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Accessibility analysis of websites of provincial governments in Indonesia

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Abstract
Web accessibility means that people with disabilities can use, navigate, and interact with the website. The World Wide Web Consortium (W3C) has provided important guidelines on web accessibility known as the Web Content Accessible Guidelines (WCAG). The Indonesian government encourages the use of new media, namely website, via Presidential Instruction number 3 of 2003 concerning the National Policy and Strategy for e-government development, which mandates every government agency to build a website. In the previous study, the tools used had limitations and were unable to complete the websites evaluation. Therefore, in this study, WCAG 2.0 standard was applied to analyze the websites of provincial governments in Indonesia. Two accessibility evaluation tools were employed, namely TAW and aXe. In addition, for data analysis and interpretation, descriptive statistics and normality tests were applied. The results showed that the most common violation was found in perceivable principle. It was expected that the findings of this study could provide insight and recommendation for web developers working on provincial government website in Indonesia.

1. Introduction

The use of website has been a concern to many groups, such as entrepreneurs, academics, marketing, mass media, company, and also the government. In Presidential Instruction number 3 of 2003 about "e-government policy" [1] which mandates every government agency to build a website in order to develop electronic-based government, the Indonesian government encourages the use of new media to improve the quality of public service. E-government is the use of information and communications technology (ICT) by the government in providing information and public service to the community [2]. Most of the previous studies in Indonesia focused on the administrative aspects and the social effects of e-government websites. Utama [3] had analyzed a number of issues related to e-government websites in Indonesia. Most of the government websites offer online public service that manually accessible. These website forms are more transactional than information-oriented.

Many website users have some disabilities, such as sensory (hearing and vision), motor (limited use of hands) and cognitive (language and learning disabilities) impairments. Sohaib [4] identidied the main disabilities that might hinder the website accessibility such as hearing impairment may require sound caption. The web accessibility can utilize the technology, such as as screen readers, voice recognition, alternative pointing devices, alternate keyboards, and the website display. According to WAI (Web Accessibility Initiative), web accessibility means that people with disability can use the web. Specifically, web accessibility means that people with disabilities can understand, navigate and interact with the web, and they can also contribute to it [5].

The data statistics from Ministry of Communication and Information shows only 14 from 34 provinces in Indonesia that currently have proper e-government website [6]. There is no explanation related to the other 20 e-government websites with poor performance. Therefore, this study aims to evaluate the web accessibility of e-government in all provinces in Indonesia. There are some guidelines and tools to make accessible websites, such as Web Content Accessible Guidelines (WCAG) developed by World Wide Web Consortium (W3C), Section 508 US government initiative, American with Disabilities Act (ADA), Australian Disability Discrimination Act, and National Institute on Aging (NIA) guidelines [7]. WCAG, developed by W3C collaborating with individuals and organizations around the world, is aimed to provide the standard related to accessibility of web content that meets the needs of individuals, organizations and international governments [8].

There are many approaches, methods and tools for evaluating website accessibility based on WCAG 2.0 standard. Ahmi, et al. [9] evaluated the accessibility of 20 State Universities in Malaysia based on WCAG 2.0 and Section 508 of the Rehabilitation Act. They found crucial problems such as differentiation, keyboard accessibility, navigation ability, adaptability, and alternative text for non-text elements. Isa [10] evaluated homestay websites in Malaysia by using automatic accessibility evaluation tool called AChecker and found six critical accessibility errors,

namely: (i) Non-text content: IMG, ALT TEXT (1.1.1), (ii) Info and relationships: INPUT (1.3.1), (iii) Contrast: LINK, TEXT COLOR (1.4.3), (iv) Link destination: ANCHOR, TEXT (2.4.4), (v) Page Language: HTML (3.1.1), and (vi) Label or instructions: BODY, INPUT (3.3.2).

Similar studies have also been conducted to evaluate the accessibility of government websites in Bangladesh [11], Dubai [12], India [13][14], Saudi Arabia [15][16], Turkey [17], Kyrgyz Republic [18], Malaysia [19], and the United States [20]. Also in these studies [21][22][23][24][25], they evaluated the accessibility of education websites. Khan, et al. [26] conducted another study manually by using WCAG 2.0. They found that international news sites are more accessible than local sites. Ismail et al. [27] evaluated web accessibility of higher educations in North India by using automatic evaluation tools called TAW and aXe. The findings showed that the higher education websites affiliated with University of Kashmir and Cluster University of Srinagar were not fully accessible for users because of their problems (2646), warnings (15995), were not reviewed (1356), identified guidelines by TAW; and violation (1951), need assessment guidelines (1733) by aXe. Regarding to the websites of the provincial governments in Indonesia, similar study has been carried out. Gusti et al. [5] evaluated the website accessibility of Indonesian provincial governments by using Total Validator and aChecker. However, Vigo et al. [28] stated that automatic tool called TAW is better in terms of completeness related to the accuracy of the identification results of violations of accessibility [29]. Therefore, the research questions in this study were (1) How are the results of the evaluation of the provincial government's web accessibility in Indonesia using TAW and aXe? (2) What are the recommendations for the web accessibility?

This study is expected to provide insights related to web accessibility for web developer. The web pages provide assistance for visual, motoric, hearing, seizures, and cognitive or intellectual disabilities that is easy to read and accessed, so all web users can have equal and barrier-free access [27]. TAW and aXe can classify the web accessibility issues appropriately to help the web developer and web designer in creating informative and functional websites.

2. Methods

The steps of this study are collecting websites of provincial governments in Indonesia, testing, collecting the test results, and analyzing the data. The research flowchart can be seen in Figure 1.

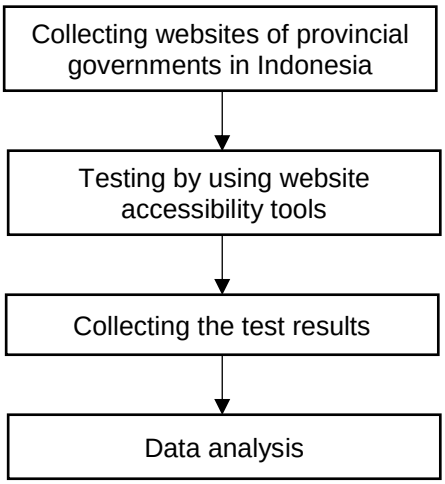

Figure 1. Research Flowchart

2.1 Data Collection

The data of provincial government websites were retrieved from www.indonesia.go.id in sub-page provincial government. In this page, there were 34 URLs from all provincial governments in Indonesia.

2.2 Testing with Tools

After collecting the websites of provincial governments, all the data were then tested by using automatic tools, namely TAW (test de accesibilidad web) and aXe (accessibility engine powering browser extensions). The tests were only conducted on the main page of the provincial government websites. TAW classified the issues as automatic issues (issues deemed to be violating WCAG guidelines) and manual issues (requires expert review). Meanwhile, aXe identified the problems and the frequency of occurrence of these problems. aXe also provided detailed description of known issues, information about the severity of the problem and the types of guidelines being violated [28].

2.2.1 Testing by Using TAW

TAW is an accessibility evaluation tool that can be accessed online at URL www.tawdis.net. The evaluation resulted from TAW were in the form of a group of accessibility issues classified into 4 classes, namely Problems (problems that need to be corrected), Warnings (problems that are not urgent to be fixed), and Not Reviewed (problems that still need to be reviewed by experts).

2.2.2 Testing by Using aXe

The use of the aXe in the accessibility evaluation was to find a detailed description of the problems on the web. The result of this tool was a list of errors from the accessibility aspect which were then classified into Violations (issues that violated the WCAG 2.0 standard) and Needs Review (requires expert review).

2.2.3 Data Analysis

The data resulted from testing by using TAW and aXe were then analyzed using descriptive statistical analysis and normality tests. The process of statistical data analysis was carried out using the SPSS Statistics version 25. The results of the descriptive statistical analysis were in the form of mean, standard deviation, variance, maximum, minimum, sum, range, kurtosis and skewness. Normality test aimed to determine whether the data were normally distributed or not. This study used Box Plot and QQ Plot as the graphical analysis and Kolmogrov-Smirnoff test as the statistical analysis.

3. Finding and Discussion

The first step of this study was collecting the URL data from the websites of the provincial governments in Indonesia on https://indonesia.go.id/province. The list of names of provincial governments in Indonesia along with their web addresses can be seen in Table 1. Based on the data, there are 34 provincial governments in Indonesia. These URL data were then analyzed by using TAW and aXe.

Table 1. Main Page of Indonesian Provincial Government Website

No	Province	Web Address
1	Aceh	https://www.acehprov.go.id/
2	Bali	https://www.baliprov.go.id/web/
3	Banten	https://www.bantenprov.go.id/home
4	Bengkulu	http://bengkuluprov.go.id/
5	Daerah Istimewa Yogyakarta	https://jogjaprov.go.id/home
6	Daerah Khusus Ibu Kota Jakarta	https://jakarta.go.id
7	Daerah Gorontalo	http://www.gorontaloprov.go.id/
8	Jambi	http://jambiprov.go.id/v2/
9	Jawa Barat	https://jabarprov.go.id
10	Jawa Tengah	www.jatengprov.go.id
11	Jawa Timur	http://www.jatimprov.go.id
12	KalimantanBarat	http://www.kalbarprov.go.id
13	Kalimantan Selatan	http://www.kalselprov.go.id/
14	Kalimantan Timur	https://kaltimprov.go.id/beranda
15	Kalimantan Tengah	https://kalteng.go.id/home
16	Kalimantan Utara	*http://www.kaltaraprov.go.id/*
17	Kepulauan Bangka Belitung	http://www.babelprov.go.id/
18	Kepulauan Riau	http://www.kepriprov.go.id/
19	Lampung	http://www.lampungprov.go.id/
20	Maluku	http://www.malukuprov.go.id/
21	Maluku Utara	*http://www.malutprov.go.id/*
22	Nusa Tenggara Barat	https://www.ntbprov.go.id
23	Nusa Tenggara Timur	http://nttprov.go.id/2018/
24	Papua	http://www.papua.go.id/
25	Papua Barat	https://papuabaratprov.go.id/homeage/
26	Riau	https://www.riau.go.id/home/
27	Sulawesi Barat	http://berita.sulbarprov.go.id/
28	Sulawesi Selatan	https://sulselprov.go.id/
29	Sulawesi Tengah	https://www.sultengprov.go.id/
30	Sulawesi Tenggara	http://www.sultraprov.go.id/
31	Sulawesi Utara	http://www.sulutprov.go.id/

32	Sumatera Barat	http://www.sumbarprov.go.id
33	Sumatera Selatan	https://sumselprov.go.id/index.phpmd=ct&id=1
34	Sumatera Utara	http://www.sumutprov.go.id

3.1 Testing by Using Accesibility Tools

3.1.1 Testing by Using TAW

After collecting the URLs, all URLs were then evaluated by using TAW software. The results of the evaluation of the 34 provincial government websites can be seen in Table 2, Table 3, and Table 4. In this table, the results of the identification of accessibility problems were classified into three groups, namely problems, warnings, and not reviewed. Each group was categorized based on the aspect violated, namely P (perceivable), O (observable), U (understandable), R (robust). Meanwhile, the SC (success criteria) column shows the number of WCAG guidelines that have been violated in that group.

Table 2. Test Results of 34 Main Pages of Provincial Government Websites using TAW

No	Problems				
	P	O	U	R	SC
1	42	28	2	17	6
2	53	49	5	59	7
3	154	152	2	2	7
4	10	32	1	6	7
5	12	41	6	11	7
6	64	40	1	9	6
7	23	16	2	10	6
8	47	34	1	73	7
9	41	36	3	17	7
10	10	19	5	36	7
11	14	11	2	39	7
12	25	234	6	7	8
13	61	23	1	11	5
14	8	14	2	11	7
15	10	28	1	4	6
16	6	13	1	1	5
17	21	31	1	14	5
18	91	53	4	14	7
19	23	38	2	6	7
20	4	16	1	5	6
21	16	1	2	2	7
22	31	8	1	39	6
23	26	152	2	12	7
24	247	51	7	8	9
25	17	30	3	12	6
26	178	151	3	57	8
27	10	34	2	14	7
28	96	41	12	72	8
29	5	7	1	13	5
30	19	11	9	13	8
31	89	15	5	20	9
32	112	19	8	12	7
33	135	86	1	10	6
34	20	4	2	9	7

Table 3. Test Results of 34 Pages of Provincial Government Websites using TAW

No	Warnings				
	P	O	U	R	SC
1	106	32	6	7	14
2	98	137	12	22	13
3	203	37	0	117	9
4	78	42	0	8	8

5	116	35	12	0	12
6	24	49	6	0	12
7	214	135	6	133	13
8	133	12	0	73	9
9	88	35	12	2	13
10	90	93	12	24	13
11	31	4	6	144	12
12	358	83	12	2	13
13	94	106	0	203	12
14	185	47	6	1	13
15	193	39	0	0	9
16	15	3	0	1	5
17	144	151	0	5	10
18	117	80	12	0	13
19	225	29	6	34	13
20	141	41	6	0	12
21	27	4	0	0	6
22	76	93	0	5	9
23	281	43	18	909	14
24	124	107	18	0	13
25	59	75	18	15	13
26	311	89	6	16	13
27	115	99	6	459	13
28	127	120	19	25	14
29	62	20	0	1	9
30	64	47	12	81	14
31	276	266	12	5	13
32	146	27	12	58	11
33	300	92	0	3	11
34	17	5	0	1	8

Table 4. Test Results of 34 main Pages of Provincial Government Websites using TAW

No	Not Reviewed				
	P	O	U	R	SC
1	4	6	4	1	15
2	4	7	5	0	16
3	4	7	5	0	16
4	4	6	6	0	16
5	4	5	7	0	16
6	4	7	6	0	17
7	4	7	6	0	17
8	4	6	5	0	15
9	4	7	5	0	16
10	4	7	5	0	16
11	4	6	5	0	15
12	4	7	4	0	15
13	3	5	5	1	14
14	4	7	5	0	16
15	4	7	5	0	16
16	4	8	5	1	18
17	4	7	5	1	17
18	4	6	5	0	15
19	4	7	5	0	16
20	4	7	6	0	17
21	4	8	5	0	17
22	4	7	5	0	16
23	3	6	5	0	14

24	4	5	4	0	13
25	4	7	6	0	17
26	4	7	4	0	15
27	3	7	5	0	15
28	4	7	4	0	15
29	4	7	5	1	17
30	3	7	4	0	14
31	4	6	4	0	14
32	4	7	5	0	16
33	4	6	5	0	15
34	4	8	5	0	17

3.1.2 Accessibility Testing by Using aXe

The results of testing by using aXe were categorized into two groups, namely Violations and Needs Review. The results can be seen in Table 5.

Table 5. Total Violations Found and Total Reviews from 34 Provincial Government Websites

Website No	Total Violations Found	Total Needs Review
1	77	41
2	33	29
3	99	128
4	64	52
5	136	240
6	74	136
7	60	60
8	103	39
9	31	33
10	56	6
11	29	11
12	144	125
13	60	20
14	117	24
15	136	29
16	14	14
17	46	34
18	80	176
19	122	52
20	13	24
21	16	7
22	43	42
23	79	56
24	63	73
25	60	106
26	94	74
27	164	76
28	112	127
29	10	25
30	47	36
31	46	83
32	58	20
33	160	103
34	11	14

3.2 Data Analysis

Statistical analysis was conducted to interpret the evaluation results. The analysis was carried out by using descriptive statistics. The descriptive statistics resulted from aXe and TAW can be seen in Table 6.

In Table 6, it can be seen the minimum and maximum score of the evaluation by using TAW were 86 and 1492 respectively. The mean score was 446.5 and the standard deviation was 278.412 which means that TAW had low variability. Meanwhile, the minimum and maximum score of the evaluation by using aXe were 23 and 276. The mean

score of aXe was 134.47 and the standard deviation was 85.887, these results show that aXe had low variability. Furthermore, normality test was carried out. The normality test aimed to know that the data from aXe and TAW were distributed normally.

Table 6. Descriptive Statistics from TAW and aXe

Statistics			
		TAW	aXe
N	Valid	34	34
	Missing	0	0
Mean		446.50	134.47
Std. Deviation		278.412	85.878
Skewness		1.714	.793
Std. Error of Skewness		.403	.403
Kurtosis		4.744	.310
Std. Error of Kurtosis		.788	.788
Minimum		86	23
Maximum		1492	376
Sum		15181	4572
Percentiles	25	283.50	63.50
	50	378.00	124.50
	75	596.50	183.00

3.3 Normality Test

Normality test was conducted by using Kolmogorov-Smirnov. In Table 7, it can be seen that the result from aXe has a significance value below 0.05, i.e. 0.161, which means that the data were normally distributed. However, the data resulted from TAW shows that the significance value is below 0.05, i.e. 0.039, which means the data were not normally distributed.

Table 7. Normality Test of TAW and aXe

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
aXe	.129	34	.161	.934	34	.041
TAW	.154	34	.039	.864	34	.001

3.4 Q-Q Plot

Q-Q Plot was used to visually determine whether the data were normally distributed or not. Figure 2 and Figure 3 show the Q-Q Plot of the TAW and aXe tools. In Figure 2, the data showed in Q-Q Plot of TAW were away from the diagonal line, which means the data were not normally distributed. Meanwhile in Figure 3, the data of Q-Q Plot of aXe moved away from the diagonal line, which means the data were not normally distributed.

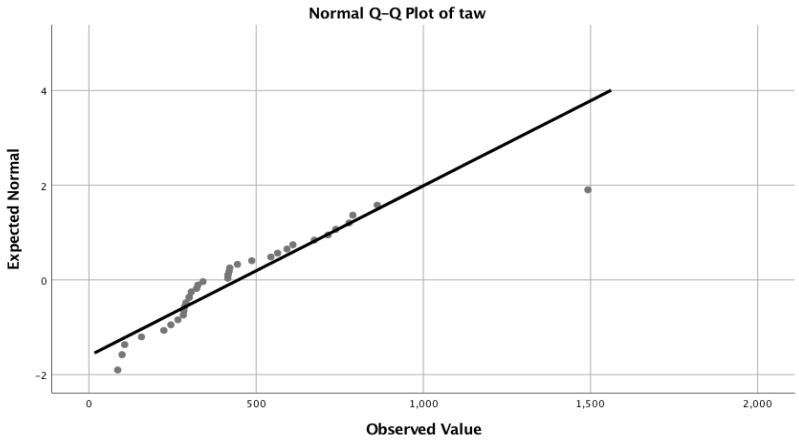

Figure 2. Q-Q Plot of TAW

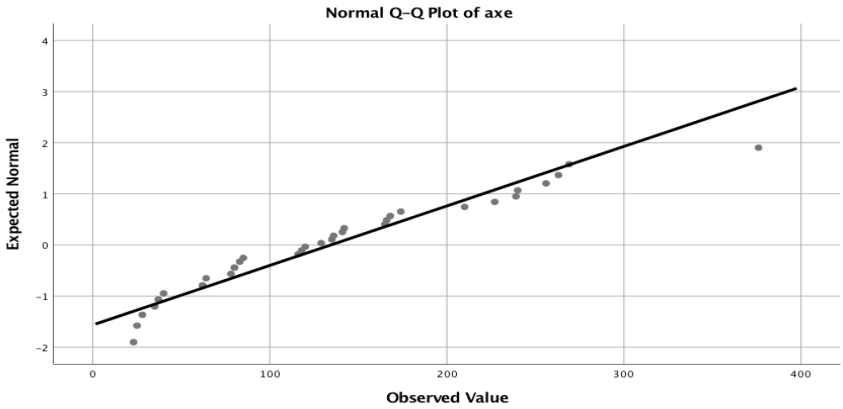

Figure 3. Q-Q Plot of aXe

3.5 Box Plot

Box plots of the TAW tool and the aXe tool can be seen in Figure 4. In Figure 4, TAW had outliner in the 23rd data, where the upper, middle, and lower quartile were 596.50, 378, and 283.5 respectively. The outlier for the aXe tool was in the 5th data. The upper, middle, and lower quartile were 183, 124.5 and 63.5 respectively.

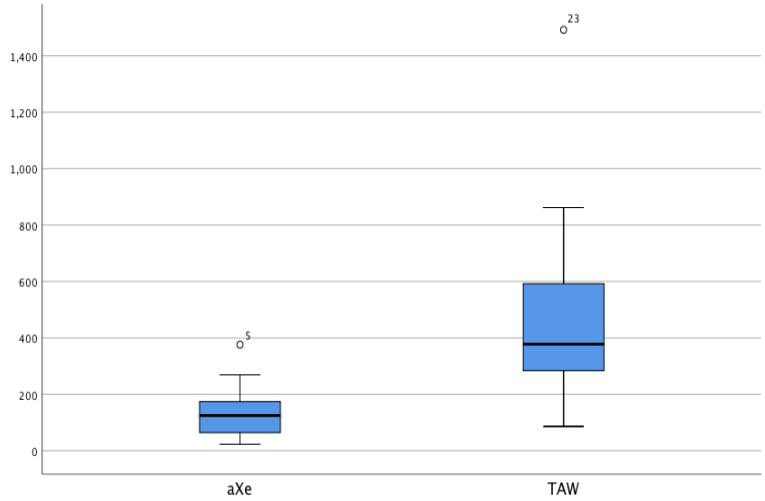

Figure 4. Box Plot of aXe and TAW

3.6 Discussion

Table 8 is the descriptive statistics resulted from TAW. In Table 8, it can be seen that the score of perceivable principle has the largest sum. Therefore, from these results the government needs to pay attention to this issue in the websites. According to the WCAG 2.0 guidelines [8] perceivable information and user interface components must be able to be displayed to users in a way that they can perceive. There are seven evaluated accessibility errors for perceivable; (i) 1.1.1 (Non-text Content: IMG, AL TEXT), (ii) 1.2.3 (Audio Description/ Media: Alt OBJECT), (iii) 1.3.1 (Info and Relationship: INPUT), (iv) 1.3.3 (Sensory Characteristic: TABLE, BODY), (v) 1.4.1 (Use of Color BODY, IMG), (vi) 1.4.3 (Contrast: LINK, TEXT COLOR), and (vii) 1.4.5 (Images of text: IMG) [10].

Table 8. Statistics from TAW

Statistics						
		Perceivable	Operable	Understandable	Robust	Success Criteria
N	Valid	34	34	34	34	34
	Missing	2	2	2	2	2
Mean		190.88	118.29	15.06	88.35	33.91
Minimum		25	13	6	2	28
Maximum		493	324	35	921	37
Sum		6490	4022	512	3004	1153

The most common types of problems found by aXe from 34 provincial government sites can be seen in Table 9. In Table 9, it can be seen that the most common type of problem found is that elements must have sufficient color contrast.

Table 9. Guidelines and Number of Violations based on aXe

Type of Guideline	Total Violations	Mean	Std. Deviation
Elements must have sufficient color contrast	1080	38.57	33.220
Links must have discernible text	703	21.97	17.499
Images must have alternate text	452	15.59	22.225
ARIA hidden element must not contain focusable elements	55	7.86	10.511
elements must be contained in a or	10	3.33	2.517
Buttons must have discernible text	34	3.09	4.392
Frames must have title attribute	50	2.78	2.922
Form Elements must have labels	32	2.29	1.684
id attribute value must be unique	14	1.56	1.333
and must only directly contain , <script> or <template> elements	4	1.33	.577
Certain ARIA roles must contain particular children	8	1.14	.378
Timed refresh must not exist	2	1.00	.000
Elements must only use allowed ARIA attributes	1	1.00	.
ARIA input fields have an accessible name	4	1.00	.000
page must have means to bypass repeated blocks	1	1.00	.
<html> elements must have a lang attribute	10	1.00	.000
Ensure that scrollable region has keyboard access	1	1.00	.
<marquee> elements are deprecated and must not be used	4	1.00	.000

A study conducted by I Bagus [5] evaluated the Indonesian provincial governments using Total Validator and aChecker evaluation tools. Therefore, a comparison was made between the evaluation resulted by the tools used in the previous study and the tools used in this study, namely AChecker and Total Validator with TAW and aXe. The comparison between the total issues is presented in Table 10.

Table 10. Comparison between 4 Accessibility Evaluation Tools

No	AChecker	Total Validator	aXe	TAW
1	1	9	23	86
2	4	10	25	99
3	16	25	28	107
4	30	46	35	157
5	49	145	37	224
6	52	156	40	245
7	64	263	62	266
8	64	378	62	282
9	74	392	64	284
10	91	393	78	286
11	112	478	80	290
12	113	430	80	300
13	126	481	83	300
14	141	450	85	306
15	155	538	116	322
16	156	503	118	326
17	161	623	120	341
18	173	533	129	415
19	205	559	135	416
20	217	626	136	419
21	229	642	141	421
22	315	672	142	444
23	314	711	165	487

24	342	751	166	544
25	368	763	168	564
26	364	896	174	592
27	423	902	210	610
28	484	1296	227	674
29	542	1049	239	715
30	628	1670	240	738
31	982	N/A	256	778
32	N/A	N/A	263	789
33	N/A	N/A	269	862
34	N/A	N/A	376	1492
Total	6995	16390	4572	15181

In Table 10, the comparison between 4 evaluation tools for the number of problems (errors) resulted from aXe and TAW are lower than those resulted from AChecker and Total Validator with scores of 4572 and 15181 respectively. Hence, in terms of the number of problems (error) aXe and TAW show better performance compared to AChecker and Total Validator tools. In addition, AChecker and Total Validator has a N/A value which indicated the websites that were failed to be accessed during the accessibility tests. In this study, we prove that aXe and TAW could be more respresentative for the accessibility of pronvicial government website in Indonesia.

4. Conclusion

Web accessibility indicates the quality of user interaction with limited capabilities. One of the standards used as an accessibility guideline was WCAG 2.0 consisting of 4 principles, namely perceivable, observable, understandable, and robust. In this study, the accessibility evaluation of 34 provincial government websites was carried out by using TAW and aXe. Based on the evaluation using TAW, a number of violations of the WCAG guidelines were identified where the most violations were on the perceivable principle. Perceivable is a component to ensure that information and web elements are acceptable to users. Meanwhile, the evaluation using aXe identified a number of main problems, namely: color contrast of web elements, text from links, text as alternative images, ARIA (Accessible Rich Internet Applications) elements, user focus guiding elements, titles in l frames, text on buttons, and labels on formulas. Based on the evaluation using both tools, the websites that violated WCAG 2.0 standard the most were identified. However, the result from these two tools were different. TAW found the sites that are considered to violate the standard the most were East Nusa Tenggara Province with a score of 1492 and Riau Province with a score of 862. Meanwhile, aXe found that the provincial sites that were considered to have the most violations of the standard were Yogyakarta Province with a score of 376 and West Kalimantan Province with a score of 269.

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