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Accessibility Analysis of Learning Management System Websites

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***Abstract*—In the digital era, Learning Management System is widely used to spread information in higher education, particularly at the university level. There are, however, issues with the Learning Management System's accessibility for users with disabilities. This research aims to investigate the accessibility issues of learning management websites of 30 universities in Indonesia. The top 30 universities in Indonesia according to Webometrics 2022 are the basis for this study. Accessibility issues will be identified and examined using the Wave evaluation tool which is in accordance with the Web Content Accessibility Guidelines 2.1 used by ISO 40500. Web Content Accessibility Guideline 2.1 has principles that any web should follow: Perceivable, Operable, Understandable, and Robust. Based on the research findings, The low contrast ratio between text and background, the absence of text explanations in the images, the lack of descriptive text on the links, the absence of text labels on the form, and the absence of text description on the button were the most frequently encountered accessibility issues.**

Keywords—web accessibility; users with disabilities; accessibility issues; webometrics; Wave

1 INTRODUCTION

Everyone from any nation, both developed and developing countries, has equal rights to education because it plays a significant role in the country's existence [1]. The quality of human resources can be improved and developed through education. Indonesia acknowledges that all citizens have equal rights to an education free from all forms of prejudice [2][3]. For those with disabilities, this also holds true. Each and every disabled individual who faces physical, intellectual, and/or mental health problems deserve similar educational opportunities [4].

The active participation rate of students with disabilities in Indonesia is 25 percent out of the target achievement of 49 percent, according to a survey by the Ministry of Education and Culture [5]. People with disabilities who do not actively participate may be unable to access learning materials before the class begins or lack the confidence to ask the teacher directly [6]. To ensure that all students, especially the disabled, can accept the learning materials, the learning methods must be modified to meet the needs of people with disabilities [7]. The educational system that provides equal rights for people with disabilities to obtain education altogether with normal students is called inclusive education.

Inclusive education aims for students with disabilities to receive better education based on their abilities and needs [8]. To support the implementation of inclusive education, the university is currently utilizing information and communication technology such as Learning Management System (LMS) [9]. Learning management systems are a common pedagogical tool in education not only to learn but also to communicate with teachers and other students. As a result, the LMS should not have any accessibility issues, especially for people with disabilities [10].

Wicaksono et al. [11] researched how to make LMS use as effective as possible for university students with disabilities. His research findings indicate that web pages were challenging for students with disabilities to access because they were not really made in a way that was accommodating to their needs. Furthermore, a system that encourages lecturers to use the LMS and take advantage of its capabilities consistently is required. This research suggests creating an LMS website design that meets the needs of people with disabilities using the WCAG, an international accessibility standard guideline.

Previous studies regarding the analysis of website accessibility include one by Bocevska et al. [12] who analyzed the accessibility of the main pages of LMS websites such as Eliademy, Moodle, Docebo, ATutor, and Sakai based on WCAG 2.0. The CROSS4ALL IPA2 project activity to choose an e-learning platform that meets the needs of everyone, including the disabled, was also included. This research recommends implementing the ATutor LMS as it helps to enhance local citizens' digital literacy in the health sector because it is more easily accessible.

Three learning management systems: Sakai, Moodle, and the platform created by the University of Ecuador were the subjects of accessibility research by Acosta et al. [13]. This research intends to assess the quality of accessibility of the three LMS to research the structure or elements of LMS that have greater accessibility to prepare for adopting legislation related to website accessibility that will be imposed in Ecuador. According to this research, clear directions on the input form, page titles, and navigation are a few aspects that should be addressed in the University LMS platform.

Shawar [14] conducted accessibility research on educational websites to compare the accessibility levels of several Jordanian universities with many other universities in the Arab world and the UK. This accessibility research followed WCAG 2.0 standard. The research shows that e-learning at numerous Jordanian universities is less accessible. The lack of alternate text in links contributes to poor web accessibility.

At Universitas Negeri Sebelas Maret, Windriyani et al. [15] conducted an accessibility analysis of several kinds of websites, including e-learning websites. This research also followed WCAG 2.0 guidelines. In terms of technology, an automatic evaluation tool is used during the inspection procedure. The study identifies several areas that need improvement to increase website accessibility, including alternate texts, info and relationships, and contrast.

These studies altogether show that many LMS websites still have poor accessibility, making it inconvenient for the disabled. Not all website developers or other related stakeholders in website development pay attention to website accessibility resulting in poor performance in this aspect [16]. The guidelines for website accessibility standards that are internationally agreed upon are issued by the World Wide Web Consortium (W3C), which is outlined in the Web Content Accessibility Guidelines (WCAG) [17]. These guidelines inform website developers to make their websites compatible and convenient for all users, including people with disabilities.

Previous studies that have just been mentioned conducted an accessibility analysis of the main website page based on WCAG 2.0. However, this research will conduct an accessibility analysis based on WCAG 2.1. This research examines the accessibility of LMS of 30 university websites in Indonesia. The top 30 Indonesian universities, according to Webometrics 2022, are the basis for the list of LMS. This research aims to assess the website's level of accessibility, highlight accessibility issues, and identify success criteria that are frequently not fulfilled. This research is expected to provide insight and recommendations for developers and parties involved in website development to improve LMS accessibility.

2 METHOD

In evaluating the accessibility of LMS websites of the 30 universities, this research followed WCAG 2.1 standard. This research assessed the WCAG compliance of these websites. Following the WCAG-EM recommended by WAI, the evaluation process was carried out [18]. Figure 1 illustrates our research stages.

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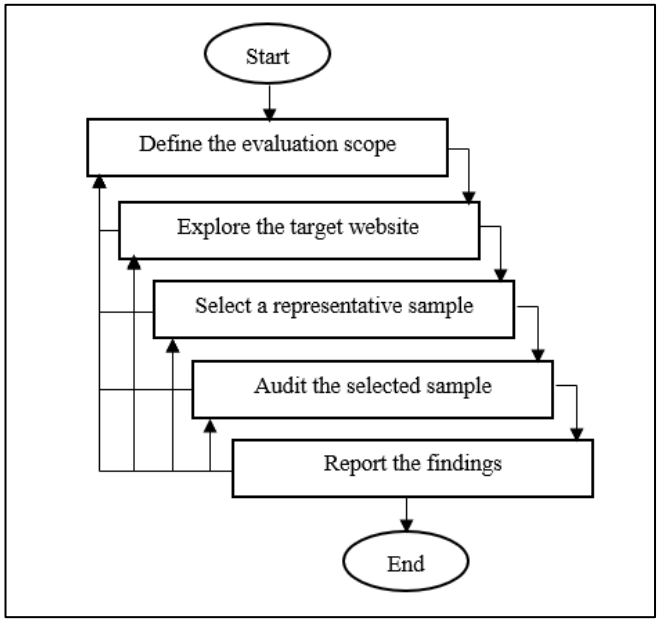

Figure 1. Research Stages

The scope of the evaluation was first defined in order to determine the target websites, establish the WCAG conformance level that would be checked during the evaluation process, define the accessibility support baseline (the hardware and software utilized to retrieve and serve the webpage), and determine additional clause requirements (optional).

To learn more about the target websites, an exploration was conducted. A list of numerous websites to be examined was made, and their availability was then confirmed.

Next, the researcher chose the pages that would serve as evaluation samples. This sampling aimed to determine whether the evaluation findings correctly depicted the accessibility performance. Simple websites were skipped in this step since they already offered a way to assess the page.

The process of auditing the selected sample was done in accordance with the guidelines established from the beginning. Lastly, the writing process was done in each step because it was used as the basis for reports.

3 RESULT AND DISCUSSION

This section will present the result and discussion of the research findings. We begin with the accessibility of a website.

3.1 Website Accessibility

The development of information and communication technology, particularly the use of websites to disseminate information and services to everyone without exception and without being constrained by space and time, making it impossible to separate website analysis research from the development. Several indicators that have been developed and adjusted to the technological and societal elements can be used to analyze websites [19]. There are six indicators that can be used to analyze a website can be found using the website evaluation model.

- Content. Evaluation of all the information on the website.
- Privacy or security. Evaluation of the website's data security measures when users interact with it.
- Usability. Assessment of the functioning of websites.
- Quality. A system performance capability evaluation.
- Accessibility. Evaluation of the website's accessibility for people with disabilities.
- Public participation. Evaluation is concerned with the website's usefulness to the community.

This research analyzes the website's accessibility to assess its level of WCAG compliance. WCAG is an accessibility standard used by ISO 40500 [20] to standardize website accessibility because it is a guideline for producing website content that everyone, particularly the disabled, can view. It is an international consensus among professionals in the field. UUAG and ATAG, the innovators in developing website accessibility principles, are summarized in WCAG [21]. Additionally, several nations utilize the WCAG as a reference for establishing legal regulations for systematically enhancing website accessibility [22].

This website accessibility research was conducted in accordance with WCAG 2.1 formulated by World Wide Web Consortium [17]. WCAG 2.1 has several layers of guidance such as the followings:

- The principle. It is the basic guideline for making the website accessible to people with disabilities.
- Guidelines. It is a framework for developing websites that are accessible to people with disabilities.
- The success criteria. It is the description of the guidelines that can be measured so that they can be used as a test guide.

The accessibility principles, guidelines, and success criteria according to WCAG 2.1 are shown in Table 1. WCAG provides recommendations for creating a website, so people with disabilities can easily access it. WCAG has four principles that must be found in a website: Perceivable, Operable, Understandable, and Robust.

1) Perceivable.

The perceivable principle provides direction that all content on a website page including images, videos, and audio, must be displayed to users in a way that they can be perceived. This principle is described in the following guidelines:

- Text alternatives recommend that all non-text content displayed on a website be supported with an alternative text that provides the same information as the displayed content.
- Time-based media recommends that all time-based media such as video be given alternatives in other forms, for example, audio format.
- Adaptable. Content on the website can be presented differently (e.g., displaying a more straightforward layout).

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Table 1. The Success Criteria of Web Content Accessibility Guidelines 2.1

Principle	Guidelines	Success criteria	Level
Perceivable	Text alternatives	Non-Text Content	A
	Time-based media	Audio-only and Video-only (Prerecorded) Captions (Prerecorded) Audio Description or Media Alternative (Prerecorded)	A
		Captions (Live) Audio Description (Prerecorded)	AA
	Time-based media	Sign Language (Prerecorded) Extended Audio Description (Prerecorded) Media Alternative (Prerecorded) Audio-only (Live)	AAA
	Adaptable	Info and Relationships Meaningful Sequence Sensory Characteristics	A
		Orientation Identify Input Purpose	AA
		Identify Purpose	AAA
	Distinguishable	Use of Color Audio Control	A
		Contrast (Minimum) Resize Text Images of Text Reflow Non-text Contrast Text Spacing Content on Hover or Focus	AA
		Contrast (Enhanced) Low or No Background Audio Visual Presentation Images of Text (No Exception)	AAA
Operable	Keyboard accessible	Keyboard No Keyboard Trap Character Key Shortcuts	A
		Keyboard (No Exception)	AAA
	Seizures and physical reaction	Three Flashes or Below Threshold	A
		Three Flashes Animation from Interactions	AAA
	Navigable	Bypass Blocks Page Titled Focus Order Link Purpose (In Context)	A
		Multiple Ways Headings and Labels Focus Visible	AA
		Location Link Purpose (Link Only) Section Headings	AAA
	Input modalities	Pointer Gestures Pointer Cancellation Label in Name Motion Actuation	A
		Target Size Concurrent Input Mechanisms	AAA
Understandable	Readable	Language of Page	A
		Language of Parts	AA
		Unusual Words Abbreviations Reading Level Pronunciation	AAA
	Predictable	On Focus On Input	A
		Consistent Navigation Consistent Identification	AA
		Change on Request	AAA
	Input Assistance	Error Identification Labels or Instructions	A
		Error Suggestion Error Prevention (Legal, Financial, Data)	AA
		Help Error Prevention (All)	AAA
Robust	Compatible	Parsing Name, Role, Value	A
		Status Messages	AA

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- Distinguishable. It is recommended that the website be designed in such a way that users can easily see and distinguish each component in the presented content.

2) Operable.

The operable principle provides directions so the interface and navigation components on web pages can be operated. This principle is described in the following guidelines:

- Keyboard accessible. It recommends that interface components with functionality be operated via the keyboard.
- Sufficient time. It recommends providing enough time for users to access the website.
- Seizures and physical reactions. It recommends that website design not trigger physical reactions that are not good for users, such as seizures.
- Navigable. It recommends making it easy for users to be able to navigate and identify the user's position.
- Input modalities. It recommends making it easy for users to operate the existing functionality on web pages by not limiting it to only one tool.

3) Understandable.

The understandable principle provides directions so the user can understand all information and interface operations. This principle is described in the following guidelines:

- Readable. It recommends that textual content can be read and understood.
- Predictable. It suggests that web pages can be displayed and operated in a predictable manner.
- Input Assistance. It recommends assisting users in avoiding and correcting errors.

4) Robust.

The robust principle provides direction, so website content is compatible with various assistive technologies. This principle recommends that websites be created using cutting-edge technology to be compatible with interpretation by multiple assistive technologies that are constantly evolving.

The four principles are converted into success criteria, which are grouped into three levels of conformity: Level A, Level AA, and Level AAA.

- Level A. Conformance to this criterion is described as the minimum level of conformity. In general, developers must reach this level. If it is not found on the website, then one or more disability groups may not be able to access it.
- Level AA. Conformance to this priority level is described as a medium suitability level. Website developers must reach this level. Some groups will have difficulty accessing the content if this level is not found on the website.
- Level AAA. Conformance to this priority level is described as the maximum level of conformity. If website developers reach this level, it will be easier for particular groups to access web content.

3.2 Accessibility Analysis

As already mentioned, this research analyzes the accessibility in the learning management systems in Indonesia by referring to the Website Accessibility Conformance Evaluation Methodology (WCAG-EM) to find accessibility issues based on WCAG 2.1. These are the findings of this research:

3.2.1. *Define the evaluation scope.* This accessibility analysis was on the LMS of 30 university websites in Indonesia. The list of the top 30 universities and LMS websites are in Table 2. This research is not intended to make a ranking based on website accessibility but to find out the level of website compliance with WCAG and identify accessibility barriers on web pages. The final goal is to provide knowledge about the extent to which a website's content meets the WCAG 2.1 standard. Such information can be used as a recommendation for website developers to improve website accessibility. The three levels of WCAG 2.1 compliance—level A, level AA, and level AAA—will all be followed. Google Chrome is the assistive technology utilized in this research to display online pages because statistically, with a market share of 65.87% as of June 2022, it has the largest browser users [23].

3.2.2. *Explore the target website.* The top 30 webometrics-ranked colleges provided information about their LMS during the the exploration phase so that the availability can be further verified.

Table 2. List of Universities and LMS Websites

ID	Universities	Website
A1	Universitas Indonesia	https://emas.ui.ac.id
A2	Universitas Gadjah Mada	https://elok.ugm.ac.id
A3	Universitas Brawijaya	https://vlm2.ub.ac.id
A4	IPB University	https://newlms.ipb.ac.id
A5	Universitas Airlangga	https://hebat.elearning.unair.ac.id
A6	Universitas Negeri Sebelas Maret (UNS) Surakarta	https://spada.uns.ac.id
A7	Institut Teknologi Sepuluh November	https://classroom.its.ac.id
A8	Universitas Telkom	https://lms.telkomuniversity.ac.id
A9	Institut Teknologi Bandung	https://kuliah.itb.ac.id
A10	Universitas Lampung	https://vclass.unila.ac.id
A11	Universitas Bina Nusantara	https://onlinelearning1.binus.ac.id
A12	Universitas Andalas	https://mbkm.ilearn.unand.ac.id
A13	Universitas Hasanuddin	https://elearning.med.unhas.ac.id

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ID	Universities	Website
A15	Universitas Padjajaran Bandung	https://mooc.unpad.ac.id
A16	Universitas Muhammadiyah Yogyakarta	https://myklass.umy.ac.id
A17	Universitas Pendidikan Indonesia	https://spada.upi.edu
A18	Universitas Diponegoro	https://kulon2.undip.ac.id
A19	Universitas Mercu Buana	https://umb-elearning.mercubuana.ac.id
A20	Universitas Negeri Malang	http://sipejar.um.ac.id
A21	Universitas Syiah Kuala	https://elearning.unsyiah.ac.id
A22	Universitas Islam Indonesia	https://klasiber.uii.ac.id
A23	Universitas Negeri Yogyakarta	https://besmart.uny.ac.id/v2
A24	Universitas Sumatera Utara	https://elearning.usu.ac.id
A25	UIN Syarif Hidayatullah Jakarta	https://ais.uinjkt.ac.id
A26	Universitas Atma Jaya Yogyakarta	https://kuliah.uajy.ac.id
A27	Universitas Gunadarma	https://v-class.gunadarma.ac.id
A28	Universitas Ahmad Dahlan Yogyakarta	https://elearning.uad.ac.id
A29	Universitas Sam Ratulangi	https://elearning.unsrat.ac.id
A30	Universitas Negeri Semarang	https://elena.unnes.ac.id

The list of universities was compiled using data from Webometrics [24]. After obtaining the list, the next step was identifying the university's LMS website address from the Ministry of Education and Culture's Online Learning System [25]. Then the researcher checked whether the website could be accessed through the Google Chrome browser. During the process, the researcher encountered a warning message about potential risks when checking the LMS website of Andalas University via a browser.The information from the error message was a notification that the https certificate from the website might have expired. Therefore, if one opens the website through a browser, one must take additional steps to confirm the agreement to accept the risks related to data security. This step can potentially cause difficulties for users, especially those with disabilities.

3.2.3. *Select a Representative Sample.* The researcher chose the pages that would serve as evaluation samples in this step. The sample's goal was to determine whether the evaluation findings properly depict accessibility performance. All simple websites were skipped during this step. The web's main page was selected to be evaluated because this is the very first page that the user accesses. This main page contains general information about the website [26]. Therefore, assessing the accessibility of the university LMS website's main page can be helpful as it may offer feedback related to the website's accessibility level [27].

3.2.4. *Audit the Selected Sample.* The evaluation of accessibility was done by following the guidelines that had been established from the beginning. To assess the accessibility, this research used the general compliance levels of level A, level AA, and level AAA. The entire page interface was evaluated, including all of its operations.

The learning management system accessibility analysis in this research used an automatic evaluation tool to simplify and shorten the procedure. A website's suitability for accessibility can be checked using the tool as the first step. As one of the instruments proposed by WAI [28], Wave was selected as a tool to assess the research process.

Additionally, everyone can use Wave for free, which always adheres to the WCAG development [29]. The assessment report was visually displayed, directly pointing to the identified object. Hence, Wave has been employed in much earlier research on website accessibility [30]. Wave provides two ways to evaluate a website. The first is to run Wave online by accessing the Wave website [29]. The second is to run Wave offline by using the Wave application already installed in the browser extension [31]. The researcher in the analysis process double-checked the existence of the intended website.

Wave assesses accessibility by looking at the website's HTML code, adapted to meet the needs of people with disabilities under WCAG 2.1. Due to the offline mode of the Wave examination used in this research, Wave had to be added to the Google Chrome extension. Once the Wave evaluation tool was installed to the Google chrome extension, it would appear as in Figure 2.

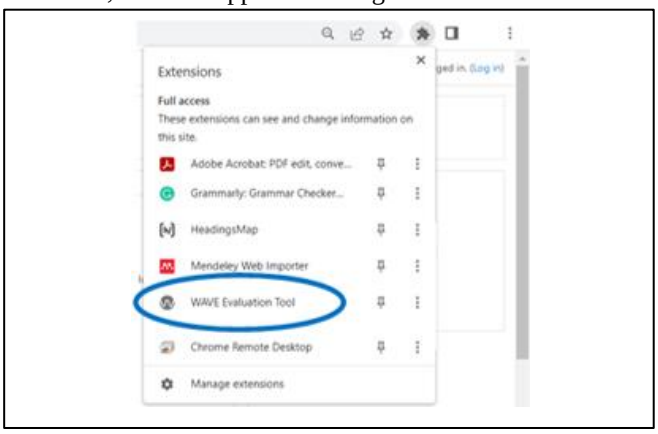

Figure 2. Screenshot of wave extension

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The evaluation reports from Wave were grouped into six categories: Error, Contrast Error, Alert, Feature, Structural Element, and Aria. An example of a screenshot of accessibility analysis using Wave can be seen in Figure 3.

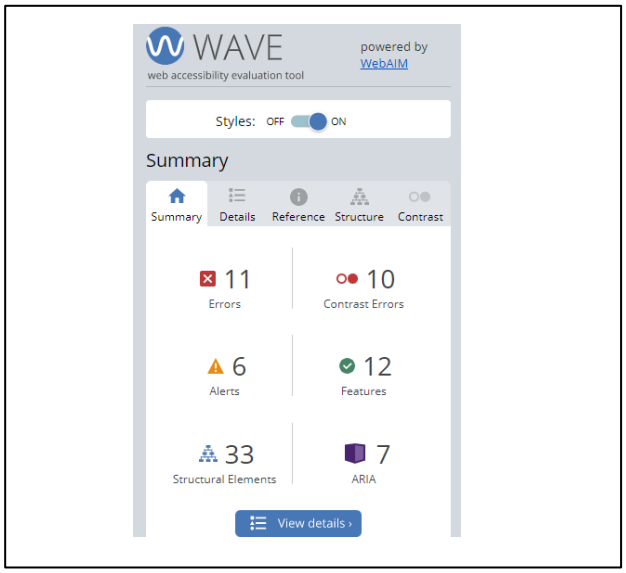

Figure 3. Screenshots of Wave evaluation result

- Error. The elements in this category pointed to a non-conformity that violated the requirements of the accessibility standard of WCAG. The problems found under this category were mostly due to the absence of an accessibility-related HTML code attribute. Therefore, it was very likely to make it difficult for impaired users to access the website.
- Contrast Error. The elements here pointed to a non-conformity that violated the requirements of the WCAG. The low contrast ratio of the text's color and background was connected to the faults found in this category; it made it difficult for impaired users to access the website.
- Alert. Elements in this category might have been the accessibility barrier, but the evaluator had to re-examine them to decide the impact. Issues here are not an indication of non-compliance with WCAG.
- Feature. This category detected feature components that could be found on web pages. There was no indication of non-compliance with accessibility standards in the elements in this category. It was possible to improve the accessibility of web pages if the HTML code for the detected features was created in accordance with the standard.
- Structural Element. This category identifies the format of giving headers (titles and subtitles) on web pages. The presence of elements does not suggest a lack of accessibility compliance. The accessibility of the website page can be improved by giving it a heading that describes the significance of the content structure.
- Aria. This category contains recognized elements on the web page with the Aria attribute. There is no indication of non-compliance with accessibility standards in the elements in this category. The accessibility of website pages will be improved if the Aria property is used correctly, following the standard.

Once conducting an accessibility analysis based on WCAG, the things that needed to be considered from the results of the Wave accessibility evaluation were the Error and Contrast Error categories. Because issues detected in the Error and Contrast Error categories indicated that the web page did not follow WCAG, the problems detected impacted on the difficulties faced by users with disabilities. Therefore, it had to be repaired so that users with disabilities could more easily access websites, and as an effort to comply with WCAG. Meanwhile, the issues detected in the Alert, Feature, Structural Element, and Aria categories did not indicate that the websites did not comply with WCAG. Therefore, analyzing the problems in the Error and Contrast Error categories was all that was required to test the accessibility of a website simply.

The next step was evaluating the LMS using the Wave evaluation tool on the Google Chrome extension. The evaluation results of website accessibility at 30 LMS in Indonesia are summarized in Table 3.

Based on the data in Table 3, it can be inferred that there was an LMS that had not been discovered as having any issues in the Error and Contrast Error categories. According to the report, the Wave evaluation results suggested that the Universitas Gunadarma LMS had not found any flaws in the Error and Contrast Error categories. Although there were no issues in both categories, there were issues in the Alert category. Although not an indication of non-compliance with WCAG, when improvements were made to this category, it would increase the accessibility of websites.

Universitas Brawijaya, Universitas Andalas, and Universitas Syiah Kuala were among the university LMSs with no Error category concerns. IPB University, Universitas Airlangga, and Universitas Lampung were among the university LMSs with no Contrast Error concerns.

The LMS websites that were detected to have the most frequent issues in the Error category were Universitas Lampung, Universitas Negeri Malang, and UIN Syarif Hidayatullah. Meanwhile, this research found the LMS websites from Universitas Atma Jaya, Universitas Bina Nusantara, and Universitas Pendidikan Indonesia to have the most frequent issues in the Contrast Error category.

Table 3. Wave Tool Summary report of 30 LMS in Indonesia

ID	Error	Contrast Error	Alert	Features	Structural Elements	Aria
A1	2	3	7	8	10	2
A2	11	11	6	12	33	7
A3	0	6	9	24	48	69
A4	11	0	13	18	29	78
A5	19	0	23	23	24	0
A6	10	19	4	24	43	56

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ID	Error	Contrast Error	Alert	Features	Structural Elements	Aria
A7	15	2	22	14	29	88
A8	17	2	1	13	32	39
A9	19	12	44	15	49	142
A10	60	0	20	39	38	106
A11	9	80	49	53	89	54
A12	0	1	3	9	10	4
A13	3	1	6	12	28	4
A14	9	2	8	0	13	0
A15	12	39	29	30	63	16
A16	3	13	3	14	21	17
A17	20	63	72	27	85	52
A18	6	7	4	19	30	3
A19	11	19	13	16	28	27
A20	35	50	24	23	54	45
A21	0	15	15	9	23	60
A22	4	5	6	6	15	7
A23	1	4	6	15	23	38
A24	7	4	18	9	48	32
A25	25	4	19	0	5	1
A26	5	98	4	15	88	49
A27	0	0	4	11	23	49
A28	9	3	8	21	20	0
A29	17	49	110	43	93	197
A30	3	2	2	1	6	2

The highest number of issues in the Alert category were discovered in the LMS from Univeritas Sam Ratulangi, Universitas Pendidikan Indonesia, and Universitas Bina Nusantara. Although the problems found in the Alert category were not indicators of the website's WCAG compliance, they might require manual inspection. Figure 4 shows the result of the website accessibility evaluation on 30 LMS in Indonesia in the diagram.

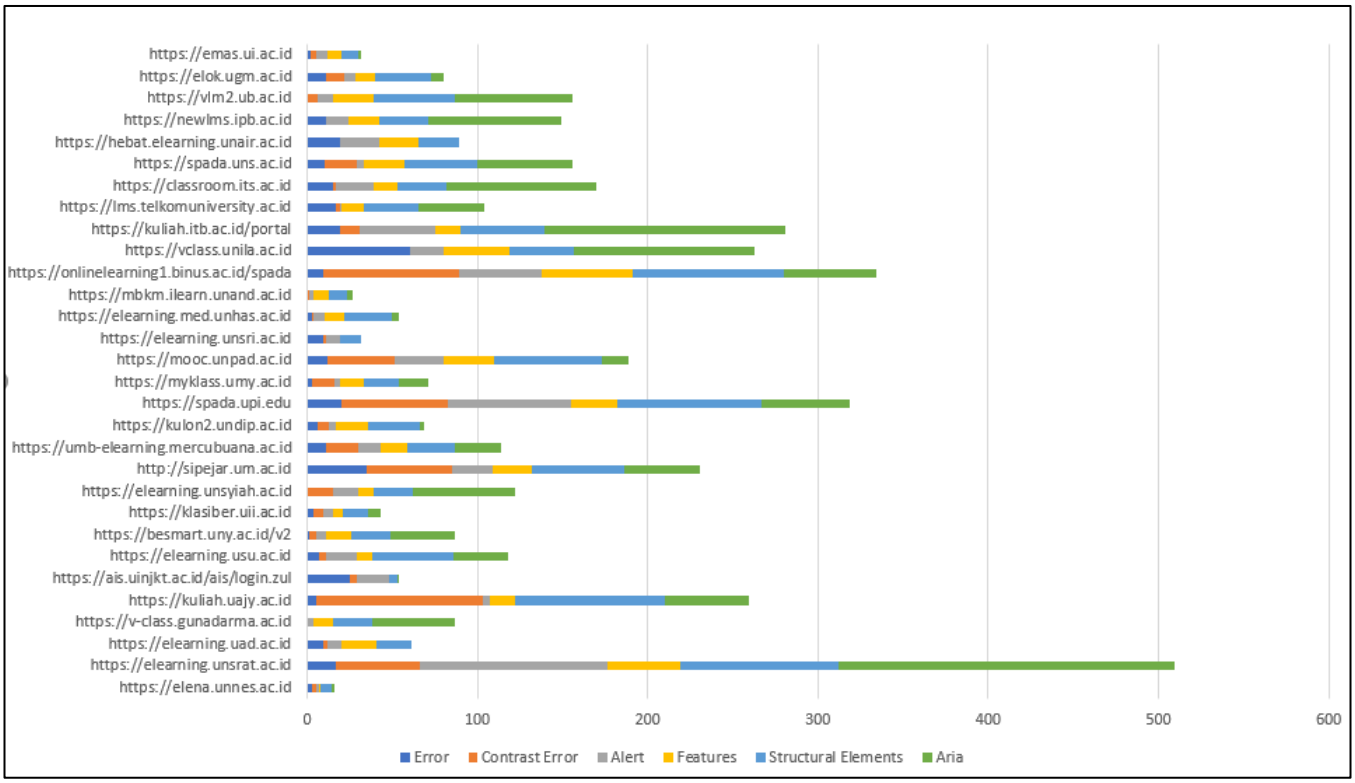

Figure 4. Wave tool summary report diagram

A deeper analysis revealed that some websites did not have any issues in the Error and Contrast Error categories and were compliant with WCAG 2.1. Website development that had followed the HTML writing guidelines correctly and adequately might be the source of websites that did not identify any issues in the Error category. Meanwhile, a website's failure to detect problems in the Contrast Error category could be due to the developer's conformity to the standard's accessible colors.

When a problem was found in the Alert category, it was frequently due to a too brief text description, many links to the same page, tiny text, or the absence of a level 1 header on the Web page. Although the issues discovered in the Alert category did not indicate WCAG 2.1 compliance, they

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could improve website accessibility if the items recognized as issues in the Alert category are rebuilt per the accessibility requirements.

The elements in the Features, Structural Element, and Aria categories did not indicate WCAG non-compliance. These specifics were provided by Wave to give a general overview and insight into the overall page structure so that it could recognize and follow the early actions from the outcomes of the Wave evaluation if an element has accessibility restrictions.

In contrast, missing alternative text, empty links, missing labels, and empty buttons were all issues that were frequently recognized as accessibility barriers in this research.

- Contrast indicates non-compliance with Contrast (Minimum) criteria. The non-fulfillment of a minimum contrast ratio of 4.5:1 between the text color and the background color was the cause of non-compliance with the Contrast (Minimum) criteria.
- The missing alternative text indicated non-compliance with non-text content criteria. The absence of text explanations in the images was the cause of non-compliance with the Non-text Content criteria.
- Empty links indicated non-compliance with the Link purpose (in context) criteria. This was frequently generated by a link that lacked a description.
- Missing form labels indicated non-compliance with non-text content, info and relationship criteria, headings and labels, labels, or instructions. The absence of a label element on the form caused some of these criteria to not be fulfilled.
- Empty buttons indicated non-compliance with criteria for non-text content and link purpose (in context). The absence of text descriptions on the value attribute was the cause of the non-fulfillment of these two criteria.

Table 4 lists the success criteria that were found to violate WCAG 2.1 frequently and could restrict accessibility for those with disabilities. If the evaluation's findings reveal that the level A standard's success criteria were not satisfied, it also means that the AA or AAA standards' success criteria were not met. Some of the accessibility problems that have been found in this research can be addressed, and some recommendations can be made to make the LMS website more accessible for people with disabilities.

Table 4. Common Error in Homepages of LMS website

The success criteria	Level
Non-text content	A
Info and relationships	A
Link purpose (in context)	A
Labels or instructions	A
Contrast (minimum)	AA

- Provide an alt attribute that contains text descriptions of non-text components such as links, link images, images, and forms that describes the information contained in the components.
- Provide a label tag containing brief text that escorts and relates to the form component.
- Assign a value attribute to a button type form component that describes the button's function.
- Increase the contrast ratio between the text and background colors according to the contrast (minimum) criterion, which is at least 4.5:1.

The research finding shows that not all websites analyzed complied with WCAG 2.1. By using the Wave evaluation tool, this research found several accessibility problems. Thus, this research can be a future reference to topics about website accessibility. It offers insight into accessibility constraints for the disabled, especially related to LMS websites. Website developers can be more concerned with this issue and create websites that are more accessible for everyone, including people with disabilities.

4 CONCLUSION

Based on the findings of accessibility analysis of 30 higher education LMS in Indonesia, it is found that there were no accessibility violations in Universitas Gunadarma's Learning Management System. Nevertheless, a lot of LMS websites still fail miserably at level A. The low contrast ratio between text and background, the absence of text explanations in the images, the lack of descriptive text on the links, the absence of text labels on the form, and the absence of text description on the button are accessibility issues that are frequently encountered. The accessibility issue occurred due to the failure to satisfy WCAG 2.1 success criteria: Contrast (minimum), non-text content, info and relationships, Link purpose (in content), and Labels or instructions.

Based on the findings of this research, websites that do not follow standard accessibility guidelines can learn from websites that are already more accessible. Hopefully, developers and parties involved in website development can pay attention to website accessibility by referring to WCAG 2.1 to enhance website accessibility. Future research can do a more thorough examination of the LMS, using automatic evaluation tools and manually analyzing accessibility using various tools required by each type of person with disabilities.

AUTHOR'S CONTRIBUTION

The first author, Dwi Fithriyaningrungrum, contributed to the practical details and journal writing. The second author, Sri Suning Kusumawardani, presented original research ideas about the accessibility of learning management systems. The third author, Sunu Wibirama, is also supervised in terms of theory and writing methods.

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COMPETING INTERESTS

Complying with the publication ethics of this journal, Dwi Fithriyaningrungrum, Sri Suning Kusumawardani and Sunu Wibirama as the authors of this article declare that this article is free from Conflict of Interest (COI) or Competing Interest (CI).

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