



## Testing the Agreement among Three Free Accessibility Evaluation Tools: A Case Study of Iraqi Public Universities

Maytham Hammood

College of Computer Science and Mathematics, Tikrit University, Tikrit, Iraq

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#### Corresponding Author:

Name: Maytham Hammood

#### E-mail:

[maythamhammood@tu.edu.iq](mailto:maythamhammood@tu.edu.iq)

#### Tel:

### ABSTRACT

The huge development in the websites and continuous exchange of the information led to more consideration of the websites accessibility. There are many accessibility-based on studies conducted throughout the world. However, the existing literature lacks a study on the assessment of accessibility to the Iraqi universities websites. Accordingly, this study measured the accessibility to websites of 36 Iraqi public universities listed in the official webpage of the Iraqi Ministry of Higher Education. Furthermore, it explored the relationships among three free web accessibility tools, namely Web Accessibility Versatile Evaluator, EIII Page Checker and Access Monitor, to test their agreement in terms of the accessibility results. These three free tools were used to evaluate the accessibility of the Iraqi universities websites. Statistical Package for the Social Sciences was used to analyze the results. The results of the three tools showed that the issue of accessibility is ignored by the webmasters of websites under the study. In addition, this study presented agreement among the three tools in terms of results.

### Introduction

Nowadays, the design and implementation of websites is not an easy job. Modern websites have to be visible via a large variety of monitor sizes and can be accessed by different users even the disabled ones. Many online tools and metrics are released to automatically measure the adherence of these websites to web content accessibility guidelines (WCAG). The study of [1] showed the pros and cons of these metrics that are based on WCAG; as well as comparing these metrics. Different websites have to follow these guidelines to be accessible. It is no more feasible to evaluate the accessibility of websites manually. Therefore, the automatic tools are widely used to evaluate the accessibility of websites. There are various free automatic accessibility evaluators like web accessibility versatile evaluator (WAVE), European internet inclusion initiative EIII Page Checker, Access Monitor, 3C\_WAI, A Checker, total1y, Automated Accessibility Testing Tool (AATT) and Accessibility Checker [2], [3] and [4].

The first 3 free online accessibility evaluators are used to evaluate the accessibility to websites of 36 Iraqi public universities.

As mentioned before, there are many accessibility-based studies. However, the literature lacks of studies

that investigates the Iraqi websites in general and the accessibility to the Iraqi university websites in particular. Accordingly, it is the task of this paper to investigate them.

This paper is divided into five sections. The first section introduces the background of research topic. The second section reviews literature related to web accessibility. The methodology used in this paper is shown in section three. While the fourth section discusses the results of the relations among the tools and the interpretations of statistical methods. Finally, the last section presents conclusions and future work.

### Literature Review

This section reviews few studies related to web accessibility in the Arab and foreign countries. The study of [5] used the top 24 USA highly ranked schools of library and information science (SLIS) as listed by USA News and World Report. The results revealed that the accessibility to these 24 websites is low.

In [3], the authors employed a multi-method analysis (in terms of compliance with standards, alternate-language and text-only content, image accessibility and web accessibility statements quality) of the accessibility to the webpages of top 100 universities

worldwide in 2006 according to Times Higher Education World University Rankings. They concluded that these top 100 universities are not interested in the issues related to the accessibilities of the disabled people.

Concerning studies on websites in the Arab world, studies conducted by [6], [7], [8], [9] and [10] have investigated Saudi websites; while [11], [12], [13], [14] and [15] have examined Jordanian websites. In addition, [16] and [8] were dedicated to study web accessibility of Bahraini websites. Omani websites were explored in [6] and [17]. Furthermore, Kuwaiti, Qatari and Emirati websites accessibility is studied by [18] and [8].

### Methodology

This part of study presents the methodology adopted by the researchers. The websites of Iraqi Universities were chosen in this study. A total number of these websites exceeds 100; thus, the authors decided to choose a sample constituting of 36 Iraqi public universities. Afterward, they choose some online tools which are free to evaluate the accessibility of these 36 websites. WAVE is the first tool that helps to recognize contrast errors (WCAG Violations), HTML 5, ARIA and alerts, features and structural elements.

The second tool is EIII Page Checker which provides accessibility services with webpages and PDF documents and automatically detects barriers in webpages. These webpages should work according to WCAG 2.0.

Access Monitor is the third free online and an automatic validator tool for the WCAG 1.0 and WCAG 2.0 developed by the ACCESS Unit of the Foundation for Science and Technology (FCT). The ACCESS Unit allows and encourages the disabled people to participate in society by the possibility of Information Technologies.

Statistical Package for the Social Sciences (SPSS) version 20 is used in this study to compute Spearman's rho rank correlation and Kendall's tau-b correlations which are non-parametric correlations that measure the strength and direction of the association between two ranked variables.

These two correlations were used to decide the congruence amount between any two columns of ranked data; whereas the correlations range is from -1.0 to 1.0.

In general, Kendall's tau\_b acquires the best likelihoods in factors of population compared to

Spearman's rho correlation, especially when the size of the sample is small. Spearman's rho correlation gets more precise results than Kendall's tau-b if there are big contradictions between two columns.

### Experiments and Results

This section presents the results of the used tools and services of the 36 Iraqi public Universities websites in September, 2018. Table 1 illustrates the evaluation of the accessibility to these universities homepages by WAVE tool. The WAVE tool failed to evaluate the accessibility to homepages of three Iraqi Public University websites (University of Technology, University of Information Technology and Communication and Southern Technical University). Therefore, the solution of this issue used the WAVE Chrome and Firefox extensions to evaluate web content accessibility directly within Chrome and Firefox browsers. WAVE can recognize the errors, that is to say, if you see a red icon in the WAVE, that's mean the page essentially surely has an accessibility problem.

The Alerts, Sum of Errors and Contrast Errors were sorted in ascending order to rank the websites of these universities, starting with the best designed website with the least number of errors, and then ending with the worst designed website with the highest number of errors. These Websites are characterized by their good design and implementation, and the number of errors in their code is less than the others.

The results showed the top 5 of Iraqi public universities websites, which were selected based on the total errors, namely Sum of Errors, Alerts & Contrast Errors, contained in the homepage of these universities. Depending on the sum of Alerts, Errors, and Contrast Errors the best 5 universities were Kirkuk University with 4 errors, University of Fallujah with 6 errors, University of Information Technology & Communication with 8 errors, Tikrit University with 26 errors and finally Samarra University with 37 errors.

On the other hand, the worst 5 universities according to WAVE tool were University of Anbar with 252 errors, Al-Muthanna University with 308 errors, Thi Qar University with 314 errors, Mustansiriyah University with 317 errors and then Al-Qadisiyah University with 328 errors.

The rest of the websites error ranks are illustrated in table 1.

**Table 1: WAVE Results Summary (September, 2018) for Iraqi Public Universities**

No	University Name	Alerts	Errors	Features	Structural Elements	HTML5 and ARIA	Contrast Errors	Sum of Errors, Alert & contrast errors	Sum of features, Structural elements & HTML5 and ARIA
1	University of Babylon	93	23	2	55	29	84	200	86
2	University of Baghdad	73	65	17	137	266	30	168	420
3	Diyala University	74	60	0	34	0	9	143	34
4	University of Technology Iraq	52	11	83	42	112	18	93	237
5	University of Mosul	58	33	36	137	5	147	238	178
6	University of Basrah	106	5	56	61	0	86	197	117
7	University of Anbar	47	23	32	57	2	182	252	91
8	Al Qadisiyah University	200	61	130	129	9	67	328	268
9	Tikrit University	20	4	25	52	0	2	26	77
10	University of Kufa	21	39	5	37	0	6	66	42
11	University of Karbala	80	104	12	115	7	55	239	133
12	Al Nahrain University	81	59	38	92	11	17	157	141
13	Mustansiriyah University	203	33	23	135	6	81	317	164
14	Thi Qar University	149	128	32	34	160	37	314	226
15	Kirkuk University	3	0	2	2	0	1	4	4
16	Misan University	28	8	22	9	1	4	40	32
17	University of Wasit	32	2	8	60	115	29	63	183
18	Al Muthanna University	127	141	1	137	5	40	308	143
19	University of Information Technology & Communication	2	4	5	21	26	2	8	52
20	Al Iraqia University	32	40	31	77	52	20	92	160
21	Al Qasim Green University	12	39	9	53	0	125	176	62
22	Middle Technical University	30	53	0	27	0	40	123	27
23	Jabir ibn Hayyan Medical University	55	61	1	21	46	42	158	68
24	Ninevah University	36	28	61	122	4	113	177	187
25	AlKarkh University for Science	36	74	2	54	2	59	169	58
26	University of Fallujah	1	4	0	1	0	1	6	1
27	Samarra University	14	14	3	20	0	9	37	23
28	Basrah University for Oil and Gas	5	41	15	32	2	7	53	49
29	Al Furat Al Awsat Technical University	105	10	87	69	11	35	150	167
30	Southern Technical University	52	11	83	42	112	18	81	237
31	University of Hamdaniya	21	21	32	70	5	36	78	107
32	Sumer University	14	18	9	28	2	28	60	39
33	University of Telafer	48	47	19	81	1	37	132	101
34	Ibn Sina University of Medical and Pharmaceutical Sciences	37	40	4	72	2	38	115	78
35	Northern Technical University	24	9	7	41	6	39	72	54
36	The Great Emam University College	84	20	76	120	49	7	111	245

Table 2 presents the results of two accessibility free online tools, which are Access Monitor and EIII checker, in September, 2018 for 36 Iraqi Public University homepages.

Access Monitor tool was used to evaluate the webpage at three levels of WCAG 2.0. This tool performed the analysis on WCAG 2.0 - Level A and provided the user with detailed analysis report. In addition, it checked the implementation of accessibility guidelines in the webpage. The summary page presented by Access Monitor included an index value that ranges from 1 to 10. Access Monitor index is a quantitative measure showing the accessibility level of the evaluated webpage. The index value 10 indicates a high degree of accessibility achieved in the tests of a webpage. The use of the index is performed by those responsible for the tool, but is not based on the recommendation of WCAG.

It is known that different checkers of the conformance of a webpage to WCAG yield different results. It has been observed that the results of the same tool, i.e., Access Monitor, are different when tested against different versions of WCAG. Therefore, Access Monitor yields the following results when it tests homepages of Iraqi university websites against WCAG 1.0: Tikrit University website is the best accessible website among the Iraqi Public University websites; whereas Ibn Sina University of Medical and Pharmaceutical Sciences website is the worst accessible website with Index Scores: 6.3 and 1.9, respectively.

Access Monitor yields the following results when it tests the homepages of Iraqi university websites against WCAG 2.0 for the second time: Tikrit University website is the best accessible website among the Iraqi Public University websites; whereas

Ibn Sina University of Medical and Pharmaceutical Sciences website is the worst accessible website with Index Scores: 6.5 and 2.7, respectively. EIII checker yields the following results when it tests the homepages of Iraqi university websites against WCAG 2.0, where Tikrit University website is best accessible website among Iraqi Public University websites and Ibn Sina University Of Medical And Pharmaceutical Sciences website is the worst accessible website among Iraqi Public University websites as the following: (Tikrit University, EIII

WCAG 2.0 Index Score: 98.63) and (Ibn Sina University Of Medical And Pharmaceutical Sciences, EIII WCAG 2.0 Index Score: 58.66). Note that EIII fails to evaluate Kirkuk University. Some systems that produce the data have bugs, flaws, and omissions, some of them known and unknown. Thus, the data may not be reliable, and there is no guarantee for its accuracy and completeness. The EIII project couldn't offer complete warranty of usability or merchantability and cannot be held responsible for any damages, even in the case of negligence [19].

**Table 2: AccessMonitor & EIII Results Summary (September, 2018) for Iraqi Public University Websites**

No.	University Name	Access Monitor Index Score WCAG 1.0	Access Monitor Index Score WCAG 2.0	EIII Score WCAG 2.0	EIII Pass Applied Test	EIII Barrier Total WCAG 2.0	EIII Applied Test Total
1	University of Babylon	4.5	3.5	82.09	563	27	590
2	University of Baghdad	6.2	5.2	74.78	55	9	64
3	Diyala University	2.3	3.0	65.62	1107	317	1424
4	University of Technology Iraq	4.9	4.3	94.44	19	1	20
5	University of Mosul	4.6	4.6	82.06	724	40	764
6	University of Basrah	4.9	4.6	93.92	1698	23	1721
7	University of Anbar	3.3	3.2	74.09	954	50	1004
8	Al Qadisiyah University	3.5	4.1	80.10	2033	178	2211
9	Tikrit University	6.3	6.5	98.63	654	7	661
10	University of Kufa	3.4	4.1	90.34	519	36	555
11	University of Karbala	5.3	5.4	93.42	1075	48	1123
12	Al Nahrain University	5.0	4.8	78.46	2053	82	2135
13	Mustansiriyah University	5.3	4.1	73.43	983	234	1217
14	Thi Qar University	3.6	3.1	81.93	956	170	1126
15	Kirkuk University	5.7	5.8	-	-	-	-
16	Misan University	3.9	3.7	80.08	397	11	408
17	University of Wasit	5.5	4.6	90.06	872	68	940
18	Al Muthanna University	6.0	5.5	83.95	1109	233	1342
19	University of Information Technology & Communication	3.1	3.1	73.41	679	53	732
20	Al Iraqia University	4.6	4.3	90.25	687	52	739
21	Al Qasim Green University	3.7	3.5	71.33	556	56	612
22	Middle Technical University	2.0	3.3	76.06	663	100	763
23	Jabir ibn Hayyan Medical University	4.6	4.3	82.17	576	57	633
24	Ninevah University	2.7	3.4	77.34	723	45	768
25	AlKarkh University for Science	2.4	3.0	74.22	1116	193	1309
26	University of Fallujah	6.3	5.8	73.33	8	4	12
27	Samarra University	3.2	3.3	76.31	298	14	312
28	Basrah University for Oil and Gas	4.2	4.6	89.82	409	46	455
29	Al Furat Al Awsat Technical University	3.9	4.1	90.96	935	62	997
30	Southern Technical University	5.3	4.5	94.51	895	52	947
31	University of Hamdaniya	5.2	4.4	87.36	427	27	454
32	Sumer University	5.1	4.6	88.01	434	30	464
33	University of Telafer	2.2	2.7	68.52	436	79	515
34	Ibn Sina University of Medical and Pharmaceutical Sciences	1.9	2.7	58.66	232	72	304
35	Northern Technical University	4.9	4.3	95.89	819	7	826
36	The Great Emam University College	5.6	5.5	90.18	1416	84	1500

Measurements presented in tables 1 and 2 clarified that webmasters of Iraqi university websites do not follow the WCAG guidelines. The results showed ignorance to accessibility of webmasters to this issue. Table 1 presents 8 measures; four of them are considered as accessibility merits including Features Rank, Structural Elements Rank, HTML5 and ARIA

Rank, Sum of features, structural elements & HTML5 and ARIA Rank, where the highest measures ranked first. The other four measures are regarded as accessibility disadvantages, namely Alerts Rank, Errors Rank, Contrast Errors Rank, Sum of Errors, Alert & Contrast Errors Rank, where the lowest measures ranked first. Additionally, table 2 presents 6

measures; the first two of them are the accessibility results of Access Monitor Index tool against WCAG 1.0 and WCAG 2.0, where the highest measures ranked first. The other four measures including WCAG 2.0 EIII Score, how many time passed applied tests, how many time failed applied tests and the total number of applied tests are considered the results of EIII tool in contradiction to WCAG 2.0. Therefore, the highest WCAG 2.0 EIII Score is

ranked first. The percentage (%) of passed applied tests is calculated by dividing the number of passed applied tests by the total number of applied tests, where the highest percentage ranked first. The ranks of other EIII measures, namely a number of failed applied tests and the total number of applied tests, are ignored. The total number of the ranked measures in tables 1 and 2 are 12.

**Table 3: Web Accessibility summary for Iraqi Public Universities (September, 2018)**

No.	University Name	WAVE's Sum of Errors Rank	AccessMonitor Index Score WCAG 1.0 Rank	AccessMonitor Index Score WCAG 2.0 Rank	EIII Score WCAG 2.0 Rank
1	University of Babylon	29	20	25	17
2	University of Baghdad	24	3	7	26
3	Diyala University	20	33	33	34
4	University of Technology Iraq	15	14	16	4
5	University of Mosul	30	17	9	18
6	University of Basrah	28	15	10	5
7	University of Anbar	32	28	30	28
8	Al Qadisiyah University	36	26	20	20
9	Tikrit University	4	1	1	1
10	University of Kufa	10	27	21	8
11	University of Karbala	31	8	6	6
12	Al Nahrain University	22	13	8	22
13	Mustansiriyah University	35	9	22	29
14	Thi Qar University	34	25	31	19
15	Kirkuk University	1	5	2	NA
16	Misan University	6	22	24	21
17	University of Wasit	9	7	11	11
18	Al Muthanna University	33	4	4	15
19	University of Information Technology & Communication	3	30	32	30
20	Al Iraqia University	14	18	17	9
21	Al Qasim Green University	26	24	26	32
22	Middle Technical University	18	35	28	25
23	Jabir ibn Hayyan Medical University	23	19	18	16
24	Ninevah University	27	31	27	23
25	AlKarkh University for Science	25	32	34	27
26	University of Fallujah	2	2	3	31
27	Samarra University	5	29	29	24
28	Basrah University for Oil and Gas	7	21	12	12
29	Al Furat Al Awsat Technical University	21	23	23	7
30	Southern Technical University	13	10	14	3
31	University of Hamdaniya	12	11	15	14
32	Sumer University	8	12	13	13
33	University of Telafer	19	34	35	33
34	Ibn Sina University Of Medical And Pharmaceutical Sciences	17	36	36	35
35	Northern Technical University	11	16	19	2
36	The Great Emam University College	16	6	5	10

Table 3 is based on tables 1 and 2; thus, these tables are covering all of the 36 Iraqi public universities. Table 3 includes the ranks of four measures out of 12 rank measures found in tables 1 and 2. Therefore, the contents of table 3 are positive integers from 1 to 36 representing the ordinal rank. The Alerts, Contrast Errors column and Sum of Errors were based on table

1; whereas Access Monitor Index Score WCAG version (1.0 & 2.0) and EIII Score WCAG 2.0 were based on table 2.

Correlation coefficients are numerical measures of the relationship between two variables. They yield a precise measurement of the strength, magnitude and the direction of the relationship. A well-known non-

parametric rank correlation used in this study called Kendall's Tau is used with Rank-Ordered data. Kendall's Tau Correlation coefficient considers the values between -1 and +1. Positive correlation signifies the relationship between two variables whose values increase or decrease together. Negative correlation signifies the relationship between two variables whose values are related inversely (-). In other words, when one variable increases, the other decreases. Therefore, 0.00 indicates no correlation, +1 indicates a perfect positive correlation; whereas -1 indicates a perfect negative correlation. This is called a correlation test. IBM SPSS version 20 which is used to compute Kendall's tau\_b non-parametric correlations. The ranked based correlation analysis is used to discover the concordance with 12 ranked metrics. The 12 ranked metrics include: the first 8 ranked metrics presented in table 1 and the other 4 ranked metrics in table 2. Table 4 shows all significant concordance among the 12 ranked measures used in this study. It presents 28 significant correlations among the ranks of 12 metrics presented in tables 1 and 2. These results showed agreement among the three tools used in this study. In the table 4 WAR stands for Wave Alerts Rank, WSER stands for

Wave Structural Elements Rank, WHAR stands for Wave HTML5 and ARIA Rank, WER stands for Wave Errors Rank, WCER stands for Wave Contrast Errors Rank, WSE stands for Wave Sum of Errors, ACER stands for Alert & Contrast Errors Rank, WSF stands for Wave Sum of Features, WFR stands for Wave Features Rank and SEHAR stands for Structural Elements & HTML5 and ARIA Rank Kendall's tau\_b is used in this study since it is the best non-parametric rank-order correlation. The Kendall's tau-b ( $\tau$ ) is a nonparametric measure that represents the correlation coefficient, showing the strength and direction of the relationship between two variables measured on ordinal scale. The values of Kendall's Tau have to be tested against the null hypothesis in order to determine whether the variables under consideration are uncorrelated. However the null hypothesis was tested. In the alternative hypothesis, the variables are considered to be correlated. When the 28 Kendall's Tau-b coefficients are smaller than the significance levels of 0.01(\*\*) and .05(\*), the null hypothesis is rejected and the alternative hypothesis is accepted.

**Table 4: Significant Correlation Coefficients of Kendall's tau\_b at 0.01 levels & 0.05 levels**

No	Pair	Correlation coefficient
1	$\tau$ (WAR , WER )	0.340**
2	$\tau$ (WAR , WFR)	-0.273*
3	$\tau$ (WAR , WSER )	-0.457**
4	$\tau$ (WAR , WHAR )	-0.349**
5	$\tau$ (WAR , WCER )	0.343**
6	$\tau$ (WAR , WSE, ACER)	0.651**
7	$\tau$ (WAR , WSF, SEHAR)	-0.508**
8	$\tau$ (WER, WSER)	-0.286*
9	$\tau$ (WER , WCER)	0.279*
10	$\tau$ (WER , WSE, ACER)	0.505**
11	$\tau$ (WER , EIII Pass Applied Test % Rank)	0.358**
12	$\tau$ (WFR, WSER )	0.340**
13	$\tau$ (WFR, WHAR )	0.308**
14	$\tau$ (WFR, WSF, SEHAR )	0.530**
15	$\tau$ (WFR, EIII Score WCAG 2.0 Rank)	0.267*
16	$\tau$ (WFR, EIII Pass Applied Test % Rank)	0.287*
17	$\tau$ (WSER , WHAR)	0.327**
18	$\tau$ (WSER , WCER )	-0.371**
19	$\tau$ (WSER , WSE, ACER)	-0.495**
20	$\tau$ (WSER , WSF, SEHAR)	0.613**
21	$\tau$ (WHAR , WSE, ACER)	-0.235*
22	$\tau$ (WHAR , WSF, SEHAR )	0.619**
23	$\tau$ (WCER , WSE, ACER)	0.629**
24	$\tau$ (WSE, ACER, WSF, SEHAR )	-0.413**
25	$\tau$ (AccessMonitor Index Score WCAG 1.0 Rank, AccessMonitor Index Score WCAG 2.0 Rank)	0.759**
26	$\tau$ (AccessMonitor Index Score WCAG 1.0 Rank, EIII Score WCAG 2.0 Rank)	0.388**
27	$\tau$ (AccessMonitor Index Score WCAG 2.0 Rank, EIII Score WCAG 2.0 Rank)	0.425**
28	$\tau$ ((EIII Score WCAG 2.0 Rank, EIII Pass Applied Test % Rank)	0.469**

\*. Correlation is significant at the 0.05 level (2-tailed).  
 \*\*. Correlation is significant at the 0.01 level (2-tailed).

**Conclusions and Future Works**

Accessibility is a common concept referring to providing access to websites for people who have different abilities and are using various types of devices. The accessibility to Iraqi websites has not been evaluated before. Therefore, the authors chose a sample of 36 Iraqi University websites to be evaluated and to test the agreement among three free online accessibility evaluation tools. The analysis clearly shows a good positive correlation between different accessibility metrics.

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## اختبار التوافق بين ثلاثة ادوات تقييم مجانية لتقييم قابلية الوصول إلى الويب: دراسة حالة الجامعات العراقية الحكومية

ميثم مصطفى حمود

قسم علوم الحاسوب ، كلية علوم الحاسوب والرياضيات، جامعة تكريت ، تكريت ، العراق

### الملخص

أدى التطور الهائل في مواقع الويب والتبادل المستمر للمعلومات إلى المزيد من الاعتبار لإمكانية الوصول إلى المواقع الالكترونية. هناك العديد من الدراسات القائمة اجريت عن إمكانية الوصول في جميع أنحاء العالم. فشلنا في العثور على أي دراسات سابقة لاختبار إمكانية الوصول إلى مواقع الجامعات العراقية. تقيس هذه الدراسة إمكانية الوصول إلى 36 موقع للجامعات العراقية الحكومية، مدرجة في الموقع الرسمي على الإنترنت لوزارة التعليم العالي العراقية. تم استخدام ثلاثة أدوات مجانية على الإنترنت لتقييم إمكانية الوصول إلى 36 جامعة حكومية عراقية. الأدوات المستخدمة هي اولاً مقيّم إمكانية الوصول متعدد الاستخدامات على الويب (WAVE) Web Accessibility Versatile Evaluator و ثانياً مدقق الصفحة الإلكترونية (EIII Page Checker) وثالثاً مراقب الوصول (AccessMonitor). تظهر نتائج الأدوات الثلاثة أن المشكلة في قابلية الوصول هي من قبل مشرفي المواقع. علاوة على ذلك، نستكشف العلاقات بين القياسات الثلاثة لثلاثة أدوات تقييمية مجانية لإمكانية الوصول إلى الويب لاختبار التوافق نتائج إمكانية الوصول بواسطة الأدوات الثلاثة. وتم استخدام الحزمة الإحصائية حزمة لبرنامج العلوم الاجتماعية 20 (SPSS) لتحليل النتائج التي اظهرت التوافق بين الأدوات الثلاثة.