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RESEARCH ARTICLE

Web Accessibility Assessment of ISBN Agencies' Websites: A 2025 Snapshot

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ABSTRACT The registration of books to the ISBN agencies (ISBN-As) is mainly done through their corresponding websites. However, due to limitations of web accessibility, persons with disabilities cannot equally access the websites of national ISBN-As. But, fortunately, the World Wide Web Consortium (W3C) has developed the Web Content Accessibility Guidelines (WCAG) that websites should conform to in order to become accessible. Despite that, the accessibility of ISBN-As' websites remain a global concern. This study aims to perform a web accessibility evaluation of ISBN-As worldwide. For that, a group of selected websites is evaluated by using Popetech web accessibility evaluation platform. The Popetech platform can scan, identify, and report issues on a group of websites in asynchronous mode. The findings indicate that most of the selected ISBN-As' websites do not comply with WCAG 2.2, and improvements are needed. In this sense, this study contributes to global awareness about the need for web accessibility for all.

INDEX TERMS ISBN agencies, persons with disabilities, web accessibility evaluation, web content accessibility guidelines (WCAG).

I. INTRODUCTION

About 16 % of the world population [1] have disabilities and encounter barriers to accessing the Web. Most of the websites in the world are not accessible by persons with disabilities and the situation is far from improving [2]. Therefore, web accessibility for all is a pending challenge [3].

The World Wide Web Consortium (W3C) has step into the problem of making the web accessible to persons with disabilities. In this sense, the W3C has developed the Web Content Accessibility Guidelines (WCAG) that the websites should conform to. Nevertheless, most websites still do not comply [2], even though many countries have ratified the United Nations Convention on the Rights of Persons with Disabilities (CRPD) [4] which considers web accessibility as basic human right.

Reducing inequalities is one of the objectives of the United Nations Sustainable Development Goals (UN-SDG) [5]. However, there is more to be done in this sense. For instance, the accessibility of the publishing industry is still a pending challenge and can be divided into publishing content accessibility and publishing process accessibility. The publishing content content accessibility has been addressed and enforced by the Marrakesh Treaty [6]; however, the publishing process accessibility still need awareness to reach worldwide enforcement.

Regarding the book publishing, one of the activities that is very dependent on the Web is the process of acquisition of International Standard Book Number (ISBN) [7]. The ISBN is a unique number issued by the ISBN agencies (ISBN-As) and identifies a book object. This unique number is associated with key information about the book content and the publisher. The publisher can be an editorial or an individual person.

In general, national libraries act as ISBN-As in many countries, although there are also commercial agencies. The interactions between ISBN-As and potential subscribers are normally done through their corresponding websites. However, on the one hand, there are countries that do not have ISBN-As and their citizens can only acquire a ISBN from the International ISBN Agency, through their website. On the other hand, ISBN-As are not distributed at different regions of a single country, but located at a specific location within a country, which is commonly the national library.

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Given that national ISBN-As provide essential public services that enable participation in the publishing ecosystem, ensuring the accessibility of their websites is not merely a technical concern but a legal, social, and institutional requirement aligned with fundamental rights and inclusive knowledge policies. ISBN-As provide essential bibliographic and administrative services: ISBN assignment, publisher registration, metadata consultation, and compliance information. These services are prerequisites for participation in the publishing ecosystem. If websites are not accessible, persons with disabilities are effectively excluded from exercising their right to access public information and services on equal terms, contradicting the principle of non-discrimination. Accessibility barriers do not affect only end-users as readers, but also professionals with disabilities—publishers, editors, authors, librarians, and researchers—who need to interact with ISBN platforms as part of their professional activity. Inaccessible systems can therefore generate structural inequalities in professional participation, with tangible economic and career consequences.

The main objective of this study is to explore the status of conformance of ISBN-As' websites against WCAG 2.2. The conformance of ISBN-As' websites against WCAG can be done manually or automatically by using automated web accessibility evaluation tools (AWAETs). Evaluation through AWAETs, in turn, can be done in two ways: quantitatively or qualitatively [8]. In this study we perform a quantitative evaluation of web accessibility of ISBN-As' websites using Popetech as the AWAET.

The remaining of this article is structured as follows: Section II sets a background about web accessibility, its enforcement in the publishing industry and previews studies related to the accessibility of ISBN-As' websites. Section III describes the methodology used in this study. Section IV presents the results obtained from applying the methodology of Section III. Section V discusses the results obtained in Section IV in relation to WCAG compliance. Section VI presents the conclusions and future work that can derive from this study.

II. BACKGROUND AND RELATED WORK

A. WEB CONTENT ACCESSIBILITY GUIDELINES

The WCAG has become a de facto standard and is produced by W3C since 1999. Several versions have been published progressively order over time to adapt to the changes of the Web:

- WCAG 1.0 was released in 1999 [9].
- WCAG 2.0 was released in 2008 [10]. In 2012, it was adopted as an international standard of web accessibility by the International Organization for Standardization (ISO) [11].
- WCAG 2.1 was released in 2018 [12].
- WCAG 2.2 was released in 2023 [13] and has replaced WCAG 2.0 as the new ISO standard of web accessibility [14].
- WCAG 3.0 is the current draft [15] and introduces some changes to the structure, conformance model and scope compared to WCAG 2.0.

WCAG 2.0 and subsequent updates are based on principles instead of the checkpoints of WCAG 1.0. The four principles of WCAG 2.x are:

- Perceivable. Users must be able to perceive information and user interfaces of the websites.
- Operable: Users must be able to operate the user interface of the websites.
- Understandable: Users must be able to understand the information and how to operate the user interface of websites.
- Robust: Users must be able to access the content of the websites using a wide variety of user agents, including assistive technologies, as well as any new technologies to come.

The WCAG principles are associated to testable success criteria, which are, in turn, related to a collection of sufficient and advisory techniques [16], [17]:

- Sufficient techniques: These are techniques that, when applied to web content, guarantee that they meet the success criteria. However, not applying them does not necessarily mean that the web content will not meet the success criteria.
- Advisory techniques: These are techniques that are recommended to improve accessibility when implemented in web content. However, they may not meet the success criteria requirements, and in some cases they may not be testable.
- Failures: These are things that cause accessibility barriers, fail specific success criteria, and help web developers identify what to avoid.

The number of Accessible Rich Internet Applications (ARIA) [18] elements that a website contains determine its level of interaction capabilities with assistive technology for persons with disabilities. The ARIA elements are related to the WCAG principle of robust and guarantees the compatibility of a website with emerging technologies.

In order to meet the needs of different groups of people in different situations, web content should fulfill the following WCAG 2.x conformance levels [16]:

- Level A conformance, which is the lowest level. Web content that satisfies all the Level A success criteria.
- Level AA conformance: The web content satisfies all Level A and Level AA success criteria.
- Level AAA conformance is the highest level. The web content satisfies all the Level A, Level AA and Level AAA success criteria.

B. THE MARRAKESH TREATY

Restrictive copyright laws create a ''book famine'', where less than 1 % of published works are accessible to print-disabled individuals, particularly in developing nations [19].

The Marrakesh Treaty [6] is worth to be mentioning in this study as it was a turning point in the struggle to facilitate access to published work to people with disabilities, especially to those with visual impairments. Although it is not focused on web accessibility, it represents a milestone in the support of human right to equally access published.

The Marrakesh Treaty gives right to share books in accessible formats across borders, which, in turn, provides educational, economic and social opportunities for visually impaired people. The only prerequisite to share books for non-profit across two countries is that both countries must have ratified the Marrakesh Treaty.

The CRPD [4] is at the basis of the Marrakesh Treaty in collaboration with the World Intellectual Property Organization (WIPO) [20]. However, the CRPD has not been able to enforce a worldwide web accessibility treaty, even though it states that web accessibility is a basic human right on their article 9 - Accessibility.

The Marrakesh Treaty is somehow related to web accessibility as the sharing of accessible books across borders is normally done through the Web. Therefore, persons with disabilities may also face web accessibility barriers to accessing these books, even though their content is accessible.

C. RELATED WORK

As national libraries normally act as ISBN-As, we start by looking at previews studies related to their web accessibility. In 2011, Fulton [21] carried out a study that discussed web accessibility in the context of United States' federal laws. Additionally, it reveals which states have statutes that mirror federal web accessibility guidelines and to what extent. Interestingly, fewer than half of the states have adopted statutes addressing web accessibility, and fewer than half of these reference Section 508 of the Rehabilitation Act or WCAG 1.0. These findings show that, regardless of sparse legislation surrounding web accessibility, librarians should consult the appropriate web accessibility resources to ensure that their specialized content reaches all.

In 2015, Glusker [22] carried out a study to determine the extent to which urban public libraries in the United States provide web sites which are readily accessible to individuals with disabilities. An assessment of each of the web sites of the purposive sample of public library systems was performed by an online evaluation tool to determine web accessibility. The results of the online accessibility evaluation tool revealed that not one of the sites surveyed was free of errors or alerts. Contrast errors (related to color combinations), missing alternative text (providing text alternatives for visual elements), and missing form labels (thereby preventing screen readers from performing searches and navigating to results) were the most common problems. The results revealed that many sites lacked specific links and/or resources for persons with disabilities, as well as noting that the resources available used oblique language and required many clicks to access.

In 2017, Liu et al. [23] carried out a study that examined 129 libraries againts the Section 508 standards for accessibility under the Rehabilitation Act, the minimum acceptable standard for accessibility under the Americans with Disabilities Act. Using the Web Accessibility Evaluation Tool (WAVE), the HTML coding of the libraries' homepages was evaluated according to the Section 508 criteria for accessibility. After one-to-one deep examination to determine the accessibility of the library websites, the results tended to mirror other studies showing that most library websites have some coding deficiencies that limit the accessibility of the websites. Notably, only 7 of the 122 libraries that were surveyed had no Section 508 errors present with their homepages. Also, in 2017, Kaeding et al. [24] did an investigation on the factors influencing access to public libraries for children with disabilities and their families from the perspective of the public librarian. The study comprises 18 public librarians who focus on providing access to public libraries for children with disabilities. Librarians from the United States and Canada took part in both a one-on-one interview and a questionnaire. Based on the research findings, a model for inclusive public libraries is proposed.

In 2019, Lazar [25] carried out a study that provided an overview of legal and policy concepts related to web accessibility at a national and regional level. He discussed the scope of these laws and policies, considering which types of organizations, disabilities and content they cover. Finally, he described actions that could be taken to improve web accessibility within organizations.

In 2023, Khawaja [26] performed a web accessibility evaluation of a total of 120 public library website URLs using Deque's Axe evaluation tool for testing WCAG 2.1 compliance. Results showed that public library websites overwhelmingly failed to meet the accessibility standards required by law in Section 508 of the Rehabilitation Act. Color contrast errors were the most common type of error found for each type of page. It was found that there were no significant relationships between community demographics libraries serve and accessibility errors. Also, in 2023, Devi and Kumar [27] conducted a study that evaluated 15 selected libraries of the Delhi-National Capital Region (NCR), focusing on low vision and visually impaired (BVI) users. The aim was to investigate and evaluate library accessibility with reference to the WCAG 2.1. The WAVE was used in the study and the results show that 13 out of 15 library websites contain errors, and 14 out of 15 have alerts based on six components (''Errors, Alerts, Features, Structural elements, ARIA, and Contrast Errors''). The study found that the most common error in websites is Linked image missing alternative text, the second highest error is Empty link, and the third highest error is Empty Button. For these three highest occurring errors, WAVE recommended solutions are also provided for resolving them to improve the accessibility of these websites.

In 2024, several studies related to web accessibility in libraries took place. Day and Michaels [28] carried out a study that provided an overview of the legal requirements, content standards, and overall workflow of how organizations can build accessibility into their digital content. This study contributed to making available a resource that can help libraries to begin making their resources available to as wide an audience as possible. Also, in 2024, Purnomo and Wikandani [29] performed an investigation that explored how adaptive technologies can improve accessibility and inclusivity in libraries for users with visual impairments. Using a qualitative methodology involving in-depth interviews and content analysis of library websites, this study assessed the effectiveness of current adaptive technologies and identified barriers to their use. The results show that, although adaptive technologies such as screen readers and indoor navigation systems hold great potential to improve user experience, there are still gaps in implementation and library staff awareness of the specific needs of visually impaired users. Based on these findings, this paper recommends better staff training, the development of strong inclusive policies, and collaboration with disabled people's organizations to improve the accessibility and inclusiveness of libraries, thus supporting wider social participation of visually impaired users.

Focusing on ISBN-As, to identify gaps in previews studies related to their web accessibility, we did take a different approach, as a simple search from Google Scholar did not report good results. To minimize coverage bias, avoid duplication, and ensure comprehensive bibliographic mapping, we selected IEEE Xplore, Scopus and Web of Science as bibliographic databases to extend the search sources. The search string used is as follows: (''international standard book number'' OR ISBN OR publishing OR ''book publishing'' OR ''publisher'') AND (accessibility OR inclusion) AND (web OR website). We searched within title, abstract and keywords and the results are presented on Table 1.

The search produced 692 papers as result, but none specifically deal with web accessibility of ISBN-As. Most of the papers that were found were related to book publishing in general and centered to providing accessible format by publishers to readers [30], [31], [32], [33].

As this study is focused on web accessibility of ISBN-As by an AWAET, we finalize this section of related work by mentioning previews studies that have used AWAET in general [34], and WAVE in particular.

Bhatia and Malek [35] carried out a study about the use of WAVE tool for web accessibility evaluation. The study consisted in collecting data on web accessibility violations between January 2013 and April 2023 from 40 homepages of websites across four popular website categories (social network, entertainment, e-commerce, and news media) in the United States using the WAVE subscription API. The results show that web accessibility on those websites is still a pending issue.

III. METHODOLOGY

The goal of this study is to determine the web accessibility status of ISBN-As worldwide. The methodology adopted for this study comprises the following phases:

1) Collect the list of ISBN-As and their URL [36]. The ISBN-As that do not have a URL from the list above were searched from Google. Initially, a total of 152 ISBN-As were identified. A total of 16 ISBN-As were removed because they did not have a website. Other five ISBN-As are not specific to a single country and are not considered in this study. In the case of Canada, with two ISBN-As for French and English speakers, we considered only one, as in this study, each country is associated to a single ISBN-A. In the case of Benin, the website was under construction. In the case of Botswana, the website did not have content about ISBN. In the case of India, the website was under maintenance. In summary, a total of 2 ISBN-As were removed for the next step.
2) Test the URLs of the ISBN-As to ensure they are online. For three days, we kept trying accessing the URL to make sure it was not offline temporary. Any URLs found to be offline were removed from the list. A total of 12 ISBN-As had a URL that was not working and, therefore, were removed for the next step.
3) Select the AWAETs that will be used to assess the WCAG 2.2 compliance of selected websites. Popetech [37] was chosen as it can crawl and scan all the pages of a list of websites for web accessibility issues. Popetech uses WAVE engine to detect WCAG 2.2 A and AA success criteria, identifying errors, alerts, contrast issues, and structure. Popetech also offers a variety of customizable reports that can be scheduled and delivered by email to the user.
4) Create a group in Popetech for ISBN-As: Add the URLs of the ISBN-As to the group. Although Popetech allows the bulk import of websites from a file, we opted for manual import as some of the websites could not be read by Popetech. After some days, we tried adding the websites again to make sure the offline status was not temporal. We could not determine the reason that some websites were not accepted by Popetech; however, we noticed slowness in response when we accessed those websites. In summary, a total of 24 ISBN-As could not be added into Popetech and, therefore, removed from the list for the next step.
5) Scan created group of ISBN-As' websites for web accessibility issues. Popetech can scan two different viewports of websites: viewport 1200 pixels for desktop and viewport 500 pixels for mobile. In this study, we focused on the desktop version. Popetech was set up to crawl the websites recursively and scan all the webpages for errors. The crawling limit was set at 900 pages. Some ISBN-As' websites were readable but not scannable by Popetech and therefore they were also removed from the sample. Several scans

TABLE 1. Results of searching for previews studies about web accessibility of ISBN agencies' websites.

Database	Search string	Results
IEEE Explore	("international standard book number" OR ISBN OR publishing OR "book publishing" OR publisher) AND (accessibility OR inclusion) AND (web OR website)	98
Scopus	TITLE-ABS-KEY ((“international standard book number" OR ISBN OR publishing OR "book publishing" OR publisher) AND (accessibility OR inclusion) AND (web OR website)) AND (LIMIT-TO (SUBJAREA, "COMP))	451
Web of Science	TS=("international standard book number" OR ISBN OR publishing OR "book publishing" OR publisher) AND (accessibility OR inclusion) AND (web OR website))	143

were performed on different days before deciding to remove certain websites. A total of 18 websites were dismissed because of not being possible to be crawled and scanned by Popetech. At the end, the evaluation sample, as shown on Table 2, is composed of 73 ISBN-As distributed as follows: 11 from Africa, 12 from America, 19, from Asia, 29 from Europe and 2 from Oceania. Figure 1 shows the process of scanning the Ukraine ISBN-A's website from Popetech. In that Figure 1, at the top we can see the summary of alerts per-page, total alerts, errors per-page, total errors, ARIA, estructural elements and features. At the bottom, we have the same information, but for each webpage of the Ukraine's ISBN-As.

6) Create three types of reports in Popetech and receive them via email in CSV format: summary-report, page-report and results-report. Table 3 contains WAVE tool items that are reported by Popetech. Figure 2 shows the WAVE tool items from the scanning of Portugal's ISBN-A's website. The report presented on Figure 2 provides additional information about the type of errors and alerts that were found on the Portugal's ISBN-A's website.
7) Analyze the results of web accessibility evaluation of ISBN-As by using the statistical tool Tableau Public edition 2024 3.4 [38].
8) Discuss the results and draw conclusions.

IV. RESULTS

In this section we present the results of evaluating the web accessibility of ISBN-As. These results were collected by performing the steps described in the methodology section of this research in September 2025. As shown in Figure 3, a total of 73 ISBN-As were evaluated from countries all over the world: 11 from Africa, 12 from America, 19 from Asia, 29 from Europe and two from Oceania. The whole dataset of this study can be found online at Mendeley Data repository [39]. Nevertheless, Figure 4 shows a screenshot of the page report generated by Popetech as part of the web accessibility evaluation of ISBN-As' websites. This report contains the list of websites of ISBN-As and the items that represents their web accessibility performance: number of scanned pages per website, errors, error density, errors per page, alerts, alert density, alerts per page, structural elements, ARIA, features, score and pages without errors.

The presentation of the results of this study is organized as follows:

1) Presentation on summary-report analysis that shows the overall web accessibility performance in the form of WAVE tool item values.
2) Presentation on page-report analysis that shows a detailed web accessibility performance of all the webpages belonging to each ISBN-As. Figure 4 shows a screenshot of the page-report file generated by Popetech from the evaluation of ISBN-As' websites.
3) Presentation on result-report analysis that shows the overall performance of all ISBN-As webpages in terms of conformance with WCAG 2.2 success criteria.

A. SUMMARY-REPORT ANALYSIS OF WEB ACCESSIBILITY PERFORMANCE OF ISBN AGENCIES' WEBSITES

Table 4 represents a summary of the web accessibility performance of the ISBN-As of countries around the world. A total of 34,287 webpages of ISBN-As were crawled and scanned by Popetech for web accessibility conformance against WCAG 2.2. There is considerable number of errors per webpage and alerts per webpage, even though these numbers are not very high. However, the error density and alert density are low. Also, the ISBN-As have around 25 errors and alerts per page. Positively, the ISBN-As have a lot of ARIA elements, but, negatively, they also have considerable number of structural elements and features that do not conform to WCAG 2.2.

B. PAGE-REPORT ANALYSIS OF WEB ACCESSIBILITY PERFORMANCE OF ISBN AGENCIES

This subsection provides an analysis of the web accessibility performance of the individual websites of ISBN-As and their corresponding webpages, as derived from the Popetech page-report. The analysis addresses the performance of ISBN-As' websites in terms of alerts, errors, ARIA, features, structural elements, scores and other web accessibility information derived from Popetech's page-report. This analysis was conducted by loading the web accessibility data from Popetech's report into Tableau Public [38].

1) ALERTS AND ERRORS

Figure 5 shows a box plot of alerts of ISBN-As reported from the evaluation. The number of alerts on ISBN-As' websites is high, although the alert density is low. The median of alerts

TABLE 2. List of selected countries whose ISBN agencies' websites are to be evaluated in this study.

Country	Country	Country	Country
Albania	Finland	Morocco	Sri Lanka
Algeria	France	New Zealand	Srpska
Armenia	Ghana	Nicaragua	Sweden
Australia	Hong Kong	Nigeria	Switzerland
Austria	Hungary	Norway	Taiwan
Belgium	Iceland	Oman	Tanzania
Bermuda	Indonesia	Palestine	Thailand
Bhutan	Israel	Panama	Tunisia
Bosnia and Herzegovina	Japan	Peru	Turkey
Brazil	Jordan	Philippines	Uganda
Bulgaria	Kenya	Portugal	Ukraine
Canada	Kosovo	Qatar	United Kingdom
China	Lithuania	Romania	United State of America
Colombia	Luxembourg	Serbia	Uruguay
Costa Rica	Macau	Seychelles	Vietnam
Cuba	Malawi	Singapore	Zimbabwe
Denmark	Malaysia	Slovakia	
Eswatini	Mexico	Slovenia	
Ethiopia	Montenegro	Spain	

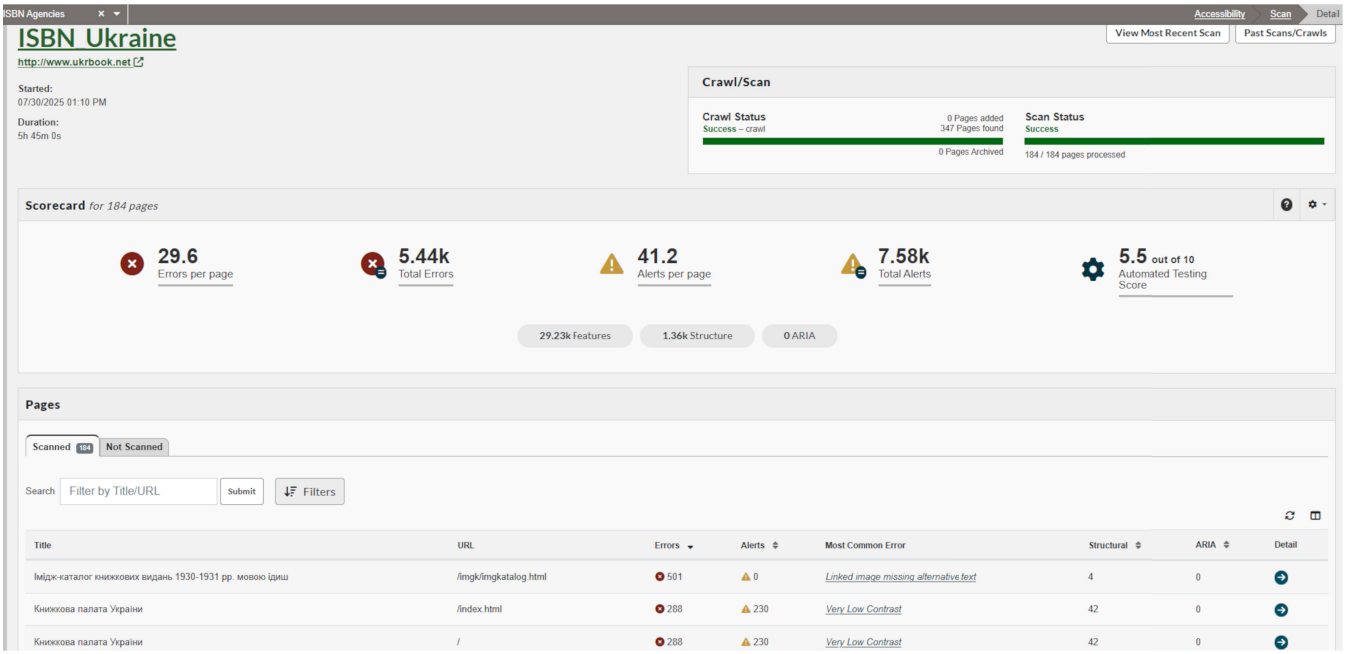

FIGURE 1. Screenshot of scanning process.

per webpage is 16.2, which means that half of ISBN-As' websites have less than 17 alerts per webpage.

Figure 6 shows the box plot of errors of ISBN-As reported from web accessibility evaluation of the websites of the corresponding ISBN-As. The errors in Popetech page-report include contrast errors. The ISBN-As' websites have a considerable number of errors, although the error density is low. Even though the range of errors per webpage is high, the value of the median in the box plot shows that half of ISBN-As' websites have less than 16 errors per webpage.

2) ARIA, FEATURES, AND STRUCTURAL

Figure 7 shows a box plot representing the performance of ISBN-As' websites in terms of ARIA, Features and Structure. ARIA enhances the interaction of a website or webpage with assistive technology. Features ensure that the website or webpage is usable by persons with disabilities. Structural elements are HTML elements that conform the heading hierarchies, lists, tables, forms and other semantic layout regions of a website or webpage.

In this case, the ISBN-As' websites contain considerable number of ARIA elements. Concerning the Features and Structural elements, the performance is low as the values of their respective medians are high.

3) AUTOMATED TESTING SCORE AND SCANNED PAGES PER ISBN AGENCIES' WEBSITES

Figure 8 shows a box plot representing the performance of ISBN-As' websites in terms of Automated testing

TABLE 3. WAVE tool items that are present in Popetech reports of web accessibility for ISBN agencies' websites.

WAVE tool item	Description
Errors	Web accessibility issues that will impact certain users as failed to meet WCAG criteria.
Alerts	Elements that may cause issues to certain users but are in accordance with WCAG criteria. For instance, an image with an alternate text, but too long.
Contrast errors	Text that does not meet WCAG contrast requirements and that may cause issues to persons with visual impairment disability.
ARIA	ARIA elements that are present in the webpages.
Features	Elements that improve accessibility if implemented correctly.
Structural	HTML and ARIA regions that highlight hidden elements and nesting.

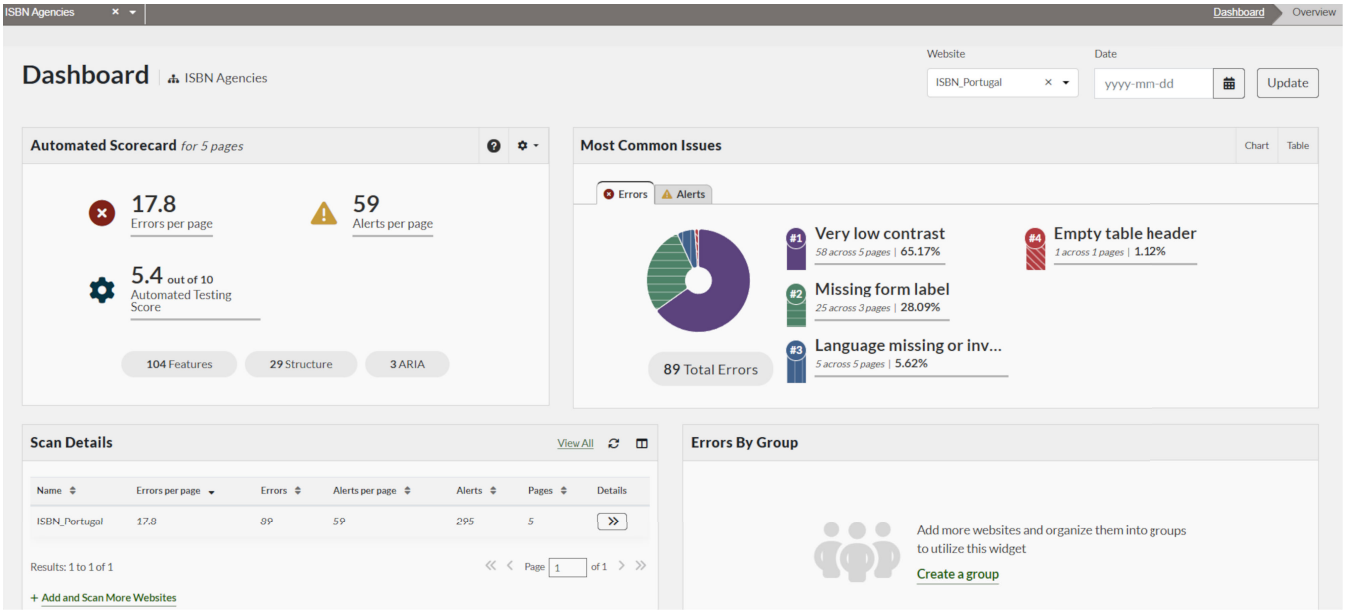

FIGURE 2. WAVE tool items from the scanning of Portugal ISBN Agency's website.

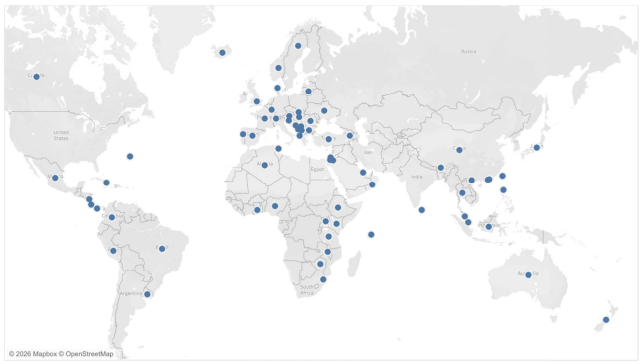

FIGURE 3. Countries selected for web accessibility evaluation of ISBN agencies' websites.

TABLE 4. Summary of web accessibility for ISBN agencies' websites reported by Popetech.

Property	Value
pages_scanned	34,287
Errors	850,751
error_density	0.052
errors_per_page	24.813
Alerts	853,780
alert_density	0.033
alerts_per_page	24.901
Structural	1,341,842
ARIA	2,626,420
Features	903,880

score (ATS) and scanned pages per ISBN-As website. We perceive that ISBN-As' websites perform very low in ATS, which is a metric provided by Popetech that compares a particular website to the top million websites, as part of new WAVE accessibility impact score [40]. Half of the ISBN-As' websites score about 6.6 or less, out of 10; while the normal threshold is 8, based on Pareto Principle (80/20 rule) [41]. Also, half of ISBN-As' websites contain an average of 184 webpages.

4) SCANNED PAGES PER ISBN AGENCIES' WEBSITES AGGREGATED BY CONTINENT

Figure 9 shows a box plot representing the performance of ISBN-As' websites in terms of scanned pages aggregated

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	name	url	pages_scanned	errors	error_density	errors_per	alerts	alert_density	alerts_per_page	structural	aria	features	automated_aim_score	pages_without_errors
2	ISBN_Albania	https://www.bksh.al	1	1	0.052631579	1	4	0.21052632	4	1	0	0	8.4	0
3	ISBN_Algeria	https://biblionat.dz	1	2	0.058823529	2	2	0.05882353	2	5	1	1	8.2	0
4	ISBN_Armenia	https://nla.am	808	54143	0.041662563	67.00866	67323	0.05180446	83.32054455	72083	117787	38973	3.5	1
5	ISBN_Australia	https://www.myidentifiers.com.au	29	211	0.017802902	7.275862	230	0.01940601	7.931034483	933	1979	334	8	0
6	ISBN_Austria	https://isbn-austria.at	16	190	0.012623746	11.875	268	0.01780613	16.75	445	4352	325	7.3	0
7	ISBN_Belgium_French	https://www.afnil.org	999	7367	0.015994633	7.374374	6860	0.01489388	6.866866867	35261	21512	2116	8	0
8	ISBN_Bermuda	http://www.bnl.bm	268	17795	0.144840834	66.39925	2786	0.0226764	10.39552239	6365	2515	3354	2.8	2
9	ISBN_Bhutan	https://bhutanstudies.org.bt	83	243	0.006058037	2.927711	1343	0.03348125	16.18072289	2838	3277	732	8.8	44
10	ISBN_Bosnia	https://nub.ba	61	246	0.009252294	4.032787	801	0.03012637	13.13114754	1813	1699	1277	8.8	0
11	ISBN_Brazil	https://www.cblservicos.org.br/isbn	92	3307	0.094865175	35.94565	2025	0.0580895	22.01086957	2645	2251	602	4.5	0
12	ISBN_Bulgaria	https://www.nationallibrary.bg/www	1176	24483	0.028914595	20.81888	53072	0.06267841	45.1292517	61429	90044	25897	5.8	0
13	ISBN_Canada	https://library-archives.canada.ca/eng/se	9	16	0.002048918	1.777778	18	0.00230503	2	565	283	317	10	1
14	ISBN_China	https://www.cnapc.cn/fuwu.html	128	10849	0.095218452	84.75781	5050	0.04432235	39.453125	1948	3686	1376	2.2	0
15	ISBN_Colombia	https://camlibro.com.co/isbn	214	3386	0.035042328	15.82243	957	0.00990417	4.471962617	3467	1001	2837	6.9	1
16	ISBN_Costa_Rica	https://www.sinabi.go.cr	993	11336	0.00956635	11.41591	56193	0.04742077	56.58912387	52849	78336	27900	7.2	48
17	ISBN_Cuba	https://isbncuba.ccl.cerlalc.org	1456	97701	0.155655643	67.10234	23783	0.03789069	16.33447802	14477	19755	4391	2.8	0
18	ISBN_Denmark	https://www.isbn.dk	2	0	0	0	32	0.13793103	16	34	2	20	9.7	2
19	ISBN_Eswatini	http://www.library.uniswa.sz	10	220	0.094137783	22	162	0.06931964	16.2	218	10	95	5.2	0
20	ISBN_Ethiopia	https://www.nala.gov.et	403	55204	0.238850141	136.9826	4045	0.01750143	10.03722084	20799	1687	2630	2.2	0
21	ISBN_Findland	https://www.kansalliskirjasto.fi/en/service	1459	190	9.09E-05	0.130226	13648	0.00652812	9.354352296	83707	419806	110091	9.8	1293
22	ISBN_France	https://www.afnil.org	999	7366	0.015991906	7.373373	6860	0.01489336	6.866866867	35261	21520	2116	8	0
23	ISBN_Ghana	https://www.library.gov.gh	1	119	0.092248062	119	34	0.02635659	34	81	4	33	2.6	0
24	ISBN_Hong_Kong	https://www.hkpl.gov.hk/en/about-us/serv	1	2	0.035087719	2	4	0.07017544	4	2	1	4	8.7	0
25	ISBN_Hungary	https://oszk.hu	1283	45416	0.057891503	35.39829	17950	0.02288076	13.99064692	24503	1	13100	4.9	0
26	ISBN_Iceland	https://landsbokasafn.is	1129	4289	0.015861745	3.798937	27226	0.10068824	24.11514615	19480	21838	11030	8.4	18
27	ISBN_Indonesia	https://isbn.perpusnas.go.id/landing_page	12	203	0.041243397	16.91667	208	0.04225924	17.33333333	201	567	51	6.3	1
28	ISBN_Israel	https://icl.org.il/isbn-eng	645	1878	0.006096749	2.911628	4535	0.01472245	7.031007752	19440	24087	2425	8.9	0

FIGURE 4. Screenshot of page-report of ISBN agencies' websites from Popetech.

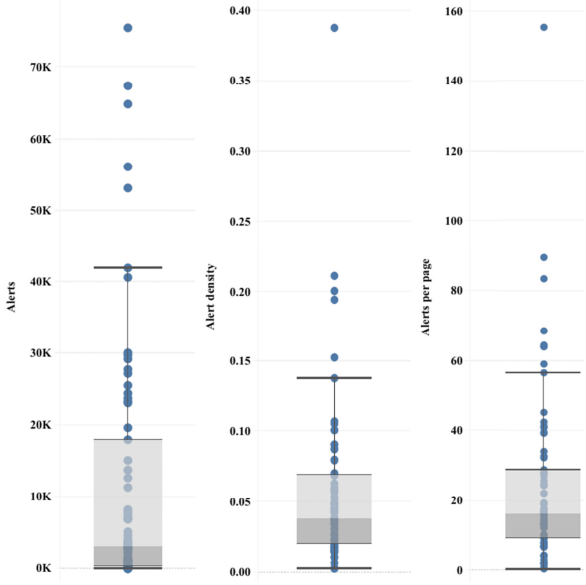

FIGURE 5. Box plot of alerts of ISBN agencies' websites.

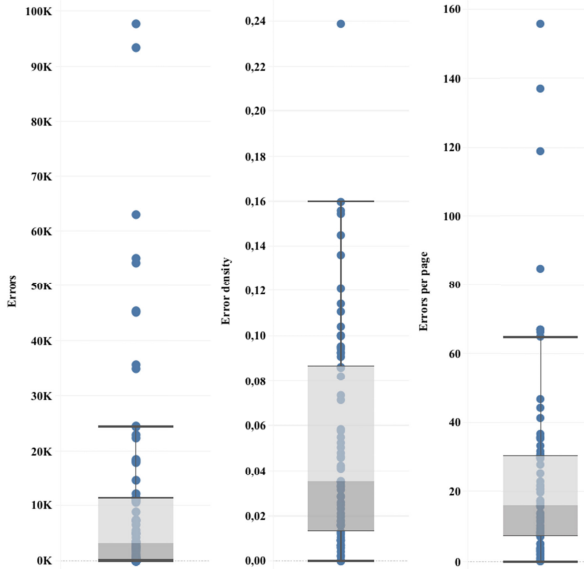

FIGURE 6. Box plots of errors of ISBN agencies' websites.

by continent. Based on the median, we can see that African ISBN-As have the lowest number of scanned pages, followed by Oceania, Asia, America and Europe, respectively.

5) AUTOMATED TESTING SCORE PER ISBN AGENCIES' WEBSITES AGGREGATED BY CONTINENT

Figure 10 shows a box plot representing the performance of ISBN-As' ATS [40] aggregated by continent. We note that, in general ISBN-As' websites perform very low in ATS, as Africa, America, Asia and Europe have a maximum median value of 6.9. This indicates that half of their ISBN-As' websites have an ATS lower that 8, which is the threshold.

We also see that Oceania has a median of 8.2, which is higher than the threshold. Therefore, half of Oceanian ISBN-As' websites can be considered as accessible.

C. RESULTS-REPORT ANALYSIS OF WEB ACCESSIBILITY PERFORMANCE OF ISBN AGENCIES

This subsection provides an analysis of the web accessibility performance of ISBN-As' websites in terms of the conformance level to success criteria of WCAG 2.2. The analysis was conducted by creating a Microsoft Excel table containing data from the result-report from Popetech which was then loaded into Tableau Public [38].

The results-report provides additional web accessibility information that is not available at page-report, such us contrast errors, WCAG conformance level and the frequency of violations of each type of web accessibility barrier detected.

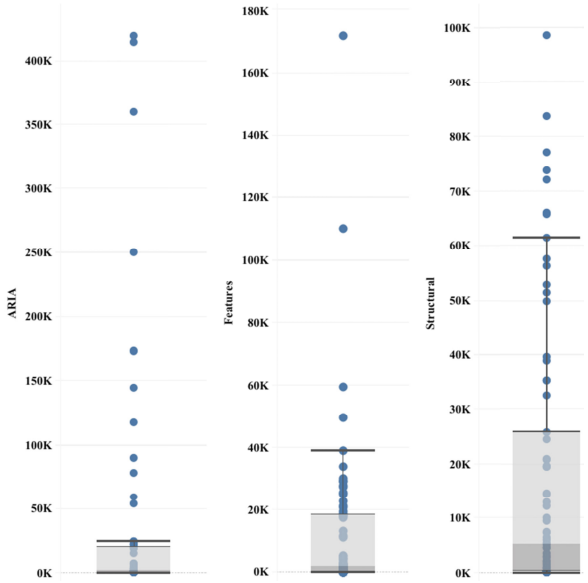

FIGURE 7. Box plot of ARIA, features and structural elements reported by Popetech for ISBN agencies' websites.

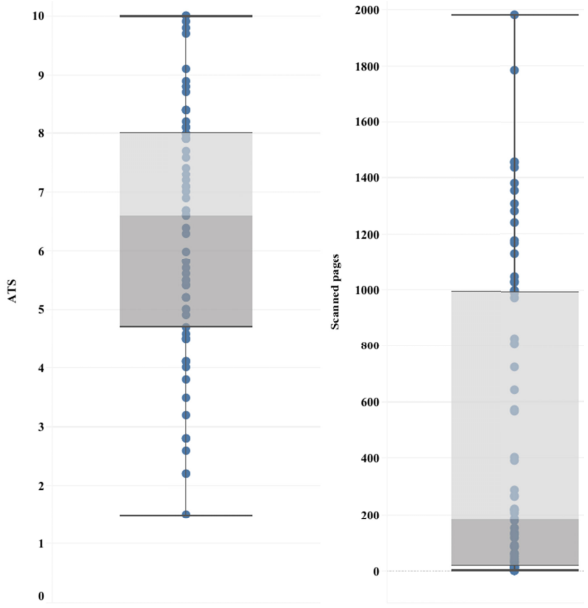

FIGURE 8. ATS and scanned pages per ISBN agencies' websites.

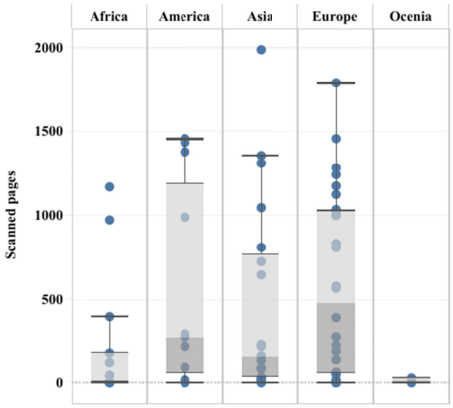

FIGURE 9. Scanned pages per ISBN agencies' websites aggregated by continent.

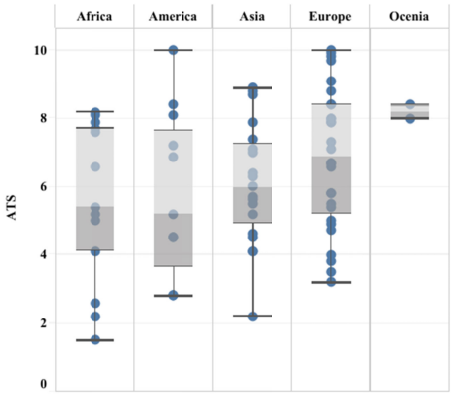

FIGURE 10. ATS per ISBN agencies' websites aggregated by continent.

1) WEB ACCESSIBILITY BARRIERS BY CATEGORY REPORTED BY POPETECH FOR ISBN AGENCIES

Table 5 shows the number of web accessibility alerts, contrast errors and common errors ISBN-As' websites. Contrary to the page-report, the result-report differentiates errors and contrast errors.

The ISBN-As' websites have more alerts in comparison to their contrast errors and ordinary errors. Also, ISBN-As' websites have more contrast errors than ordinary errors. The prevalence of contrast errors represent barriers to persons with visual impairment.

2) WEB ACCESSIBILITY BARRIERS BY WCAG CONFORMANCE LEVEL REPORTED BY POPETECH FOR ISBN AGENCIES

Table 6 shows the WCAG 2.2 conformance level of the accessibility barriers found in the ISBN-As. The ISBN-As' websites present more violations of the WCAG conformance level A, followed by AA and AAA. The higher amount of web accessibility elements non-conformance to WCAG conformance level A indicates that a great amount of persons with disabilities encounter barriers to accessing major part of ISBN-As' websites.

3) TYPES OF WCAG VIOLATIONS REPORTED BY POPETECH FOR ISBN AGENCIES

Table 7 presents the frequency of violation of each type of web accessibility barrier detected against WCAG 2.2. There are about 21 type of violations on that table and 20 of them were violated; however no webpage had blinking content.

We can perceive that the top-6 most frequent violations are: empty link, missing form label, linked image missing alternative text, missing alternative text, empty heading and empty button. These represents the most frequent barriers that persons with disabilities will encounter while accessing ISBN-As' websites.

TABLE 5. Web accessibility performance in terms of alerts, errors and contrast errors, and errors reported by Popetech for ISBN agencies' websites.

Category	Value
Alerts	853,780
Contrast errors	495,201
Errors	355,291

TABLE 6. WCAG conformance levels for ISBN agencies' websites.

WCAG conformance level	Value
A	543,871
AA	495,201
AAA	246,604

TABLE 7. Frequency of WCAG violation types detected in the ISBN agencies' websites.

Type of WCAG violation	Value
Blinking content	0
Broken ARIA menu	4,586
Broken ARIA reference	11,860
Broken skip link	2,008
Empty button	25,022
Empty form label	8,245
Empty heading	27,544
Empty link	79,874
Empty table header	1,414
Image button missing alternative text	4
Image map area missing alternative text	106
Image map missing alternative text	79
Invalid longdesc	10
Language missing or invalid	4,954
Linked image missing alternative text	68,069
Markee	10
Missing alternative text	38,276
Missing form label	78,671
Missing or uninformative page title	688
Multiple form label	2,552
Page refreshes or redirects	1,300
Spacer image missing alternative text	21

V. DISCUSSION

This study aimed to determine the web accessibility status of ISBN-As around the world, by examining their web accessibility performance. National ISBN-As typically operate under public mandates or delegated public functions. As such, their websites fall within the scope of public sector digital services, which in many jurisdictions are legally required to comply with accessibility regulations. At the international level, this obligation is grounded in the CRPD, particularly Article 9 on accessibility [4]. At the technical level, accessibility requirements are operationalized through standards such as WCAG, often referenced by national or regional legislation. Non-compliance therefore represents not only a technical shortcoming but also a potential legal and institutional failure.

In this section we discuss the findings of the research in relation to the WCAG principles, success criteria, conformance levels and regulations. A total of 73 ISBN-As from different countries were included in this study. The selection criteria was that the ISBN-As' websites should be online, added, crawled and scanned on the Popetech platform. The evaluation reports provided by Popetech were analyzed using Tableau Public [38], a data visualization and statistical analysis tool.

A. ALERTS AND ERRORS

Alerts from a web accessibility evaluation highlight potential accessibility issues that require manual review to determine whether they constitute actual problems that need to be fixed. As shown in Figure 5, the median value of alert density of ISBN-As' websites is low and that indicates that the overall performance is acceptable.

Errors identified by the WAVE tool in a web accessibility evaluation represent direct non-conformance with WCAG directives. These errors represent barriers to a website or webpage to be perceivable, operable and understandable [42]. As it is shown on Figure 6, the median error density and error per page on ISBN-As' websites are low, which means that the overall performance is not so bad.

B. ARIA, FEATURES, AND STRUCTURE

The data indicates that ISBN-As' websites have considerable number of ARIA elements, as shown in Figure 7. Having more ARIA means that ISBN-As' websites adhere more closely to the WCAG principle of robustness [42]. Therefore, their content can be reliably interpreted by a wide variety of user agents, including current and future assistive technologies. However, the elevated presence of ARIA features in the analyzed web pages suggests further studies about a potential misuse of ARIA in place of native HTML elements. This can negatively affect web accessibility when not applied according to established best practices.

There is a considerable number of features failure, as depicted on Figure 7, meaning that ISBN-As' websites do not adhere to the WCAG principle of operable. Therefore, users may find it more difficult to navigate and interact with ISBN-As' websites using a keyboard.

In terms of structure, Figure 7 also shows that ISBN-As' websites again present a lot of barriers to the WCAG principle of ''understandable''. A website is understandable when its content is easy to read and predictable, helping users to avoid and recover from errors [42].

The lack of conformity to WCAG in terms of the features and structural elements of ISBN-As is comparable to that identified by Devi and Kumar [27] in their evaluation of NCR library websites in India. Therefore, adopting the legal requirements [25], content standards and overall workflow for building accessibility into digital content may improve conformance of ISBN-As' websites to WCAG [28].

C. AUTOMATED TESTING SCORE AND SCANNED PAGES PER ISBN AGENCIES' WEBSITES

The data analysis identifies that ISBN-As' websites have poor performance in web accessibility as most of the ATS are

lower than 8, as shown on Figure 8. The common threshold is 80 %, based on Pareto Principle [41]; any website scoring lower than 8 is considered inaccessible. Having ISBN-As websites with low threshold indicates that they are not fully perceivable, operable, understandable, and Robust.

In terms of the number of scanned pages per ISBN-A, Figure 8, we also perceive that half of ISBN-As' websites contain about 184 pages, in average. This high number of webpages increases the reliability of the results of the evaluation that was carried out.

D. SCANNED PAGES PER ISBN AGENCIES' WEBSITES AGGREGATED BY CONTINENT

The fact that Africa has the lowest number of scanned pages per ISBN-A, as shown on Figure 9, reduces the reliability of its results from the evaluation. The higher the sample of websites that participate in the evaluation, the more reliable are the results derived from the evaluation.

We can see that America, Europe and Asia present a high number of webpages per website. The statistical analysis derived from their results are more reliable than those for Africa and Oceania.

E. AUTOMATED TESTING SCORE PER ISBN AGENCIES' WEBSITES AGGREGATED BY CONTINENT

The fact that half of ISBN-As' websites from Oceania score higher than 8, as shown on Figure 10, indicates that they score is higher than the threshold. Therefore, these ISBN-As can be considered as accessible.

We have realized that some regions, such as Oceania, performed well in the ATS, exceeding the minimum threshold, while others struggled to reach it. This evidence can be attributed to the level of commitment to digital accessibility rights among countries [43]. For instance, Australia's Dare Index increased from 71 in 2018 to 80 in 2020. However, Portugal's Dare Index decreased from 43 to 33.5. In some cases, a lack of commitment to digital accessibility rights may be forced due to war situation. This may be the case for Ukraine, which had a Dare Index of 67 and a global ranking of 15 in 2018, before the war began. However, we cannot exclude other reasons that would require more detailed analysis.

In general, ISBN-As' websites from Africa, America, Asia and Europe perform low in web accessibility score. This behavior is in line with the worldwide web accessibility trending [2].

F. CONTRAST ERRORS

Most of the WCAG misconformance are contrast errors, as shown on Table 5, which means that persons with visual impairment encounter barriers to accessing ISBN-As' websites.

Contrast errors are related to the web accessibility principles of perceivable and understandable [42]. A person with visual impairment may have difficulties to perceive a website's content with low contrast, therefore, making it hard to be understood.

G. WCAG CONFORMANCE LEVEL

Considering the conformance level, as shown on Table 6, there are more ISBN-As' websites that conform to level A, follows that those that conform to level A and AA. This is the normal behavior in performance is as expected.

WCAG conformance is essential because it provides an internationally recognized, objective framework for ensuring that web content is accessible to people with disabilities. It enables consistent and measurable evaluation based on the principles of being perceivable, operable, understandable, and robust. From a legal perspective, WCAG is widely referenced in accessibility regulations and standards, making conformance necessary to demonstrate compliance and reduce legal risk. Ethically, it supports equal access to information, services, and participation in digital society, helping to prevent digital exclusion.

Conformance level A comprises a minimum set of accessibility barriers that a webpage should not present to be accessed by most of the persons with disabilities. Conformance level AA adds more barriers to be satisfy by a webpage, including those at level A. Conformance level AAA is more demanding to fulfill by a webpage [16].

H. TYPE OF WCAG VIOLATIONS

The data analysis from Table 7 suggest that the top-6 most violated WCAG elements are: empty link, missing form label, linked image missing alternative text, missing alternative text, empty heading and empty buttons. These are web accessibility barriers that violate the four WCAG principles: operable, perceivable and understandable and robust.

A webpage with empty links is not operable. A webpage with linked image missing alterative text is not perceivable. A webpage with empty buttons is not robust. And, finally, a webpage with a missing alternative text is not understandable and robust, as screen readers cannot read the alternative text, making a person with visual impairment to have difficulties to understand the webpage.

The top-6 frequent type of WCAG violations that are found in this study share similarities with the top-6 WCAG violations of the WebAIM million report [2]: missing alternative text, missing form label and empty button.

I. LIMITATIONS

During the development of this research study, we encounter some limitations that are worth to be mentioned:

1) A considerable number of ISBN-As were removed from the evaluation sample. This was due to a lack of a website, technical errors, or an inability to be scanned by Popetech. At first glance, this attrition may appear to introduce 'survivorship bias', whereby only libraries that can be scanned by Popetech are considered in the evaluation. However, the fact that

many of the removed ISBN-As either did not have a website or presented technical errors suggests that these websites are inaccessible to everyone, not just people with disabilities.

2) This study relies solely on automated web accessibility evaluation tools (AWAETs), which capture only 30–50 % of potential web accessibility issues. In future, this study should be extended to include a combination of quantitative and qualitative evaluation methods to increase the accuracy of the results.

VI. CONCLUSION AND FUTURE WORK

This study aimed to examine the web accessibility performance of ISBN-As. National ISBN-As are expected to act as reference institutions in terms of good governance, transparency, and inclusion. An inaccessible website undermines institutional credibility and weakens public trust, particularly when accessibility is already a stated policy objective in many public administrations [44]. This work is pioneering in addressing the accessibility of ISBN-As' websites, which have not previously been evaluated from an accessibility perspective. In addition, this work makes a methodological contribution to the field of evaluating institutional public websites using WCAG, expanding the corpus of comparative studies beyond universities, governments, libraries, etc.

The web accessibility evaluation of ISBN-As was carried out by using the Popetech platform. A total of 34,287 from selected ISBN-As' websites were scanned by Popetech, which reports were later analyzed using Tableau Public, a statistical and data visualization tool.

Despite that a great majority of selected ISBN-As are from countries that have signed and ratified the CRPD [4], the results showed that ISBN-As' websites are not in conformance to WCAG 2.2 [13]. The ISBN-As scored low on ATS and presented several web accessibility errors, contrast errors, issues with structural elements and features that pose barriers to persons with disabilities. However, ISBN-As used ARIA elements in great amounts, which is good for their integration with assistive technology, such as screen readers, braille displays and others.

In summary, to reach a worldwide enforcement of web accessibility there is a need for continuous awareness to potential stakeholders from researchers. In this sense, this study contributes to the awareness about the need to improve the accessibility of ISBN-As' websites for persons with disabilities. The ISBN-As play a substantial role in book publishing process. Therefore, full compliance of ISBN-As' websites with WCAG will allow persons with disabilities to equally acquire and ISBN from the corresponding websites of their respective ISBN-As. By doing so, ISBN-As will also comply with the CRPD [4] and the UN-SDG number 10 [5], which aim to reduce inequalities. But, to have ISBN-As' websites to conform to WCAG worldwide, there is a need for commitment from countries in terms of laws, regulations, policies and programs [43].

This study could be extended by incorporating more ISBN-As' websites that are not currently included, especially those that were removed from the evaluation sample. Another way to extend this study would be to perform a full comparison analysis between continents on web accessibility of ISBN-As. Also, this study can be extended by including performing the web accessibility evaluation with a combination of quantitative and qualitative web accessibility evaluation methods to increase accuracy and reliability of the results. The recommendation of the inclusion of qualitative web accessibility evaluation methods is due to the fact that quantitative AWAETs can only detect about 30-50 % of issues with accuracy. Finally, another way of extending this study is to cross reference its results with the DARE Index [43] and the Human Development Index.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study is openly available at https://doi.org/10.17632/6znx3k3b93.2

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