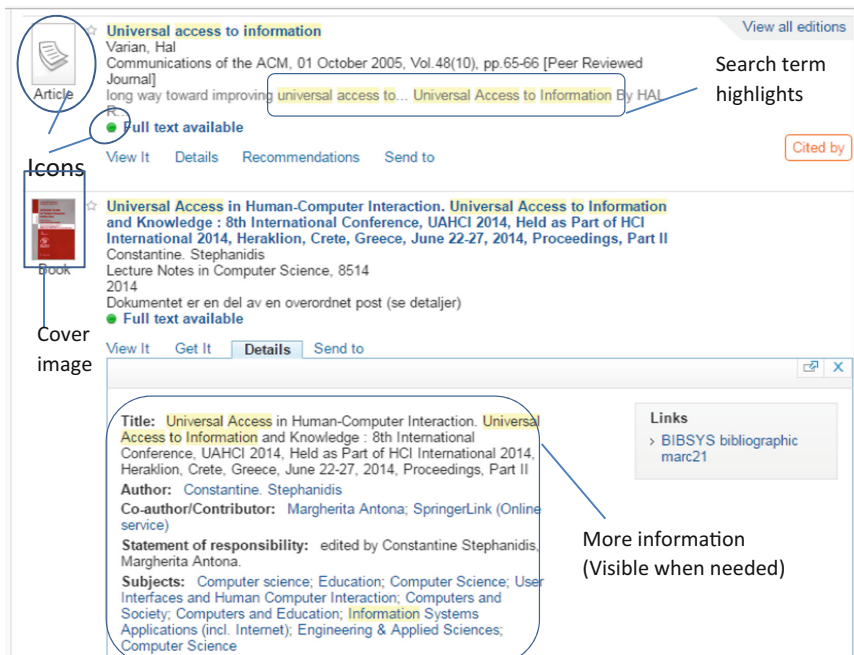


Fig. 2. A snippet of search result list for “universal access to information.” (Color figure online)

Beyene [17] also emphasized the importance of technical metadata (also called as accessibility metadata) that could provide important information for users with disabilities (e.g., whether a resource is accessible by text-to-speech tools, whether it is

behind a paywall). A study made on selected libraries showed that the use of accessibility metadata is not yet well explored [1].

3.3 Navigation

Accessing electronic journals or eBooks is a lengthy process that requires clicking multiple links, which at times takes the user out of the library interface. The possibility of “smooth navigation to other web pages” has been mentioned as an important usability trait of library RDTs [12]. However, this type of navigation could discourage users with a disability from using a library RDT [17]. Related to this, a problem pertaining to navigation of websites is the poor or inaccurate labeling of links [34]. This could pose a problem for users of screen reader technologies, such as JAWS, which generates a list of links to facilitate the navigation [17].

The examples discussed so far show the diversity in needs and preferences even among users with similar disabilities. As discussed by Kelly et al. [11] and Paternò and Mancini [25], adaptation seems a viable alternative to improve accessibility and usability. Next, we attempt to explain how this could be applied to library RDTs.

4 Adaptation: Addressing Accessibility and Usability

Adaptation has been discussed in terms of facilitating ease of interaction, quick discovery of information [35], adjusting web-based systems to accommodate user diversity [25, 35] and ‘individualization’ of solutions as opposed to the “one-size-fits-all” approach [36]. A study by Knutov et al. [37] classified the works on adaptation as *content*, *presentation* and *navigation* adaptation. Valencia et al. [38] claim that works on the adaptation of websites have largely been restricted to transcoding functionality and focused on “a single group” such as elderly people, people with limited mobility, and blind people. They sought to adapt web pages through the annotation approach based on WAI-ARIA³. Using similar approach, Ferati and Sulejmani [34] introduced techniques that can automatically increase website accessibility through a link, image, and navigation enrichment.

Literature shows two types of adaptation techniques: *adaptable* and *adaptive* [36, 39]. The *adaptable* approach allows users to control the behavior of the system by specifying their needs and preferences. The *adaptive* approach is an automatic process where the system learns user’s behavior from his/her interaction history and adapts the interface automatically [40]. As explained by Peißner [36], the adaptable systems give the user total control to change the appearance of the interfaces from his/her perspective. However, it would be taxing to users to spend time doing the modifications. On the other hand, the adaptive approach would let the system do the modifications on user’s behalf. However, those automatic changes could confuse some users [25].

The pros and cons of both approaches in library environments could be weighed at least from two different perspectives. First, the tradition of libraries where privacy is

³ <https://www.w3.org/TR/wai-aria-1.1/>.

sacrosanct would discourage collecting any type of information from the user. That goes to the extent of deleting log files and loan history [41]. Second, as it can be learned from the discussion made so far, it could be impractical to profile people by their disabilities as people with similar disability could have different accessibility-related needs. This would, therefore, entail empowering users to choose the mode of interaction that better suits their needs, which makes the adaptable approach a better way to start the adaptation of RDTs.

4.1 Adaptation of Library Resource Discovery Tools

Paternò and Mancini [25] presented levels of adaptation that can be considered for helping users in an information space: *Presentation*, *Information*, and *Navigation* levels. This type of categorization seems well aligned to the categorization of accessibility and usability problems presented in Sect. 3. We have not come across works that attempted this approach for improving accessibility and usability of library RDTs at these three levels. However, there are some examples that could be discussed here in order to suggest adaptation at the three levels.

Interface/Presentation Level Adaptation. Needs related to the interface elements such as the search box, filters, results list, background and foreground color, and font type and size, could be considered as elements of *presentation* level adaptation. There are some examples of presentation/interface level adaptation available, though not related to libraries. For instance, the Cloud4All home page⁴ shows how a web page can be adapted to the needs of those who prefer to use it in high contrast mode and/or to those who do not like images and prefer big fonts. The other option that can be mentioned here is to imitate the Gmail interface by providing *standard* and *basic/html* views, as suggested by a user with low vision impairment [17]. The standard view is supposed to be used by a standard user and the basic/html view is to be used by people who want to have a simplified view. Another example that could be related to interface level adaptation is *Accessibility Toolbar*⁵, an open source toolbar that can be installed on web browsers to help users customize the way they view and interact with web pages [42]. Considerations could be made to enable users to change the interface characteristics from their profiles or to have an external toolbar to change elements on the interface.

Information Level Adaptation. The information provided regarding the search results including titles, icons and other visual cues, list of alternative formats (audio, video or textual alternatives such as PDF, HTML and EPUB), and resource description/metadata (e.g., title, subject, format, abstract/review, accessibility to text-to-speech tools, etc.), can be considered for an information level adaptation. A closely related work that can be mentioned here is a case presented by researchers from the eLearning community⁶. The search interface of the education media library

⁴ <http://www.cloud4all.info/>.

⁵ <https://www.atbar.org/>.

⁶ <http://www.a11ymetadata.org/accessibility-metadata-in-action-at-teachers-domain/>.

showcases the use of accessibility metadata for faceted search – to filter resources by their accessibility attributes. For example, a person with hearing impairment can use filters to display only videos with subtitles. The user can also set his needs and preferences in his profile to see the search results coming up with kind of information he/she needs. For instance, if a hearing-impaired person wants videos with captions to appear in search results, he can log in his profile and set his accessibility preference, indicating he prefers videos with captions. The next time he searches, the result list displays a list of videos with additional information: videos with captions come up with a label “accessible” whereas those without caption display the label “inaccessible”.

Not all users would need or want icons or other pictorial representations and not all of them would require information on the accessibility of the resources [17]. Therefore, it would be important to enable turning them on and off, depending on the user’s needs.

Navigation Level Adaptation. The different methods of navigation users require in an information space could be treated as an issue of *Navigation* level adaptation. The study by Ferati and Sulejmani [34] showed that poor link descriptions cause navigational problems. The solution they provided for automatic enrichment of links could be suggested for RDT interfaces.

Experiments and further research would be required to weigh the applicability of those examples to design adaptable RDTs. The best of the three examples given above could also be combined to experiment adaptation of RDTs at different levels.

5 Conclusion and Future Work

Library discovery tools have evolved to a web scale search tools that offer users a one-point access to multiple repositories and databases. However, the usability and accessibility issues explored in this paper suggest the need for simplifying knowledge discovery and access to all users. Users are diverse in terms of needs, goals, preferences and disabilities. Library search interfaces are rich with different features, which aid resource discovery and access. However, they could also present a scene of complication for some users, especially for those with different types of disabilities.

The primary goal of this paper was to build a case for the adaptation of library RDTs based on a literature review and empirical findings, and then to provide examples that could be followed. The overall discussion shows that adaptation can be done at interface/presentation, information, and navigation levels to entertain the accessibility and usability needs of diverse users. The study focused on providing suggestions on how to empower users to make their own choices regarding their interaction with library search tools. Therefore, examples that conform to the adaptable approach were presented to suggest their applicability for adaptation of RDTs at presentation, information, and navigation levels. As future steps, we initially intend to develop a prototype informed by best practices as discussed in the above section. Using this prototype, we will then conduct experiments to compare several designs, which would result in design recommendations that could inform future endeavors related to RDTs.

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Paper 5

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Paper 6

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Paper 7

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Improving Resource Discovery and Access through User-Controlled Adaptation: Exploring the Role of Library Metadata

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Abstract. Accessibility of library search tools is measured not only by their adherence to accessibility guidelines, but also by the ease they offer users to find accessible resources. This makes library metadata an object of study in library accessibility. Past studies encouraged exploring the application of metadata in fostering accessibility. The studies also recommend considering user requirements. This study aimed to examine the role of metadata in making the process of resource discovery and access accessible to people with low vision impairments. Based on recommendations of past studies, a simple prototype was developed to test the idea of allowing users to set their own metadata preferences on their search interfaces. Participants were recruited to explore the prototype. The initial findings showed that adding such option in preference settings may be more appealing to frequent users than “one-time” users. However, the participants were able to provide comments on what to improve for the next iteration.

Keywords: Digital Accessibility, universal design, accessible search, accessibility metadata, library metadata

1 Introduction

Search interfaces are what stand between users and multitudes of information resources such as ebooks, multimedia and others stored in digital library environments. Therefore, the way they are designed affects user’s experience in resource discovery and access. Literature shows that libraries are increasingly using developments in web accessibility to make their websites as well as search interfaces accessible to people with disabilities [1][2][3][4]. However, compliance to guidelines may not guarantee accessibility and usability of search interfaces in the overall user-information interaction partly for the following reasons:

- Library search tools are used by diverse group of users whose needs and preferences may contradict each other [5].

- For the average user, the search tools are about finding a resource. However, for people with disability, it could be about finding an accessible resource. Therefore, the accessibility of search interfaces is determined not only by their compliance to accessibility guidelines, but also by the ease they offer users to find resources accessible to them [5][6]. This extends the span of accessibility to include library metadata.

There have been studies conducted on accessibility of library search interfaces. However, there is a shortage of works that focus on the process of resource discovery and access. Moreover, there are very few that examine the role of metadata. This paper aims to examine the roles library metadata could play in making the process more accessible to users with low vision impairments.

Discussing best practices for designing search interfaces, Resnick and Vaughan [7:782] stated, “Any system that includes metadata must consider what fields are relevant”. Resnick and Vaughan also recommended that the process of creating metadata fields should be informed by user requirements. In this paper, we ask: which metadata fields are more relevant for users with low vision impairment? How could metadata be harnessed for enhancing user experience in resource discovery and access? To answer the questions, a simple prototype informed by past studies was developed to be tested by users with low vision impairments. The findings are compared with existing literature to recommend how library search tools could be augmented to serve the purpose of accessibility and inclusive design.

The rest of the paper is organized as follows: Next, a literature review is presented followed by explanations of the methodology used in the study. Then the findings are presented to be discussed in the section that follows. Finally, the paper closes with conclusive remarks and recommendations for the next iteration of the prototype.

2 Literature Review

2.1. Barriers of Access for People with Visual impairments

Library catalogs have evolved to the current web-scale resource discovery tools that provide improved interface to submit queries, receive results, and make content selections [8]. Depending on their design, they may include features such as a search box, search results, visual cues to the results, links, and tools for faceted navigation [8]. The overall evolution is partly driven by the need for improving users’ experience in resource discovery and access.

Studies, however, show that library search tools are complex to use when compared with Internet search engines [4][9][10]. For instance, Horwath [11] revealed that rich graphic interfaces and complex web designs would pose barriers to users of screen reader technologies. Beyene [5] also confirmed that such interfaces turn away some users with low-vision impairments.

Yoon, Dols and Hulscher [12] reported that the most common barriers their study identified were related to navigation. They categorized navigational problems as linearization and semantic issues. Linearization refers to the order screen reader technologies follow to read contents of HTML documents. Yoon et al. [12] claimed that linearization caused cognitive overload to their study participants by requiring

them “to “read” far more irrelevant text just to find the information they were looking for. The semantic issues included poor link labeling, lack of context in a surrounding text and lack of descriptive attributes in the HTML code [12]. The study by Beyene [5] confirmed the presence of such problems showing that there were links simply labeled as “link 1”, “link 2”, etc.

Beyene [5] illustrated that a user may finally succeed in searching and retrieving an ebook just to find that it is not accessible to screen readers or is behind a paywall. This would be frustrating for some users with visual impairments. Some studies recommend that adding metadata fields to describe resources by their accessibility attributes (e.g. whether a document is accessible to screen readers) would help a user to inspect the results list and judge whether a material is suitable for him [6][13][14].

The examples provided above show that the accessibility of library search tools is dependent not only on the designer’s compliance to accessibility guidelines but also on the knowledge representation and organization schemes followed by librarians or content (database) vendors. Moreover, the diversity in needs and preferences of users makes the problem even more complex. Some scholars, therefore, suggested complimenting the compliance-based approach with the adaptation approach to adapt the search tools to each user’s needs and preferences [15]. Beyene and Ferati [15] and Paternò & Mancini [16] therefore recommended tackling the problems by breaking them down into three categories: presentation level, information level and navigation level issues.

2.2. The role of metadata

Metadata provides users with input, control or informational support [17]. As part of the input support, metadata offers users the capability for lookup and exploratory searches [17][18]. Lookup search refers to the process of typing a query and checking the search results whereas exploratory search involves using faceted metadata to browse for a material of potential interest [18][19]. Examples of the control support could be the filters on search interfaces which are used to narrow down search results [17]. The informational support could be exemplified by the metadata information such as author, title, abstract and others which help the user to decide on a resource’s suitability for his/her needs. Therefore, a “well-designed use of metadata” can help in resolving problems at information and navigation levels mentioned above [17].

Scholars recommend considering metadata as integral component of search interface design [7][17]. Efforts aimed at designing accessible search interfaces thus need to incorporate the use of metadata for improving the search experience of users with disabilities. However, there are not many examples of related works. Few of the available works include an accessibility metadata project which is linked to the eLearning community and some digital libraries which incorporated the recommendations from the project for annotating their resources¹. The intent of the accessibility metadata was described as offering vocabularies for annotating resources by their accessibility attributes and making it easy for people with disability to find accessible resources [20].

¹ www.allymetadata.org

The study by Beyene and Godwin [6] entitled “Accessible Search and The Role of Metadata” provided design recommendations on how metadata could be employed to design accessible library search interfaces. The conclusions from that study and others mentioned above were that:

- Metadata could be used to improve accessibility of search interfaces to people with print disabilities. That can be done by providing information on the accessibility qualities of an information resource (e.g., accessible/not accessible to screen reader technologies, with/without caption, etc.)
- Information which is crucial for some could be irrelevant to others and vice versa. Current library search tools apply the view more/less toggle to limit the amount of information displayed with search results. However, users may need be given the opportunity to decide on which information should always be visible and which should be hidden behind a “view more/less” functionality.
- Users may opt to have shortcuts by faceted metadata; e.g. genre, resource type (audio books, braille, etc.), series, “popularity” and others to conduct exploratory searches.
- Therefore, it might be advisable to improve search interfaces, by augmenting the already existing preference settings to allow users configure their own tools, as they deem necessary.

3. Methodology

3.1. The prototype

An interactive hi-fi prototype, informed by the studies discussed above, was developed to be tested by users with low vision impairment. The search interface as shown by Fig.1. provides a single search box with sample shortcuts/filters for resource types such as PDFs, eBooks, audiobooks, Braille, Video and ‘new books’; which can be added or removed by the user.

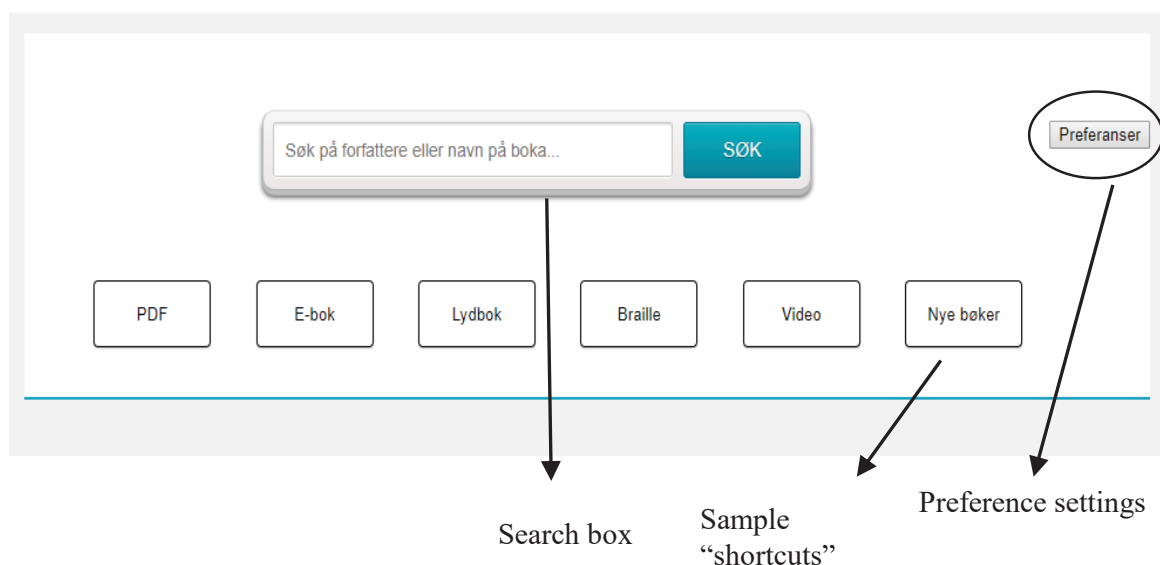


Fig 1. The search interface

The prototype includes a preferences setting, shown by Fig. 2, designed to give the user the option to limit the amount/type of metadata information that should always be shown in the results list above the view more/less options. As discussed in the literature review, this would help screen reader users to quickly go through the results list without reading “unnecessary information”. The intent is to offer the user the flexibility to configure the results list, as he/she deems necessary.

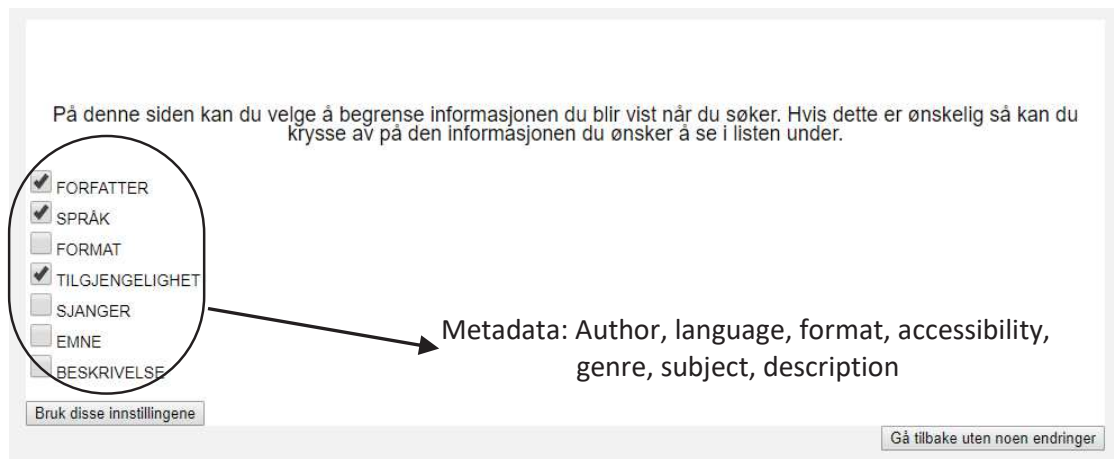


Fig 2. Preference settings

Figure 3 shows a sample search results presentation where a user has specified information on author, language, and accessibility to be visible while the rest is hidden behind the view more/less button.

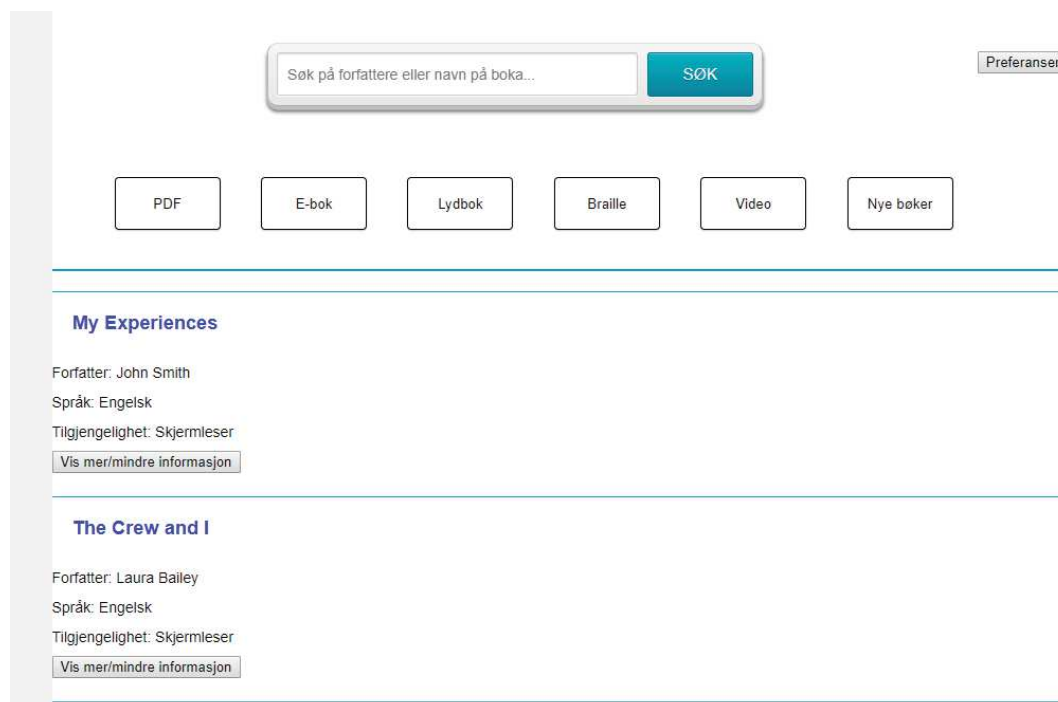


Fig 3. A sample search result with minimized information

Fig 4 shows what would happen if the user chooses to view the whole metadata information.

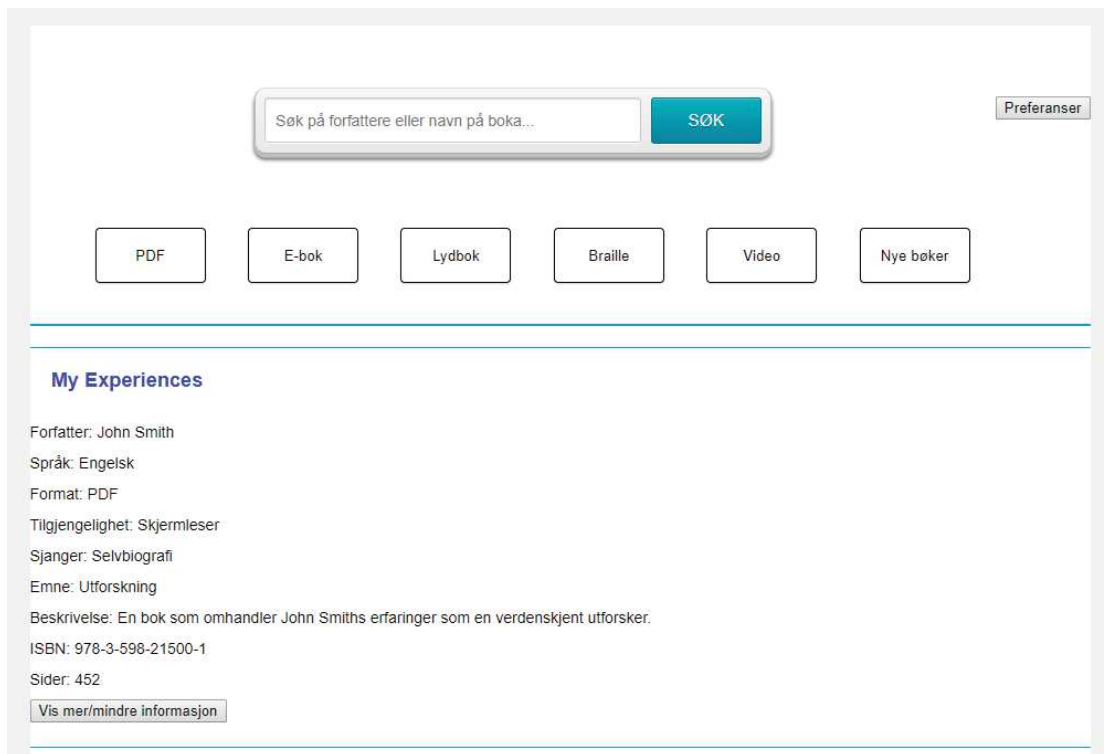


Fig 4. A sample results presentation

Moreover, the prototype included a sample searchable database. The prototype at this stage was designed an initial opinion-gathering tool that can be improved for further interactions to include not only metadata preferences but also others related to fonts, backgrounds, and other features.

3.2. Participants

The literature of usability testing shows that there is no fixed law on the minimum number of participants to include in user tests. They state that is dependent on the type of test and the time and money one has to conduct the test [21]. The cost-benefit analysis discussed by Nielsen [22][23] sets the optimal ration 3 to 5 users.

Efforts were made to recruit participants for this study through the disability-related advocacy organizations in Norway. However, the process has proved to be challenging, as we were able to recruit only three participants at this stage. Two of them were female while one of them was male. One of them uses screen reader technology whereas the others just used the magnification tools available on web browser. One of them said that he is a retiree; one other said she works and studies while the other mentioned she is employed at some institution. All of the participants have provided informed consent to take part in the study.

3.3. Data collection and Analysis

The study is designed as a qualitative study. The participants were first guided through the prototype and given briefings on the purpose of the test. Moreover, as exemplified by Figures 2, 3 4, they were given pre-determined search tasks and were encouraged to test it with different preference settings. The sessions took from 30 to 60 minutes on a laptop presented to the participants. All of them needed screen magnification and making the mouse pointer bigger. As they progress through the tasks, the participants were encouraged to ask, “think aloud” and provide feedbacks. The conversations were recorded with an audio device and later transcribed for thematic analysis.

4. Results

All of the participants were quick to understand the idea behind the prototype, though one of them seemed to have some doubts on the need of adding metadata in the preference settings. That particular person said he would have preferred being able to choose different colors for the fonts and the background. After walkthroughs through the prototype and conducting search activities, the participants have given feedbacks that could be presented as follows.

4.1 Search Results Presentation and Metadata Preferences

The prototype included fields such as title, author, language, format, genre, subject, description, ISBN, number of pages, and accessibility. It surely did not include all elements in a particular metadata schema. The intent was to use these fields as starting points and invoke users to discuss what other type of information should be included. One of them said,

“A form of user reviews would actually be quite nice. I mean, the description is nice, but that’s usually written by the publisher, which wants to sell the book, so it’s often presented in the best way possible, but if I could read actual readers’ feedback, it would help me decide on whether I should get this book or not”

The other participant mentioned the need for information on alternative format. It was thought to see whether a material is available in audio and braille formats. One other respondent mentioned the need of subgenres. Speaking of her experience with library search tools, one of them said,

“... They have like 20000 results for “crime” novels, and I find that to be ridiculous, because that doesn’t help me at all. So I would like to be able to sort on subgenres again. Being able to choose subgenres [...] will let you limit the search result a lot before you search”

Existing library tools offer the capability of narrowing search results by different facets. It could, however, be a subject of further research to see to what extent those tools are helpful. One other feedback from a participant is to add a label “Research Results” just above the results list.

4.2. Setting Metadata Preferences.

Two of the participants explicitly stated that they don't like to see excessive information on search interfaces. Speaking of the metadata information presented after clicking a "view more" button, the other participant said, «I think this is a bit overwhelming». When experimenting with the preference settings, one of them selected author and subject, one other selected the field for accessibility (which states whether the book he selected is accessible to screen readers), and the other experimented with genre and subject. During the activities, they have been experimenting with the show more/less buttons.

When asked about the importance of controlling the metadata information in the way they did, all of them concurred that it could be a good idea. One of them however said that it might be meaningful for frequent users rather than "one-time" users. One other participant said that he could not see the full benefit of this functionality because of the small size of the database presented by the prototype.

4.3. Vocabularies

The participants also reflected on the use of keywords and terminologies for faceted metadata. One of them said the word "format", for her, signifies dimensions rather than file types. She recommended finding another expression such as "file format" or "file type". She also said the word "description" is also not clear. The word was meant to connote summaries, abstracts or more information about an item. Two participants commented on the use of the word "braille" and explained that "punkt" or "punktskrift" are the words used by Norwegian users [the language used on the prototype was Norwegian]. One of them said "lesepunkt" is the word used in the everyday speech. These feedbacks show the role vocabularies play to make search interfaces user friendly.

4.4. Shortcuts/Filters

One participant liked the idea of having one search box that can be used to perform searches either by author or by title. However, the need for alternative form of resource discovery was noted. One of them said,

"Sometimes you know exactly what you're looking for and then it'd be nice to filter, but other times it would be nice to just browse, [for instance], by resource format"

One participant said she liked the idea of creating shortcuts to some groups of resources on the home page of the search interface. She said she would prefer shortcuts by resource formats (ebook, braille, etc.), genre, 'last search', and common (popular) searches.

5. Discussion

The main purpose of improving accessibility is to identify and remove barriers that prevent users from accessing information, or give users the means to overcome the

barriers. In case of library search tools the barriers could be interpreted in terms of complex search interfaces, overwhelming amount of search results, overwhelming amount of metadata per search result, the difficulty to locate accessible resources, poor and faulty navigation, vocabulary and others which could largely be categorized as presentation, information and navigation level issues.

As discussed in the literature review, a “well-designed” metadata has the potential of resolving some problems related to information and navigation level [17]. Moreover as recommended in literature, the use of metadata in search systems should be informed by user requirements [7].

The intent of this study, therefore, was to answer the following questions: which metadata fields are more relevant for users with low vision impairment? How could they be harnessed for enhancing their experience in resource discovery and access?

5.1. “Relevant” metadata

The preliminary results didn’t show clear preferences to specific sets of metadata information. Two of the participants however recommended addition of information on “popular” resources and reviews from other users. Past studies show that users with print disability give high value to information about what other readers think about a resource [6]. This could be interpreted in different ways. One reason could be that they want to reduce their interaction with search systems and get an interesting or popular book. This would suggest the need of adding social metadata such as ratings, “likes”, and reviews on library search tools. The other more pronounced need the participants discussed was related to faceted metadata which was discussed in the relation to shortening navigation to a specific group of information resource.

The other issue is related to the nomenclature of metadata fields. Past studies already show that the vocabularies used on library search tools are difficult to understand to some users [24][25]. That by itself is a barrier to access. Participants of this study also affirmed the need for “user-friendly” resource descriptions. The case where a participant said the word “format” is ambiguous and the instance where the other participant discussed choice of terms for Norwegian language interfaces could be mentioned as examples.

The participants generally said they do not like excessive information to be shown on search interfaces. However, they didn’t discuss what type of information they don’t want to see. During the sessions, they were observed selecting fields from the preferences settings to experiment the view more/less options. From these simple experiments, it might be possible to say that it is important to leave the choice to the user in the manner demonstrated in the experiment.

5.2. Harnessing Metadata for Accessibility

One of the core objectives of this study was to see whether giving users the control over the search results presentation makes search interfaces easier and more effective to use. Studies show that users with print disability may not want to flip through many pages of results lists [5]. The option experimented in this study would help to squeeze more search results into the first page and thereby saving the user some

navigation overload. That would also make search interfaces handy for mobile interfaces.

It is worth mentioning that many library search interfaces do provide the view more/less option. However, they do not allow users to determine which information should be always visible. In this study, we tested giving users that control. Though the users understood the intent of the study, their reactions were mixed. As one of them said, that could be meaningful for the frequent users than for the “one-time” users.

As discussed in literature, there are studies that recommend labeling resources by their accessibility features [20]. This experiment intentionally included a metadata field for accessibility. One of the participants was seen experimenting with it. However, a study with a larger group would be necessary to assess the impact of accessibility metadata.

Faceted metadata has been used to filter search results after users submitted their queries [26]. The possibility discussed in this study was giving users the ability to set some of them as shortcuts at the home pages of their search interfaces. Berget and Sandnes [27] found that some users with disability would struggle to formulate queries on search tools which are intolerant to spelling errors and which don't offer autocomplete suggestions. Past studies [6] and this study show that filters such as ‘new books’, ‘popular books’, ‘past searches (history)’, ‘favorites’, ‘audio law books’ and others could provide an alternative way of searching by reducing the demand of keying in search terms.

5.3. Accessibility as Part of Preference Settings?

It would be worth remembering that library search tools and other search engines provide users with options for setting preferences by language, region etc. It would require research to see how well those functionalities are used. Nevertheless, the settings are there for whomever who chooses to use them. One recommendation from this study could be to augment those already existing functionalities to include options related to accessibility. That would help users to set their own accessibility preferences and control what should be displayed on their interfaces. That in the end would make the search tools usable and accessible to all to the extent possible.

5.4. Limitations

While our study shows that all participants understood the purpose of the study, the participants commented that the sample database included with the prototype was so small. Therefore, it did not give them enough chance to test and appreciate its advantage. Yet they recommended experimenting it with a larger set of database. Nevertheless, they did see a definite need for it in larger collections of resources. The other major limitation is the low number of participants who took part in the study.

6. Further work

For the next iteration of the prototype, we would improve all current features according to feedback gathered at the current stage. Some of the improvements will

be: increasing the size of the test database, improving the vocabulary and make them more user-friendly, and making the search results more distinguishable. Furthermore, the next iteration of the prototype will feature the possibility for the users themselves to control some of the design aspects of the search interface through additional sets of preferences. That includes things such as color, font types and sizes, and tools to add and remove shortcuts on the home page of the search interface. That would hopefully show how a search interface could be made adaptable to each user's needs and preferences. Furthermore, effort will be made to test the next iteration with a larger group of participants.

7. Conclusion

The value of this paper is more in the themes it offered for further research and the ideas it gathered for further improvement of the prototype. Based on the results found and the literature reviewed, we can however confirm that metadata has informational and navigational values that can improve accessibility and usability. Simplifying discovery of accessible resources and simplifying navigation amount to removing barriers of access to information. The solution tested in this study may be appealing more to frequent users. However, the idea of augmenting the preference settings of search interfaces to handle demands of accessibility would be an interesting undertaking for researchers as well as practitioners.

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