Testing The Usability Of Eastern Libyan University Websites Using GTmetrix Tool

Yousuf A Maneetah
yousuf.maneetah@uob.edu.ly

Computer Science, University of Benghazi, Benghazi, Libya

Abstract
Many people have been working on the issue of Web site performance in recent years. It is typically performed in various aspects such as user interface, functionality, interface compatibility, load/stress, and security. This research investigates Eastern Libyan university performance of the website under the World Wide Web environment. The evaluation procedure is used in the World Wide Web environment to measure real data and obtain response time. A website test is used in this study to measure the performance of a website. To get results on the performance of a Web site, measured some data from the calculate page size, composition, Structure and download time. In this study, website performance evaluation tools, GTmetrix, was used to evaluate Eastern university websites in libya, including University of Benghazi, Omar Al-Mukhtar University, Tobruk University, University of Ajdabia, Islamic University of Mohamed Bin Ali Al Sanussi, Bright Star University. Based on the observation result indicates that, the university of Ajdabia received the highest score for the majority of metrics. As a result, this University of Ajdabia website is the best in terms of usability, followed by the University of Benghazi.

Keywords: Gtmetrix tool, Lighthouse, Metric, Page size, Performance, Time, University website, Usability.

1. Introduction

Universities already have websites that explain the campus's profile, the activities of students and lecturers, and promote the University by displaying the students' and lecturers' previous accomplishments. Because university websites are one of the media for the publication of information, such research is required to measure and determine the quality of the website's performance [1, 2]. Web performance refers to the speed with which web pages are downloaded and displayed on the user's web browser. The study of how to improve the performance of a website is known as website optimization. Faster website download speeds have been shown to increase visitor retention and loyalty, as well as user satisfaction, especially among users with slow internet connections and those who use mobile devices [3]. Web performance also means less data traveling across the web, which reduces a website's power consumption and environmental impact. Browser/server cache, image optimization, and encryption (such as SSL) are all metrics that can influence how long it takes for pages to load. Overall load time - The amount of time it takes to download a file required to render the website. Latency, file size, and the number of HTTP requests made by the file are typically influencing factors. The availability of file preloading can help to shorten load times. Time required for a site to be usable -The time it takes for a user to utilize it while other assets are being loaded in the background. Smoothness and interactivity - This refers to how user feel while using a site and how smooth the scrolling is, as well as if the buttons and pop-ups are clickable and open. Perceived performance relates to how quickly a website responds to a user request and what websites may do to avoid giving consumers the impression that the website is malfunctioning or that there is no response when loading a huge file. Performance measures and

LJAST
Libyan Journal of Applied Science and Technology

مجلة ليبيا للعلوم التطبيقية والتقنية

Volume 10 Issue 01
June 2022

LJAST

مجلة ليبيا للعلوم التطبيقية والتقنية

perceived speed refer to the real speed when the user has made no request. When compared to other website performance evaluation tools, each one may display a different set of evaluation criteria [4, 5, 6]. By monitoring website up time, performance, and interactions and identifying optimization opportunities, these evaluations can show us how a site performs across different platforms or devices and reveal potential metrics that cause it to slow down [7, 8]. In the evaluation tools mentioned in this paper, common criteria were used.

2. RELATED WORK

2.1 Usability Evaluation of Encyclopedia Websites.

Usability is an important aspect on which every website should place a greater emphasis. This also indicates how well and successfully the website will function with real users. Many people believe that usability tests are costly and time-consuming. Usability testing can be a cost-effective and time-saving alternative to spending more time fixing an unusable website. The usability of encyclopedia websites is evaluated in this study using automated usability testing tools and questionnaire methods. The questionnaire was created using a standard form known as the Website Analysis and Measurement Inventory (WAMMI), which identified 20 common usability questions divided into five categories. Each category focuses on a different aspect of usability. Pingdom and GT-Metrix were used concurrently in this study to calculate and analyze the website performance of selected encyclopedia websites based on website components such as page load time, media size, and overall web performance grades. This research could aid web designers, developers, and practitioners in creating more user-friendly encyclopedia websites [9].

2.2 An Empirical Performance Evaluation of Universities Website.

Usability is recognized as a critical eminence aspect of any website. The quality assurance of a website is dependent on automation testing tools, which reduce costs while increasing efficiency. Usability testing tools are used to assess the usability and effectiveness of websites. The performance of a website can be an important metric in determining its success. It is determined by the major metric speed. When a website's speed is fast, performance improves automatically. The performance of a website can be assessed using tools that provide information about its resources and components. There are numerous automated website testing tools available. The purpose of this research paper is to assess and compare automated testing tools in terms of performance, speed, number of requests, load time, page size, SEO (Search Engine Optimization), mobile, and security. The performance of various Punjabi universities is evaluated using automated usability testing tools such as Pingdom, GTMetrix, Website Grader, and Site Speed Checker Tool, and the results are analyzed based on the aforementioned parameters [10].

2.3 Accessibility, usability, quality performance, and readability evaluation of university websites of Turkey: a comparative study of state and private universities.

The World Wide Web is now an essential component of higher education institutions. Universities can effectively, efficiently, and satisfactorily provide information and services to their target groups, regardless of disability, by using their websites. Universities must make the necessary design changes to ensure web content accessibility as the number of disabled students in higher education increases.

This paper assesses the accessibility, usability, quality performance, and readability of all Turkish public and private university websites. The majority of them failed to meet the WCAG 2.0 accessibility criteria. Only 10 state university websites and four private university websites achieved conformance Level an out of 110 state university websites and 69 private university websites. These results indicate that Turkish institutions should dedicate more resources to making their websites more accessible, useable, high-quality performance, and legible for all prospective users [11].

3. METHODOLOGY

Data was collected from six selected universities websites in east of Libya using GTmetrix usability testing tool based on their usability scores. In order to ensure the consistency of the results and analysis, GTmetrix usability testing tool was used in this study and is described below.

4. Eastern Libya Universities

Libyan university websites, particularly those in eastern Libya, which are the subject of our investigation in this paper, must serve a wide range of users. Every website must provide essential information to current students, faculty, staff, parents, and alumni. At the same time, a colleges' websites should empower new students. Colleges' websites must be kept up to date with upcoming events, announcements, and information on classes, majors, and programs in order to meet these goals. Overall, universities' websites must attract and inform users by providing relevant, timely, and engaging content that is tailored to a variety of users, which is difficult. Universities' websites give online services and their websites' usability metrics are below.

4.1 University of Benghazi

The University of Benghazi, founded in 1955, is a non-profit public higher-education institution located in the suburbs of the large city of Benghazi (population range of 500,000-1,000,000 inhabitants). This institution also has branch campuses in Al Kufra, Al Abyar, Al Wahat, Gamenes, Soluq, and Toukra. The University of Benghazi (UoB), which is officially recognized by Libya's Ministry of Higher Education and Scientific Research, is a large coeducational Libyan higher education institution. The University of Benghazi (UoB) provides courses and programs that lead to officially recognized higher education degrees such as bachelors, master's, and doctorate degrees in a variety of fields of study. The university website portal on Internet is https://uob.edu.ly [12].

4.2 Omar Al-Mukhtar University

Omar Al-Mukhtar University started its scientific and educational journey in 1975 with the Faculty of Agriculture. This faculty was the first building block and cornerstone of this leader university, which comprises 22 main faculties and 16 sub faculties having been established since the calendar year 1985/1986, and be diverse in various empirical sciences and human sciences through its scientific ability. Based on the needs of the region, extending from Marij in the west to the Libyan-Egyptian border in the east, the University has paid more attention to establishing extra faculties to support development projects in this region rich in human and natural resources. Omar Al-Mukhtar University started its scientific and educational journey in 1975 with the Faculty of Agriculture. This faculty was the first building block and cornerstone of this leader university, which comprises 22 main faculties and 16 sub faculties having been established since the calendar year 1985/1986, and be

diverse in various empirical sciences and human sciences through its scientific ability. Based on the needs of the region, extending from Marij in the west to the Libyan-Egyptian border in the east, the University has paid more attention to establishing extra faculties to support development projects in this region rich in human and natural resources. Furthermore, the availability of scientific abilities and administrative qualified people capable of establishing a number of faculties in an outstanding chain of the University's scientific and architectural up-to-date achievements alerts the university to be a scientific integral castle contributing to the society's advancement along a significant region in the geography of New. The university website portal on Internet is https://omu.edu.ly [13].

4.3 Tobruk University

Tobruk University, established in 2016, is a non-profit public higher-education institution in the city of Tobruk, Butnan. Tobruk University is a coeducational Libyan higher education institution that is officially recognized by Libya's Ministry of Higher Education and Scientific Research. Tobruk University offers courses and programs that lead to officially recognized higher education degrees in a variety of disciplines. Tobruk University also provides students with a variety of academic and non-academic facilities and services, as well as administrative services. The university website portal on Internet is https://tu.edu.ly [14].

4.4 University of Ajdabia

University of Ajdabia, established in 2014, is a non-profit public higher-education institution in the city of Ajdabiya, Al Wahat. The University of Ajdabia is a coeducational Libyan higher education institution that is officially recognized by the Ministry of Higher Education and Scientific Research. Ajdabia University offers courses and programs leading to officially recognized higher education degrees in a variety of fields of study. Students are also provided with a variety of academic and non-academic facilities and services by the University of Ajdabia, including administrative services. The university website portal on Internet is http://uoa.edu.ly [15].

4.5 Islamic University of Mohamed Bin Ali Al Sanussi

Islamic University of Mohamed Bin Ali Al Sanussi, established in 2012, is a non-profit public higher-education institution in the city of Bayda, Jabal al Akhdar area. Islamic University of Mohamed Bin Ali Al Sanussi, officially recognized by Libya's Ministry of Higher Education and Scientific Research, is a coeducational Libyan higher education institution formally affiliated with the Islamic religion. Mohamed Bin Ali Al Sanussi Islamic University offers courses and programs leading to officially recognized higher education degrees in a variety of fields of study. The Islamic University of Mohamed Bin Ali Al Sanussi also offers students a variety of academic and non-academic facilities and services, as well as administrative services. The university website portal on Internet is https://ius.edu.ly [16].

4.6 Bright Star University

Bright Star University, established in 1981, is a non-profit public higher-education institution in the town of Brega, close to institutions and oil fields. Bright Star University is a coeducational Libyan

higher education institution that is officially recognized by the Libyan Ministry of Higher Education and Scientific Research. Bright Star University provides courses and programs that lead to officially recognized higher education degrees in a variety of fields. Bright Star University also provides students with academic and non-academic facilities and services, such as a library and administrative services. The university website portal on Internet is https://bsu.edu.ly [17].

5. Testing tools

Web application testing is a type of software testing that focuses on web applications. Issues may include the security of the web application, the basic functionality of the site, accessibility to users, its ability to adapt to a wide range of desktops, devices, and operating systems, as well as readiness for expected traffic and number of users, both of which are related to load testing. The emphasis was on selecting one of measuring instruments for page size, load time, and performance. The tool is described in detail below.

5.1 GTmetrix tool

GTmetrix contains comprehensive information on destination page speed, timings, performance score, and other metrics. GTmetrix also provides information on how to resolve the issues revealed by the test.User will be able to select location, browser, and even connection type. This should provide a clearer picture of how destination website performs in various scenarios. GTmetrix is using Google's Lighthouse metrics – today's modern standard for web performance. With Lighthouse as the engine powering GTmetrix, we've created a new scoring system, resulting in the introduction of an all-new GTmetrix Grade, as well as, new Speed and Structure scores [18].
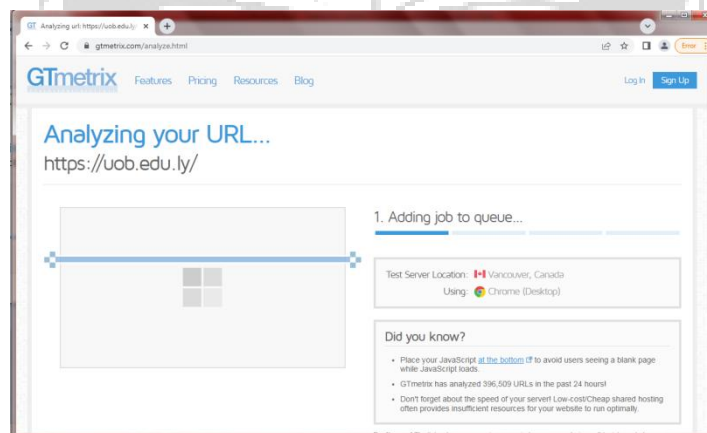
Fig.1 main web page of GTMetrix tool [19]

Figure 1 shows the GTmetrix tool as well as the outcome of one of the six universities' website discussed in this paper.

5.2 Lighthouse

Lighthouse is Google's open-source tool that was launched in 2016 and represents the modern standard in web performance testing. Lighthouse analyzes webpages in various ways, with a particularly strong focus on user experience. Lighthouse metrics are geared towards key page load milestones that reflect the perception of performance [20].

LJAST
Libyan Journal of Applied Science and Technology

مجلة ليبيا للعلوم التطبيقية والتقنية

Volume 10 Issue 01
June 2022

LJAST

مجلة ليبيا للعلوم التطبيقية والتقنية

5.2.1 Time to First Byte (TTFB)

The total amount of time from the start of the request to the first byte of the response is referred to as the Time to First Byte (TTFB). It is calculated by adding "Redirect Duration" + "Connection Duration" + "Backend Duration." This is a key indicator of web performance. Websites should aim for a Time to First Byte (TTFB) of less than 200 milliseconds [21].

5.2.2 First Contentful Paint

The First Contentful Paint (FCP) metric measures how quickly visitors can view actual content (text, images, video, etc.) on destination page. FCP is the time required from the start of destination page load to the point at which any content is rendered on the screen. A low FCP time contributes to a positive user experience because visitors perceive the page to load quickly if the content is delivered sooner. Websites should aim for a First Contentful Paint time of 1.8 seconds or less [22].

5.2.3 Largest Contentful Paint

 Lighthouse introduced the Largest Contentful Paint (LCP) performance metric in 2020 to better measure the perceived loading experience for users. The length of time it takes for the largest "content element" on the page to become visible within visitor's viewport is measured by LCP. Sites should strive for a Largest Contentful Paint time of less than 2.5 seconds [23].

5.2.4 Onload Time

 Onload Time occurs when all of the page's resources (images, CSS, etc.) have finished downloading [24].

5.2.5 Fully Loaded Time

Fully Loaded Time is the maximum time after FCP and Onload have triggered, and there has been network and CPU idle (5.25 s each) after the last request has been captured [25].

5.2.6 Time to Interactive

Time to Interactive is a performance metric that measures a page's load responsiveness and assists in identifying situations where a page appears to be interactive. TTI determines the earliest point after First Contentful Paint (FCP) at which the page is reliably ready for user interaction. TTI contributes to the usability of the page. Sites should aim for a Time to Interactive of less than 3.8 seconds [26].

5.2.7 Total Page Size

Page size is the total of all the elements required to render destinatipage. This includes the HTML file, CSS files, images, scripts, multimedia, and so on. Sites should aim for a total page size of no more than 1.80 MB [27].

5.2.8 Structure

The structure score describes how well the page is constructed for enhanced efficiency [28].

6. RESULTS AND DISCUSSION

The paper has focused on one web usability tool to calculate eastern Libyan university platforms

website usability. The evaluation results are showing below.

6.1 Result of GTMetrix Tool

Each university website was tested 5 times at different times to confirm the results and know the efficiency of the website, and then the average was taken for the results to be as close as possible to accuracy. GTMetrix tool evaluated the websites using nine metrics which are Time to First Byte, First Contentful Paint, Largest Contentful Paint, Onload Time, Fully Loaded Time, and Time to Interactive, Total Page Size, Structure and performance. The data generated from the GTMetrix usability tool produced another result with the highest score of websites in each sector.

Table 1 University of Benghazi website evaluated by GTMetrix Tool

University of Benghazi	TTFB (s)	First Contentful Paint: (s)	Largest Contentful Paint (s)	Onload Time (s)	Time to Interactive	Fully Loaded Time (s)	Page size MB	Performance %100	Structure %100
Test1	1.400	2.20	2.80	3.30	2.60	8.60	7.54	53.00	73.00
Test2	1.200	1.90	2.60	2.90	2.50	32.90	7.36	66.00	74.00
Test3	1.300	2.00	2.70	3.00	3.10	33.10	7.36	59.00	74.00
Test4	1.100	1.70	2.50	2.80	2.40	8.00	7.55	60.00	76.00
Test5	1.300	2.00	2.70	3.10	2.60	33.10	7.44	58.00	74.00
Mean	1.260	1.96	2.66	3.02	2.64	23.14	7.45	59.20	74.20

Table 2 Omar Al-Mukhtar university website evaluated by GTMetrix Tool

Omar Al-Mukhtar University	TTFB (s)	First Contentful Paint: (s)	Largest Contentful Paint (s)	Onload Time (s)	Time to Interactive	Fully Loaded Time (s)	Page size MB	Performance %100	Structure %100
Test1	0.709	6.50	7.10	48.00	46.70	49.00	51.90	22.00	12.00
Test2	0.847	6.60	7.40	49.10	50.00	51.10	51.90	18.00	16.00
Test3	0.670	6.40	7.10	48.70	37.80	50.10	51.90	21.00	16.00
Test4	0.772	6.50	7.20	48.20	43.90	49.20	51.90	22.00	17.00
Test5	0.797	6.50	7.30	48.40	43.90	50.50	51.80	20.00	14.00
Mean	0.759	6.50	7.22	48.48	44.46	49.98	51.88	20.60	15.00

Table 3 Tobruk University website evaluated by GTMetrix Tool

Tobruk University	TTFB (s)	First Contentful Paint: (s)	Largest Contentful Paint (s)	Onload Time (s)	Time to Interactive	Fully Loaded Time (s)	Page size MB	Performance %100	Structure %100
Test1	2.100	4.90	8.10	8.50	7.90	8.60	8.12	18.00	49.00
Test2	1.900	4.60	7.80	8.1	7.70	8.30	8.12	18.00	49.00
Test3	1.900	4.20	7.20	7.30	7.10	7.40	8.12	19.00	52.00
Test4	1.900	4.30	7.50	7.60	7.30	7.80	8.12	16.00	51.00
Test5	1.900	4.30	7.30	7.30	7.10	7.40	8.12	18.00	52.00

LJAST
Libyan Journal of Applied Science and Technology

مجلة ليبيا للعلوم التطبيقية والتقنية

Volume 10 Issue 01
June 2022

LJAST

مجلة ليبيا للعلوم التطبيقية والتقنية

Mean	1.900	4.46	7.58	7.76	7.42	7.90	8.12	17.80	50.60

Table 4 University of Ajdabia website evaluated by GTMetrix Tool

University of Ajdabia	TTFB (s)	First Contentful Paint: (s)	Largest Contentful Paint (s)	Onload Time (s)	Time to Interactive	Fully Loaded Time (s)	Page size MB	Performance %100	Structure %100
Test1	1.90	2.60	2.80	3.00	3.00	3.40	0.691	67.00	78.00
Test2	1.80	2.50	2.70	2.90	2.90	3.40	0.691	69.00	78.00
Test3	1.40	2.10	2.30	2.50	2.40	3.10	0.691	76.00	79.00
Test4	1.90	2.50	2.70	3.00	2.90	3.40	0.691	69.00	76.00
Test5	1.50	2.20	2.40	2.60	2.50	3.10	0.691	74.00	77.00
Mean	1.70	2.38	2.58	2.80	2.74	3.28	0.691	71.00	77.60

Table 5 Islamic University of Mohamed Bin Ali Al Sanussi website evaluated by GTMetrix Tool

Islamic University of Mohamed Bin Ali Al Sanussi	TTFB (s)	First Contentful Paint: (s)	Largest Contentful Paint (s)	Onload Time (s)	Time to Interactive	Fully Loaded Time (s)	Page size MB	Performance %100	Structure %100
Test1	1.20	5.50	6.30	14.10	8.80	14.60	3.52	45.00	40.00
Test2	1.10	5.40	6.20	14.00	8.70	14.50	3.52	46.00	40.00
Test3	1.10	5.40	6.30	14.10	8.80	14.60	3.52	46.00	40.00
Test4	1.30	5.60	6.40	14.20	8.90	14.70	3.52	46.00	40.00
Test5	1.10	5.40	6.30	14.10	8.80	14.60	3.52	46.00	40.00
Mean	1.16	5.46	6.30	14.10	8.80	14.6	3.52	45.80	40.00

Table 6 Bright Star university website evaluated by GTMetrix Tool

Bright Star University	TTFB (s)	First Contentful Paint: (s)	Largest Contentful Paint (s)	Onload Time (s)	Time to Interactive	Fully Loaded Time (s)	Page size MB	Performance %100	Structure %100
Test1	1.10	3.50	5.10	5.80	13.80	13.80	2.84	38.00	54.00
Test2	0.937	3.30	4.10	5.70	13.60	13.60	2.84	41.00	54.00
Test3	0.947	2.60	3.50	4.90	13.00	13.00	2.84	45.00	55.00
Test4	1.000	2.70	6.10	6.70	13.00	13.00	2.84	38.00	49.00
Test5	1.000	2.40	3.50	6.50	12.80	12.80	2.84	46.00	52.00
Mean	0.997	2.90	4.46	5.92	13.24	13.24	2.84	41.60	52.80

LJAST
Libyan Journal of Applied Science and Technology

مجلة ليبيا للعلوم التطبيقية والتقنية

Volume 10 Issue 01
June 2022

LJAST

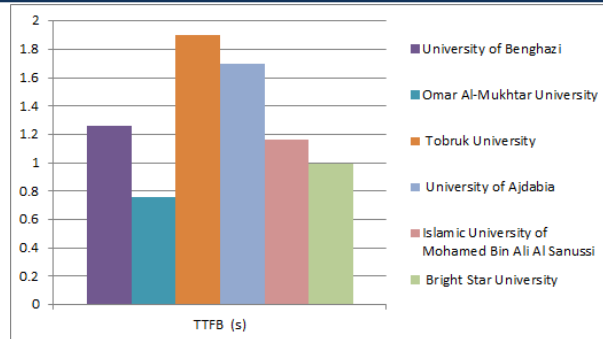مجلة ليبيا للعلوم التطبيقية والتقنية

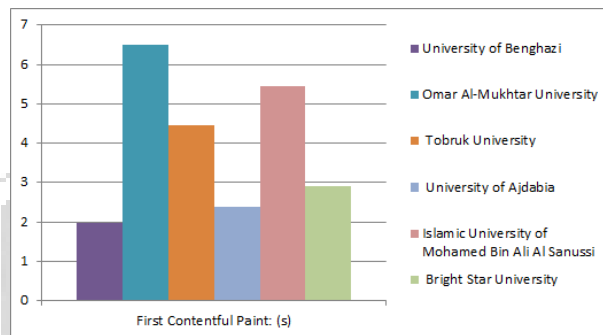**Fig.2** University websites Time to First Byte (TTFB) Testing.

Fig.3 University websites First Contentful Paint Testing.

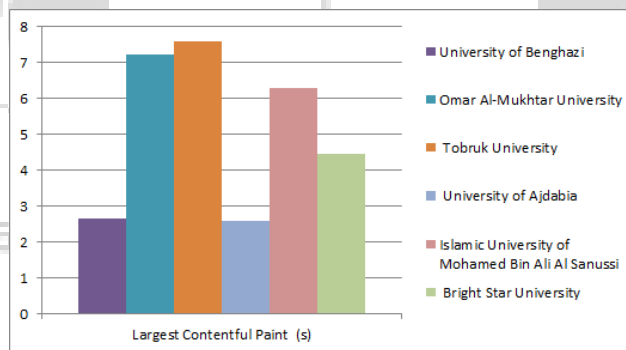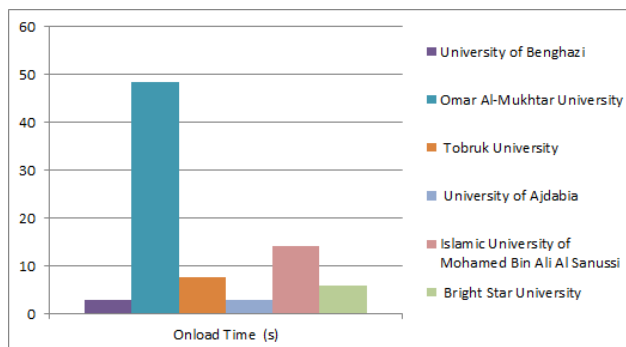**Fig.4** University websites Largest Contentful Paint Testing

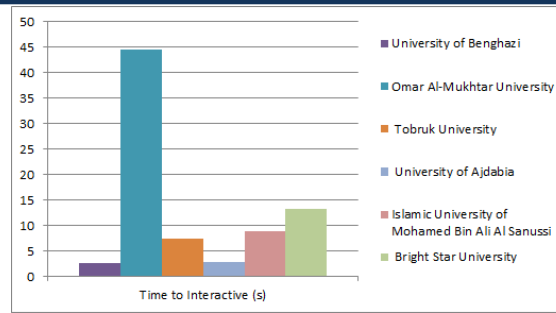**Fig.5** University websites Onload Time Testing.

LJAST
Libyan Journal of Applied Science and Technology

مجلة ليبيا للعلوم التطبيقية والتقنية

Volume 10 Issue 01
June 2022

LJAST

مجلة ليبيا للعلوم التطبيقية والتقنية

Fig.6 University websites Time to Interactive Testing
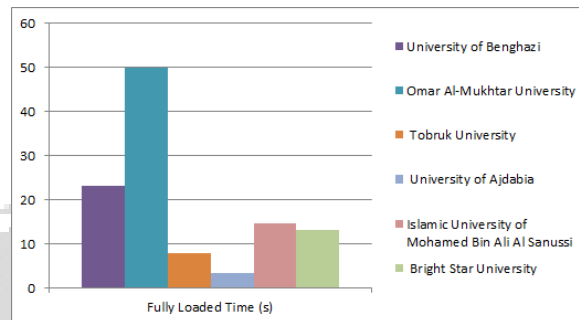
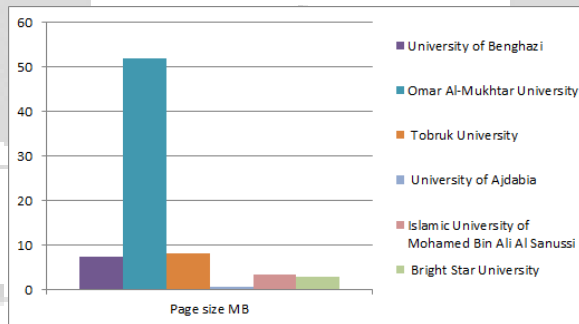**Fig.7** University websites Fully Loaded Time Testing

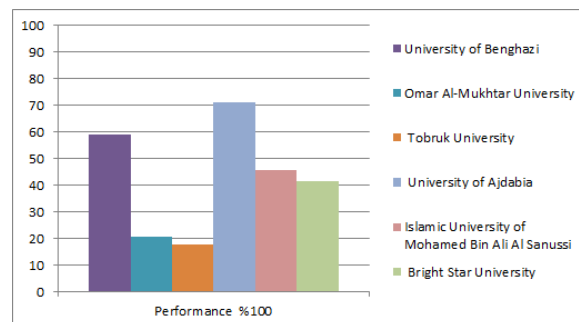**Fig.8** University websites Page size Testing
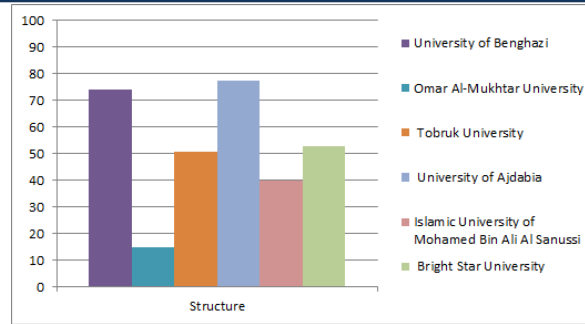

Fig.9 University websites Performance Testing

Fig.10 University websites Structure Testing

Omar Al-Mukhtar University has the best time, but Tobruk University has a worst time with University of Ajdabia in TTFB metric, is showing in Figure 2. University of Benghazi has the best time, but Omar Al-Mukhtar University has the worst time in First Contentful Paint metric, is showing in Figure 3. University of Ajdabia has the best time, but Tobruk University has the worst time in Largest Contentful Paint metric, is showing in Figure 4. University of Ajdabia has the best time with university of Benghazi, but Omar Al-Mukhtar University has the worst time in onload time metric, is showing in Figure 5. University of Benghazi with University of Ajdabia has the best time, but Omar Al-Mukhtar University has the worst time in Time to Interactive time metric, is showing in Figure 6. University of Ajdabia has the best time with Tobruk University, but Omar Al-Mukhtar University has the worst time in Fully Loaded Time metric, is showing in Figure 7. University of Ajdabia has the smallest size, but Omar Al-Mukhtar University has the biggest size in Page size metric, is showing in Figure 8. University of Ajdabia has the highest structure metric with university of Benghazi, but Omar Al-Mukhtar University has the lowest one, is showing in Figure 9. University of Ajdabia has the highest performance metric with university of Benghazi, but Tobruk University has the lowest one, is showing in Figure 10.

7. CONCLUSION

Based on the evaluation usability criteria through **GTMetrix** automated tool, University of Ajdabia has scored the highest for the most metrics. Hence, this University of Ajdabia website can be concluded as the best website based on usability followed by the University of Benghazi, despite the long time it takes to Fully Loaded time metric. The worst site is Omar Al-Mukhtar University. However, for all website could be improved the parameters which website are lacking. In general, all university websites standards are higher than ideal, so these websites must be redeveloped to suit their use by faculty members, researchers and students.

REFERENCES

[1] Hasan, L. (2013). Heuristic evaluation of three Jordanian university websites. Informatics in Education-An International Journal, 12(2), 231-251.

[2] Sreedhar, G. (Ed.). (2016). Design solutions for improving website quality and effectiveness. IGI Global.

[3] Astani, M., & Elhindi, M. (2008). An empirical study of university websites. Issues in Information Systems, 9(2), 460-465.

[4] Page, R. (2012). Website Optimization: An Hour a Day. John Wiley & Sons.e

[5] Albreem, M. A., Sheikh, A. M., Alsharif, M. H., Jusoh, M., & Yasin, M. N. M. (2021). Green Internet of Things (GIoT): applications, practices, awareness, and challenges. IEEE Access, 9, 38833-38858.

[6] AlMeraj, Z., Boujarwah, F., Alhuwail, D., & Qadri, R. (2021). Evaluating the accessibility of higher education institution websites in the State of Kuwait: empirical evidence. Universal Access in the Information Society, 20(1), 121-138.

[7] Reis, C., Moshchuk, A., & Oskov, N. (2019). Site isolation: Process separation for web sites within the browser. In 28th USENIX Security Symposium (USENIX Security 19) (pp. 1661-1678).

[8] Kivilohkare, G. (2020). Optimizing the Critical Rendering Path for Decreased Website Loading Time.

[9] Ismail, N. A., Jamaluddin, F. I., Hamidan, A. H., Ali, A. F., Mohamed, S. E., & Said, C. S. (2021). Usability Evaluation of Encyclopedia Websites. International Journal of Innovative Computing, 11(1), 21-25.

[10] Kaur, S., Kaur, K., & Kaur, P. (2016). An empirical performance evaluation of universities website. International Journal of Computer Applications, 146(15), 10-16.

[11] Akgül, Y. (2021). Accessibility, usability, quality performance, and readability evaluation of university websites of Turkey: a comparative study of state and private universities. Universal Access in the Information Society, 20(1), 157-170.

[12] https://uob.edu.ly/ accessed on 01-jan -2022 at 02:00 pm.

[13] https://omu.edu.ly/ accessed on 05-jan -2022 at 06:00 pm.

[14] https://tu.edu.ly/ accessed on 06-jan -2022 at 05:00 pm.

[15] http://uoa.edu.ly/ accessed on 01-feb -2022 at 09:00 am.

[16] https://ius.edu.ly/ accessed on 15-feb -2022 at 03:00 pm.

[17] https://bsu.edu.ly/ accessed on 25-feb -2022 at 10:00 am.

[18] QUINITO JR, F. B., & CATIPAY, J. P. Technical Review and Analysis on Students Academic Website Projects Using GTmetrix Web Speed and Optimization Tool.

[19] Heričko, T., Šumak, B., & Brdnik, S. (2021, September). Towards Representative Web Performance Measurements with Google Lighthouse. In Proceedings of the 2021 7th Student Computer Science Research Conference (p. 39).

[20] Https://gtmetrix.com/analyze.html

[21] Indra, D. (2018). Performance Analysis of the Resource Loading Time for Borneo Biodiversity Information System.

[22] Budiman, E., Puspitasari, N., Alam, S. N., Akbar, M. A., & Indra, D. (2018, October). Performance Analysis of the Resource Loading Time for Borneo Biodiversity Information System. In 2018 Third International Conference on Informatics and Computing (ICIC) (pp. 1-5). IEEE.

[23] Enghardt, T., Zinner, T., & Feldmann, A. (2019, March). Web performance pitfalls. In International Conference on Passive and Active Network Measurement (pp. 286-303). Springer, Cham.

[24] Böttger, T., Cuadrado, F., Antichi, G., Fernandes, E. L., Tyson, G., Castro, I., & Uhlig, S. (2019, October). An Empirical Study of the Cost of DNS-over-HTTPS. In Proceedings of the Internet Measurement Conference (pp. 15-21).

[25] Król, K. (2018). Comparative analysis of the performance of selected raster map viewers. *Geomatics, Landmanagement and Landscape.*

[26] Amjad, M., Hossain, M., Hassan, R., & Rahman, M. (2021). Web Application Performance Analysis of E-Commerce Sites in Bangladesh: An Empirical Study. International Journal of Information Engineering and Electronic Business, 13(2), 47-54.

[27] Heriăko, T., Čučko, Š., Šumak, B., & Brdnik, S. (2021). Web Performance Tuning of WordPress-Based Websites Through Automatic Image Optimization. In Central European Conference on Information and Intelligent Systems (pp. 343-350). Faculty of Organization and Informatics Varazdin.

[28] Ramakrishnan, R., & Kaur, A. (2020). An empirical comparison of predictive models for web page performance. Information and Software Technology, 123, 106307.