THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

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# Accessibility Analysis of Digital Libraries and Specialized Library Resources

**Objective**. The article focuses on the current state of library web content accessibility. **Methods**. 56 library websites of different countries (27 digital libraries and 29 specialized library resources for people with disabilities) have been successfully tested for the compliance with the WCAG 2.1 standards using the Webaccessibility.com service. Using the Alexa.com service the comparative analysis of the websites traffic ranking has been additionally conducted. **Results.** It has been established that only 3 websites out of 56 meet the accessibility standards of WCAG 2.1 with the compliance score of 92%. **Conclusions.** It has been concluded that the libraries' current practices of providing web content accessibility are insufficient. The emphasis has been placed on the need to optimize and promote specialized library resources and to implement a continuous audit of web content accessibility by means of automatic testing and engaging users with disabilities into these processes.

*Keywords*: digital library; digital library website; digital library for persons with disabilities; website accessibility; web accessibility; web accessibility for people with disabilities; web content accessibility guidelines; WCAG 2.1

## Introduction

Digitization is rapidly finding its way to all areas of the people's life, but still a lot of people do not have access to the most essential digital resources and are forced to fight for their use. Most particularly people with disabilities find themselves in the risk group and remain outside the digital society even in the countries with a high level of technology development and successful implementation of digital society strategies. Web accessibility for this category of users is the demand of times. In particular, it is becoming a priority to provide access to web content produced by libraries as they are institutions that produce, store and transmit information of social importance.

Libraries are working their way and adjusting to technological social development. Currently they are actively engaging in socio-communicative processes and are focusing on introduction of digital technologies and improvement of information, library and socio-communication technologies. The library's contribution to society with reference to people with disabilities is in performing the following functions: informational, cultural, educational, socializing and inclusive including but not limited to performing them in the digital environment. However, the standards of library's web content accessibility in different countries still do not meet the needs of users with disabilities and it makes it more difficult for libraries to perform the above

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THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

mentioned functions. It happens due to the lack of attention to this question in the library field at the institutional level and it is complicated by the dynamics of technological development.

This article sheds light on the current state of accessibility of both digital libraries, as they are universal resources for a wide number of users, and specialized library websites for people with disabilities and their compliance with the WCAG 2.1 standard.

The aim of the article is to examine the state of accessibility and the implementation level of different types of digital libraries and specialized library resources websites' content for people with disabilities.

## Literature review

An analysis of recent studies and publications shows that the question of web content accessibility is addressed from different angles. Groups of authors develop a methodology for selecting general criteria for adapting websites for people with disabilities (Horoshevskij & Matyunina, 2017); determine the structure of information materials, summarize the design of resources and the range of digital library services potentially needed by people with disabilities during social and educational inclusion (Devi & Verma, 2017; Xie et al., 2021; Spina & Cohen, 2018), analyze the national libraries' websites accessibility (Marina & Marin, 2019) and websites of research libraries and state institutions of different countries and their compliance with WCAG 2.0 standard (Pasichnyk et al., 2019); outline the possibilities of using digital library projects by different categories of users with disabilities (Xie et al., 2019), etc.

Since the introduction of the first (1999) and second editions (2008), Web content accessibility guidelines (WCAG) have become the main international standard for website accessibility, which has been seen as a "globally recognized and technology-neutral set of web content accessibility guides" ("*Information and Communication Technology (ICT)*", 2017). WCAG has been included into the legislative framework in Australia, Ireland, Israel, Italy, the Netherlands, Switzerland and the United Kingdom, and in France, Germany and the Republic of Korea it has been adapted to it. However, despite the broad introduction of WCAG 1.0 and WCAG 2.0 (WCAG 2.0, 2018), the content that complied with the guidelines was not always fully accessible by all categories of users with disabilities.

Considering the overall situation with web accessibility, the libraries' web content has not become generally available for people with disabilities during WCAG 1.0 and WCAG 2.0 functioning and in most countries its adaptation for the above mentioned user category has not become a priority among the other areas of institutional policy of library and information science field. However, many libraries have referred to the WCAG 2.0 criteria to set their own accessibility standards. In the United States, for example, the survey of members of the Association of Research Libraries showed that 67% of respondents used WCAG 2.0 AA as a criterion for web accessibility testing, and 12% of them went on to use AAA compliance as an accessibility criterion. The survey also showed that only 33% of respondents included the factor of accessibility in their policy for the development of digital collections (Spina & Cohen, 2018). In most countries, ignoring the optimization of libraries' web content to the needs of socially vulnerable users has led to its de facto absence. Even the accessibility of national resources has become challenging. This was confirmed by the results of a study of 151 national libraries websites of different countries in 2019. Specifically 29 of them (19%) fully complied, 3 - partially complied, 119 - did not comply with the WCAG 2.0 recommendations at the A, AA and AAA levels (Marina & Marin, 2019).

WCAG 2.1 is the third updated version of the standard that was released on June 5, 2018. This version was initiated to improve accessibility guidelines for three main groups of users: users

with cognitive difficulties; low vision users; users with disabilities who prefer to use mobile devices and tablets. WCAG 2.1 introduced 17 additional success criteria to increase the usability of web content based on language recognition software; optimization of motion and gestures; simplification of content use without display orientation restrictions; visual presentation of non-text components; animation settings; facilitating the ways of inputting information; streamlining of gesture optimization, etc. (W3C, 2018). Given that the adaptation of library resources to WCAG 2.0 has not been completed, the compliance with the new WCAG 2.1 criteria has become a challenge to them.

On January 21, 2021 the first public working draft of WCAG 3.0 was presented, which provides a wide range of recommendations for making web content more accessible to users with disabilities These guidelines address accessibility of web content on desktops, laptops, tablets, mobile devices, wearable devices, and other web of things devices. They address various types of web content including static content, interactive content, visual and auditory media, as well as virtual and augmented reality, a variety of web tools such as browsers and assistive technologies. The presented new accessibility guidelines fit into the existing structure of WCAG 2.0 and WCAG 2.1, but also qualitatively extend the previous versions. With the implementation of WCAG 3.0 the inability to test resources automatically will be a challenge.

## Methods

Within the framework of the current study the quantitative analysis of the collected data has been done by applying the descriptive research methodology. The Webaccessibility.com service has been chosen as the library web content accessibility data source. Having used the above mentioned service, 56 library websites have been tested and their compliance with the Web Content Accessibility Guidelines 2.1 standard has been determined. Additionally, the comparative analysis of the websites traffic ranking has been conducted. Alexa.com has been chosen as the global traffic ranking data source. The process of data accumulation was done on January, 2022.

## Results and Discussion

In order to determine the web accessibility of library web content, the webometric analysis of 56 library websites and the comparative analysis of their Global Rank have been conducted at the first stage of the current study. Alexa.com has been used for this purpose. The first group of the resources that have been studied consists of digital libraries of different types and scale of implementation (Table 1). The second group includes specialized library resources focused on serving different categories of users with disabilities (Table 2): digital libraries, websites of specialized libraries of national, state and regional levels.

Table 1

**WCAG 2.1 Compliance Score of Digital Libraries' Web Content**

| Number Library | Name | URL | Global Rank |
|---|---|---|---|
| Lib.1 | CyberLeninka | cyberleninka.ru/ | 1637 |

| Lib.2 | World Digital Library — UNESCO | unesdoc.unesco.org/library | 3706 |
|---|---|---|---|
| Lib.3 | Gutenberg | gutenberg.org/ | 7197 |
| Lib.4 | Gallica | gallica.bnf.fr/ | 14381 |
| Lib.5 | National Digital Library of India | ndl.iitkgp.ac.in/ | 19593 |
| Lib.6 | The World Digital Library | www.wdl.org/ | 50806 |
| Lib.7 | Digital library of historical and cultural heritage (Ukraine) | irbis-nbuv.gov.ua/cgi-bin/irbis_ir/cgiirbis_64.exe?C21COM=F&I21DBN=NAV&P21DBN=ELIB | 71249 |
| Lib.8 | Europeana | europeana.eu | 87861 |
| Lib.9 | California Digital Library | cdlib.org/ | 123443 |
| Lib.10 | BNDigital | bndigital.bn.gov.br/ | 143546 |
| Lib.11 | Biblioteca Digital Hispánica | bne.es/es/Catalogos/BibliotecaDigitalHispanica/Inicio/ | 144758 |
| Lib.12 | Digital Public Library of America | dp.la/ | 163866 |
| Lib.13 | Networked Digital Library of Theses and Dissertations | ndltd.org | 225631 |
| Lib.14 | International Children's Digital Library | childrenslibrary.org/ | 282484 |
| Lib.15 | National Digital Library Polona | polona.pl/ | 293241 |
| Lib.16 | Latvijas Nacionālās digitālās bibliotēkas | lndb.lv | 411565 |
| Lib.17 | DigiVatLib | digi.vatlib.it/ | 495795 |
| Lib.18 | China Digital Library | apabi.com/ruc/pub.mvc/Index2?pid=login&cult=US | 586508 |
| Lib.19 | Digitale Bibliotheek voor de Nederlandse Letteren | dbnl.org | 612088 |

THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

| Lib.20 | Deutsche Digitale Bibliothek | deutsche-digitale-bibliothek.de | 710986 |
|---|---|---|---|
| Lib.21 | Diasporiana | diasporiana.org.ua/ | 873339 |
| Lib.22 | Manuscriptorium | manuscriptorium.com | 2334661 |
| Lib.23 | Digital Library of Mexico | bdmx.mx/ | 4068915 |
| Lib.24 | AODL | aodl.org | 4556792 |
| Lib.25 | Digital Library of the Caribbean | dloc.com/ | 7205134 |
| Lib.26 | Czech Digital Library | http://czechdigitallibrary.cz/ | - |
| Lib.27 | ASEAN Digital Library | aseanlibrary.org | - |

Table 2

**Library Resources for People with Disabilities**

| Number Library | Name | URL | Global Rank |
|---|---|---|---|
| Lib.28 | La Bibliothèque Numérique Francophone Accessible (BNFA) | bnfa.fr | 354100 |
| Lib.29 | ÉOLE | http://eole.avh.asso.fr/ | 811787 |
| Lib.30 | Norwegian Library of Talking Books and Braille (NLB) | nlb.no | 818330 |
| Lib.31 | Danish National Library for Persons with Print Disabilities (Nota) | https://nota.dk/ | 867987 |
| Lib.32 | State Special Central Library for the Blind and Visually Impaired | gbs.spb.ru | 937885 |
| Lib.33 | Bibliothèque de la Ligue Braille | bibliotheque.braille.be/fr | 1160652 |

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UniLibNSD-2022
THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF
LIBRARIES

| Lib.34 | National Digital Library Services for the Blind | nlj.gov.jm/NDLSB/ | 1607343 |
|---|---|---|---|
| Lib.35 | National Library for the Disabled (NLD) | nld.go.kr/ableFront/index.jsp | 2242694 |
| Lib.36 | National Network for Equitable Library Service | nnels.ca | 2490158 |
| Lib.37 | Centre for Equitable Library Access Public library service for Canadians with print disabilities | celalibrary.ca/node/22584184 | 2928206 |
| Lib.38 | Russian State Library for the Blind | rgbs.ru | 3030508 |
| Lib.39 | Biblioteca digital Tiflolibros | tiflolibros.tiflonexos.org/signin?ReturnUrl=%2FWorks%2FIndex | 3313268 |
| Lib.40 | Hljóðbókasafns Íslands | hbs.is | 3785823 |
| Lib.41 | National Library Service Talking Books | nlstalkingbooks.org/talkingbooksform | 5039815 |
| Lib.42 | Bibliothèque Sonore Romande | bibliothequesonore.ch | 6206175 |
| Lib.43 | Westdeutsche Bibliothek der Hörmedien für blinde, seh- und lesebehinderte Menschen e.V. | wbh-online.de | - |
| Lib.44 | Central Specialized Library for the Blind. M. Ostrovsky | csbs.org.ua | - |
| Lib.45 | The South African Library for the Blind | salb.org.za | - |
| Lib.46 | The German Central Library for the Blind | dzblesen.de | - |
| Lib.47 | Biblioteca Italiana per i Ciechi "Regina Margherita" | bibliotecaciechi.it | - |

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University Library at a New Stage of Social Communications Development. Conference Proceedings, 2022, No. 7
UniLibNSD-2022

THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

| Lib.48 | Lithuanian Library for the Blind | labiblioteka.lt/en | - |
| Lib.49 | Etoile Sonore | etoilesonore.ch | - |
| Lib.50 | Centre d'accès équitable aux bibliothèques Services de bibliothèque publique pour les Canadiens incapables de lire les imprimés | bibliocaeb.ca | - |
| Lib.51 | National Library Service for the Blind and Print Disabled | loc.gov/nls | - |
| Lib.52 | Viittomakielinen kirjasto | viittomakielinenkirjasto.fi | - |
| Lib.53 | Swiss Library for the Blind, Visually Impaired and Print Disabled | sbs.ch/startseite/ | - |
| Lib.54 | The National Accessible Library (Scotland) | accessiblelibrary.org.uk/ | - |
| Lib.55 | Latvijas Neredzīgo bibliotēka | neredzigobiblioteka.lv | - |
| Lib.56 | Fachbibliothek und öffentliche (Schul)Bibliothek für Sehbehinderte und Blinde | odilieninstitut.web-opac.at/search | - |

The formal popularity ranking of 42 library websites is the result of the current study. The analysis of webometric data has provided means of identifying a high demand level of digital library websites implemented at the international, national and regional levels. Still there has been an extremely low use of specialized resources for people with disabilities, even of the resources that are implemented at the national level in the developed countries. The comparative analysis has shown that the most visited websites in each group of resources are the websites of France and the Russian Federation. It has been determined that the resources of France, USA, Norway, Denmark and the Russian Federation have the websites for people with disabilities with the highest Global Rank. It should be noted that 14 specialized libraries' websites out of 56 studied websites have not been included into the rank as their Global Rank has not been established by means of the Alexa.com service due to the insufficient level of technical implementation.

THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

Both groups of library websites have been tested for compliance with the Web Content Accessibility Guidelines 2.1 using the Webaccessibility.com service. The results are shown in Table 3 and Table 4. The resources of the following countries have the highest established compliance score of web content accessibility for people with disabilities: the United States (California Digital Library project: 92%, 0 violations; Gutenberg project: 92%, 0 violations) and Iceland (Hljóðbókasafns Íslands project: 92%, 0 violations). It should be emphasised that only 3 websites out of 56 meet the accessibility standards with the compliance score of 92% and have no violations. 2 of these websites belong to the first group (Table 1), they are the projects of digital universal libraries - Lib.9, Lib.3; 1 website belongs to the second group (Table 2), it is the specialized project of the Icelandic Audio Library "Hljóðbókasafns Íslands project" - Lib.40. The following resources from the first group (Table 1): Lib.24, AODL project (76%, 129 violations); Lib.11, Biblioteca Digital Hispánica project (77%, 47 violations); and from the second group (Table 2): Lib.55, project Latvijas Neredzīgo bibliotēka (73%, 30 violations) have the lowest compliance score of web content accessibility.

Table 3

**WCAG 2.1 Compliance Score of Digital Libraries' Web Content**

| Number Library | WCAG 2.1 compliance score, % | Number of violations |
|---|---|---|
| Lib.1 | 85% | 5 |
| Lib.2 | 77% | 87 |
| Lib.3 | 92% | 0 |
| Lib.4 | 85% | 88 |
| Lib.5 | 77% | 21 |
| Lib.6 | 88% | 12 |
| Lib.7 | 76% | 18 |
| Lib.8 | 88% | 3 |
| Lib.9 | 92 % | 0 |
| Lib.10 | 75% | 19 |
| Lib.11 | 77% | 47 |
| Lib.12 | 81% | 8 |
| Lib.13 | 78% | 70 |
| Lib.14 | 84% | 4 |
| Lib.15 | 88% | 3 |

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UniLibNSD-2022
THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF
LIBRARIES

| | | |
|---|---|---|
| Lib.16 | 74% | 36 |
| Lib.17 | 73% | 19 |
| Lib.18 | 73% | 16 |
| Lib.19 | 77% | 12 |
| Lib.20 | 80% | 10 |
| Lib.21 | 81% | 3 |
| Lib.22 | 79% | 7 |
| Lib.23 | 87% | 13 |
| Lib.24 | 76% | 129 |
| Lib.25 | 89% | 12 |
| Lib.26 | 81% | 19 |
| Lib.27 | 78% | 6 |

Table 4

**WCAG 2.1 Compliance Score of Specialized Libraries' Web Content**

| Number Library | WCAG 2.1 compliance score, % | Number of violations |
|---|---|---|
| Lib.28 | 82% | 14 |
| Lib.29 | 86% | 6 |
| Lib.30 | 82% | 9 |
| Lib.31 | 88% | 5 |
| Lib.32 | 78% | 24 |
| Lib.33 | 86% | 4 |
| Lib.34 | 87% | 4 |
| Lib.35 | 84% | 23 |
| Lib.36 | 81% | 1 |
| Lib.37 | 80% | 16 |
| Lib.38 | 76% | 17 |

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UniLibNSD-2022

THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

| | | |
|---|---|---|
| Lib.39 | 88% | 6 |
| Lib.40 | 92% | 0 |
| Lib.41 | 89% | 16 |
| Lib.42 | 74% | 10 |
| Lib.43 | 91% | 6 |
| Lib.44 | 90% | 1 |
| Lib.45 | 88% | 4 |
| Lib.46 | 88% | 2 |
| Lib.47 | 86% | 3 |
| Lib.48 | 86% | 16 |
| Lib.49 | 85% | 21 |
| Lib.50 | 84% | 13 |
| Lib.51 | 82% | 7 |
| Lib.52 | 79% | 23 |
| Lib.53 | 75% | 24 |
| Lib.54 | 74% | 15 |
| Lib.55 | 73% | 30 |
| Lib.56 | 78% | 7 |

The fact is that the range of WCAG 2.1 compliance score of the first group's resources (Fig. 1) is 92% -77%, and the range of compliance score of the second group's specialized resources (Fig. 2) is wider (92% -73%). At the same time, specialized resources that are developed for people with disabilities have fewer violations: the range of violations of the resources from the first group (Table 3) is from 3 to 129; the range of violations of the resources from the second group (Table 4) is from 1 to 30. In general, the accessibility level of the specialized resources for users with disabilities is not fundamentally different from the accessibility level of the resources that are designed for a wide audience.

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UniLibNSD-2022
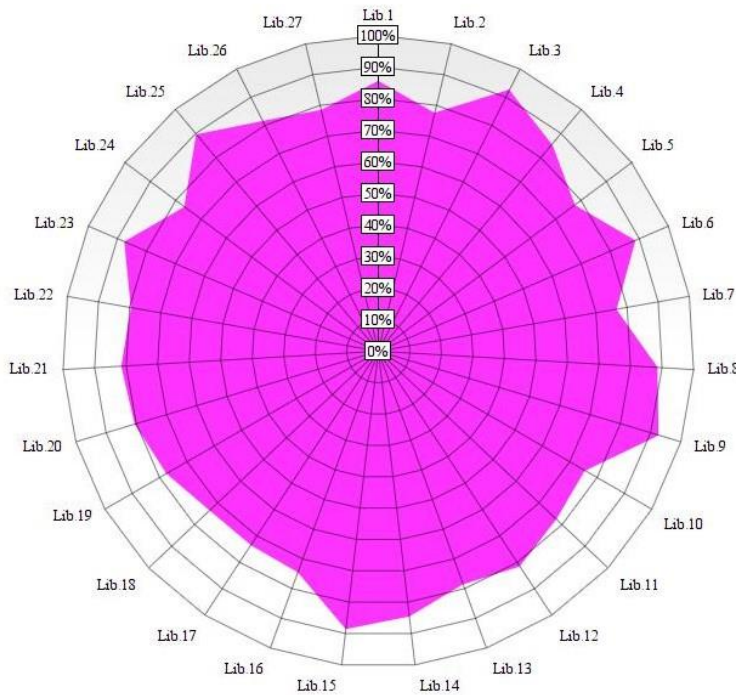THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF
LIBRARIES

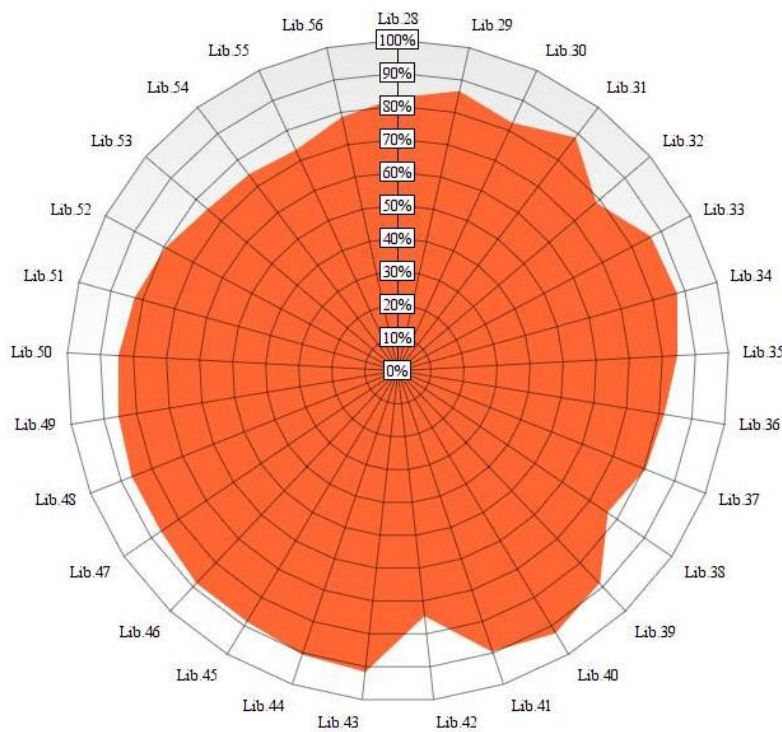Fig. 1. The Range of WCAG 2.1 Compliance Score of the First Group's Resources



Fig. 2. The Range of WCAG 2.1 Compliance Score of the Second Group's Specialized
Resources

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UniLibNSD-2022

THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

Analysis of violations has shown that the most common violation is the lack of text alternatives for non-textual content. 93% of all identified violations are violations associated with the fact that the developers did not pay enough attention to providing textual alternatives to visual objects. The content of the websites that do not always meet the language criteria is another common violation. The controversial criterion is the adaptability of the websites' pages, which allows to present the content in different ways (for example, a simple layout) without losing the semantics of the information provided. Functional violations have also been identified on the websites. They are imperfect navigation, which prevents users from finding content and clearly identifying where they are on the website; unavailability of certain website features when using the keyboard. A lot of violations are related to contrast, which makes textual content readable and understandable, making it easier for users to separate the foreground from the background.

Content analysis of 56 websites has indicated that most of them use a variety of tools that allow people with disabilities to be potential users of these websites. In most cases, the studied resources offer users the functions of scaling texts and images, audio playback of the documents. These functions are required and can be found in different forms on almost 100% of the studied specialized libraries websites, but very few digital libraries websites have the described functionality. For example, the ReadSpeaker technology is only used by the World Digital Library (Lib.6), Norwegian Library of Talking Books and Braille (Lib.30), Hljóðbókasafns Íslands (Lib.40). Some libraries offer specialized services for users with disabilities. The Digital Library of Brazil (Lib.10) offers an innovative «VLibras» system that translates digital audio and video content into Brazilian Sign Language for people with hearing disability. Sign language e-library Viittomakielinen kirjasto (Lib.52) has been established in Finland.

## Conclusions

The results of the study indicate that current practices are insufficient to allow most libraries to achieve a medium level of compliance with WCAG 2.1 standard. No version of WCAG standard guarantees web content accessibility, but each version is an important standard for providing users with disabilities with equal access to web content and digital library services. No version of WCAG standard takes into account all possible aspects of library web content accessibility, but each demonstrates the need for a more integrated approach to organizing its accessibility.

The state of library resources requires implementing continuous audit of accessibility, most particularly by means of automatic testing using free tools, and their regular optimization. At the same time, it should be stated that in-depth testing of the websites automatically is not possible. That is why real and potential users with disabilities should be engaged into the evaluation, development and optimization processes. To ensure effective accessibility of web content, libraries should not only strive to meet certain success criteria of WCAG 2.1, but also develop workflows, bring in best practices of interaction with special users, which will make functional accessibility a priority at all stages of creation and promotion of web content. It should be done systematically and it should cover social and digital inclusion matters. From this point of view, WCAG 2.1 effectively takes accessibility beyond technological implementation and encourages libraries to consider further adaptation of policies, services for people with disabilities and people facing social and digital exclusion due to physical or cognitive impairments.

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THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

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## THE CONTRIBUTION OF THEORY AND RESEARCH TO THE TRANSFORMATION OF LIBRARIES

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## Аналіз доступності цифрових бібліотек та спеціалізованих бібліотечних ресурсів

**Мета**. Дослідження сучасного стану доступності бібліотечного веб-контенту. **Методика**. 56 бібліотечних веб-сайтів різних країн (27 цифрових бібліотек та 29 спеціалізованих бібліотечних ресурсів для людей з обмеженими можливостями) пройшли успішну перевірку на відповідність стандартам WCAG 2.1 за допомогою сервісу Webaccessibility.com. За допомогою сервісу Alexa.com додатково проведено порівняльний аналіз рейтингу відвідуваності сайтів. **Результати.** Встановлено, що лише 3 веб-сайти з 56 відповідають стандартам доступності WCAG 2.1 з показником відповідності 92%. **Висновки.** Зроблено висновок, що існуючі в бібліотеках практики забезпечення доступності веб-контенту є недостатніми. Акцент було зроблено на необхідності оптимізації та просування спеціалізованих бібліотечних ресурсів та впровадження постійного аудиту доступності веб-контенту шляхом автоматичного тестування та залучення до цих процесів користувачів з обмеженими можливостями.

*Ключові слова:* цифрова бібліотека; веб-сайт цифрової бібліотеки; цифрова бібліотека для людей з обмеженими можливостями; доступність веб-сайту; веб-доступність; веб-доступність для людей з обмеженими можливостями; рекомендації щодо доступності веб-контенту; WCAG 2.1