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Accessibility and Performance Evaluation of E-Services in Oman Using Web Diagnostic Tools

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Abstract

With the advancements in technology, there is a paradigm shift in the outlook, usage, provision, and access of e-services. This has led to increased availability of services through electronic media as e-services, e-government services, e-businesses, e-commerce, and many more. It is imperative to ascertain the quality of such services regularly against internationally accepted guidelines, standards, and tools to verify whether it is satisfying, increasing user expectations and technological advancements. This research investigates the current status of the quality of e-services in Oman by considering key quality dimensions that affect the services in the country using web diagnostic tools. The study not only benchmarks against international standards but also gives an insight into any meager aspects of quality of e-service in Oman. The study concluded that selected e-services in Oman performed at adequate or superior levels in some metrics; however, they fell short in a few metrics.

Keywords: *e-Services, Quality dimensions, Web diagnostic tools, Metrics, Performance, Accessibility*

1. Introduction

Electronic services (e-services) are collaborative services with a provider (business entity), a consumer (customer), an electronic medium for communication, and a service that benefits both parties [1-5]. This integrate business processes, technology, and human resources to facilitate services electronically [6]. E-services, when adopted by a government body, become e-Government [7], which facilitates traditional operations over the Internet [8] in an efficient, convenient, and cost-effective manner. Electronic government (e-government) is viewed as a road map to develop a more sustainable economy in many countries, including the GCC (Gulf Cooperation Council) countries. GCC states are persistently enhancing e-services through strong leadership commitment, infrastructure, funds, initiatives, strong Internet penetration, and technology usage [9] In 2012, the United Nations Development Programme (UNDP) reported a high level of adoption and readiness of e-Government and high penetration of Internet in GCC [10]. The United Nations (UN) indicated improved e-Government readiness for all GCC states in 2014; Oman was in 48th place [9]. Although e-services cater to increasingly demanding and tech-savvy users, it is imperative to measure the quality of these services. To measure their effectiveness and efficiency against international standards, periodic assessment of e-Government services is essential. Assessment and gauging of e-Government portals enables service providers to pin down weaknesses and influence outcomes through continuous improvement.

In the context of this paper, e-services refer to services offered by public organizations. This research ascertains the current status of e-service in Oman by using web diagnostic tools. Section 2 discusses the background research on quality of e-services, quality

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dimensions, models, and e-Government services and the case of Oman. Section 3 covers the research methodology used in this study. Section 4 details the analysis for the tests being carried out and section 5 outlines the conclusion.

2. Quality of E-Government Services

A holistic approach to quality of an e-Government service considers dimensions such as quality of content, response speed, and security, which will lead to customer satisfaction while using government e-services [11]. A number of researchers have used different approaches related to domains, industries, and countries. Table 1 summarizes a list of quality dimensions proposed by various researchers in the context of e-Government services. Factors such as accessibility, quality, and privacy are inherent for the success of e-Government portals [12]. It is imperative to measure the quality of e-Government [13] in terms of the needs of the citizens and sustainable environment and against traditional ways of services [14]. Quality of service has many dimensions; for example, [15] looked at quantitative and functional quality, whereas Halaris *et al.* [16] defined quality in terms of customer satisfaction, site quality, and technical and process performance. With the availability of e-services, only a low percentage of these services is actually being used [17]. Web design, reliability, response, customization, quality of information [15], system quality (usability, responsiveness, ease of access, privacy), information quality (accuracy, dependability, coverage, ease of use), and service quality (empathy, interactivity, playfulness, and aesthetics) [18] are some key dimensions.

Researchers extended prevalent models and approaches by considering additional key quality factors. SERVQUAL [13] is a prevalent and generic model that was revised by [19-21]. On the other hand, the e-GSQA model [22] was based on E-S-Qual [19] and E-GovQual [20], while [23] proposed eight-dimension scale by modifying SERVQUAL. Alhyari and Alhyari [7] used SERVQUAL and lean six sigma applications by considering technological factors and user expectation factors, the ISO/IEC 9126, based on the review of the quality scales and SERVQUAL, and Lai and Pires's approach indicated that quality in the Asian e-Government context depends largely on user satisfaction [24]. These latest models and approaches give more attention to users' customized needs [25].

From the inception of e-Government in 2003 [26], Oman took tangible steps in transforming communities and integrating societies. The Information Technology Authority (ITA) recently launched the e-Government Transformation Plan [27] and Oman e-Government Architecture Framework (OeGAF) and e-Accessibility policy [28]. OeGAF prompts proficient IT initiatives and proliferates trust and confidence to service providers and consumers [29-30]. Despite the significant investments for e-governance initiatives, the e-service industry is still at an outset in Oman [28]. Security, efficiency, responsiveness, and reliability were identified by researchers as the key success factors in e-Government services [31-33] and web accessibility and integration of government agencies as factors influencing the e-Government implementation in Oman [26].

Table 1. Review of E-Government Services' Quality Models and Dimensions

Model	Quality Dimensions
(Cox & Dale, 2001)	Accessibility, communication, credibility, understanding, appearance, and availability
(Madu & Madu, 2002)	Performance, features, structure, aesthetics, reliability, storage capability, serviceability, security and system integrity, trust, responsiveness, product/service differentiation and customization, web store policies, reputation, assurance, empathy
(Santos, 2003)	Ease of use, appearance, linkage, structure and layout, content, reliability, efficiency, support, communication, security and incentive
(Yang and Fang, 2004)	Responsiveness, reliability, credibility, competence, access, courtesy, communication, information, responsiveness, and web site design
(Lee & Lin, 2005)	Web design, reliability, responsiveness, trust and personalization
E-RecS-QUAL (Parasuraman et al, 2005)	Efficiency, fulfillment, system availability, and privacy
E-SQUAL (Parasuraman et al, 2005))	Reliability, responsiveness, competence, access, courtesy, communication, credibility, security, understanding and tangibles
(Rowley 2006)	Site features, security, communication, reliability, customer support, responsiveness, information, accessibility, delivery and personalization
(Halaris *et al.* 2007)	Back office performance layer, site technical performance layer, site quality layer, customer's overall satisfaction
PeSQ (Cristobal *et al.* (2007))	Customer service, web design, assurance, and order management.
e-ServEval model (Balog et al, 2008)	Quality evaluation of e-services
e-GOSQ(Agrawal. et.al.2008)	Reliability, resourceful and utility
Esteves and Joseph (2008)	e-Government maturity level, stakeholders, and assessment levels.
Chutimaskul et al, 2008	Accuracy, relevance, information quality, user satisfaction
Behkamal, Kahani, & Akbari 2008	Functionality, reliability, usability, efficiency, maintainability and portability
Sohn and Tadisina (2008)	Trust, customized communication, ease of use, website content functionality, reliability, and speed of delivery.
Li And Suomi 2009	Website design, reliability, responsiveness, security, fulfillment, personalization, information and empathy.
e-GovQual , (Papadomichelaki & Mentzas, 2009)	Reliability, efficiency, user support and trust
CBM (Jansen et al (2010))	Three levels and five aspects; levels are group of organizations, individual organization, e-Governmente-Government services. Five aspects are: goal, respondents, indicator, methods, and infrastructure

e-GSQA **(Zaidi&Qteishat, 2012)**	WebSite quality, design, reliability, responsiveness, security, privacy, efficiency; ease of use and citizen confidence.
(Alhyari &Alhyari **2014)**	Security, reliability, responsiveness, ease of use, personalization and design.

3. Research Methodology

This research determines the present status of e-Government services in Oman by evaluating the quality of e-services with respect to performance and accessibility dimensions using web diagnostic tools. The accessibility dimension was used as a basis for evaluation since governments across the globe, in general, and the Omani government, in particular, are working to ensure effective communication across the community at various levels and across different experiences, ages, and backgrounds. The web offers vast opportunities for the disabled, and by not catering to this segment, this group will be at a disadvantage [34]. The other key dimension investigated in this research is performance—a key factor as argued by a number of researches as illustrated in Table 1. It is a decisive factor for user buy-in, as performance characteristics can only be validated at users' level.

The focus of this study is to assess Oman's popular e-services used by public at large scale, hence, not restrictive to services offered by governmental bodies but also inclusive of e-services provided by private sectors. To this end, a few key leading portals in e-Government and e-services (identified by an authoritative body in Oman) from different domains of business were evaluated using web diagnostic tools. The study was conducted in phases. In the first phase, two dimensions for measuring quality were selected; then open-source web tools were identified to measure those quality dimensions. In the second phase, the selected websites were evaluated intermittently using web diagnostic tools at specific times for better accuracy. The following sections detail the selection of web diagnostic tools and websites for conducting this research.

3.1. Performance Factors and Choice of Web Diagnostic Tools

To measure the performance dimension of websites, it is essential to understand the factors affecting performance and to identify the online tools used to evaluate it. The key factors affecting the performance of websites that can be construed from the literature review on the basis of common features are identified as load time, page size, performance grade, average speed, total number of requests, speed, and response time. These factors are vital as it is indicative of a well-performing website to have less load time, optimized page size, a high overall performance grade, high speed and average speed, and lesser response time. The web diagnostic tools that determine the performance factors were identified after a profound review of the several tools available. The eight shortlisted tools presented in Table 2 are WebtoolHub, Site Speed Checker, Google PageSpeed Insights, Page Scoring, Pingdom, WebWait, GTmetrix, and Yahoo! Yslow.

The WebtoolHub tool measures factors such as load time, page size, and average speed. The Site Speed Checker measures load time, page size, response time, and speed. Google PageSpeed, developed by Google, measures the overall performance grade according to the guidelines of W3C and HTML5. Pagescoring.com details several factors of which three are vital for performance measure: load time, pages size, and average speed. Pingdom measures load time, page size, and request time and generates performance-related statistics based on the test results. WebWait accurately measures the load speed of the websites by considering ajax processing and image loading. GTmetrix measures

factors such as load time, page size, and total number of requests. Yslow is a powerful tool developed by Yahoo! to analyze web page performance on the basis of Yahoo! rules for measuring of high performance of websites.

Table 2. List of Diagnostic Tools for Performance Measurements

Tool Name	Tools Description	URLs
WebToolHub	WebToolHub checks how fast web pages load. If loading time is too long then content optimizing or hosting server should be considered.	http://www.webtoolhub.com/tn561353-website-speed-test.aspx
Site Speed Checker	Side speed checker indicates the time it takes to get a control packet from the remote host.	http://www.seomastering.com/site-speed-checker.php
Google Page Insights	Google page insights analyze the content of website pages and provide suggestions to make that website faster in loading.	https://developers.google.com/speed/pagespeed/insights/
PageScoring	Page Scoring is an online tool for checking the website performance by checking the load time of different factors of websites.	http://pagescoring.com/website-speed-test/
Pingdom	Pingdom is an online tools which tracks the up and down time and the performance of the websites. It monitors the websites from different location around the world so that can give the genuine downtime from routing and access problem which can help to improve the performance of websites.	https://www.pingdom.com
WebWait	Webwait tests the speed of website connection.	https://www.webwait.com/
GTmetrix	Gtmetrix gives details of how well the website loads and also provides recommendation to make websites more optimized.	https://gtmetrix.com/
Yslow	Yslow tool is based on Yahoo rules for high performance websites. Yslow analyzes the web page performance and recommends areas for performance improvements.	http://yslow.org/

3.2. Accessibility Dimension and Choice of Web Diagnostic Tools

Website accessibility ensures that websites are designed, developed, and modified suitably for all users to take uniform access to functionality and information. If factors such as design, functionality, content type, and environment of websites are effectually implemented, a website will be easily accessible. In the case of accessibility, it is essential to identify the most effective guideline prior to selecting a web diagnostic tool since each tool follows a different guideline. For this purpose, it should be ensured that the tools that follow guidelines streamlined with the international standard guidelines are only selected for the evaluation of accessibility.

There are guidelines such WAI, WCAG, iCITA HTML best practices, 508 Sections, and BITV that describe the roles of web accessibility and how developers can improve accessibility. WAI and WCAG are recommended by W3C. iCITA HTML best practices guidelines are developed by the Illinois Center for Information Technology and Web

Accessibility. Section 508 guidelines are developed by the government of the United States to provide accessibility of information technology to the disabled, and Barrierefreie Informationstechnik-Verordnung (BITV) is a German standard for measuring the accessibility of the websites. Later, 13 tools which are following these accessibility guidelines were identified as presented in Table 3; Wave, Achecker, T.A.W, FAE, Etre Accessibility Checker, Eval Acess 2.0, HERA, PowerMapper, W3C HTML Validate Service, W3C CSS Validate Service, Mauve, Tenon, and Vamola.

Table 3. List of Diagnostic Tools for Accessibility Measurements

Tool Name	Tools Description	URLs
WebToolHub	WebToolHub checks how fast web pages load. If loading time is too long then content optimizing or hosting server should be considered.	http://www.webtoolhub.com/tn561353-website-speed-test.aspx
Site Speed Checker	Side speed checker indicates the time it takes to get a control packet from the remote host.	http://www.seomastering.com/site-speed-checker.php
Google Page Insights	Google page insights analyze the content of website pages and provide suggestions to make that website faster in loading.	https://developers.google.com/speed/pagespeed/insights/
PageScoring	Page Scoring is an online tool for checking the website performance by checking the load time of different factors of websites.	http://pagescoring.com/website-speed-test/
Pingdom	Pingdom is an online tools which tracks the up and down time and the performance of the websites. It monitors the websites from different location around the world so that can give the genuine downtime from routing and access problem which can help to improve the performance of websites.	https://www.pingdom.com
WebWait	Webwait tests the speed of website connection.	https://www.webwait.com/
GTmetrix	Gtmetrix gives details of how well the website loads and also provides recommendation to make websites more optimized.	https://gtmetrix.com/
Yslow	Yslow tool is based on Yahoo rules for high performance websites. Yslow analyzes the web page performance and recommends areas for performance improvements.	http://yslow.org/

3.3 Choice of Websites

This research evaluates the current state of e-Government and e-services by choosing websites identified as leaders in different domains by the Oman Web Awards. Choudrie *et al.* [12] advocate that a selection of portal-identified leaders in specific domains for better analysis and measurement of quality to establish best practices and encourage wider adoption in other business entities. The e-services evaluated for this research are popular Omani services that won in the Oman Web Awards 2014 as listed in Table 4.

Table 4. E-Services Analyzed Using the Selected Web Diagnostic Tools (Amended from [30])

Website	URL	Award/Category
Oman Air	http://www.omanair.com/en	Winner of Gold Award in e-Commerce, and FMCG at Oman Web
Nawras (Ooredoo)	http://www.ooredoo.om	Winner of Gold Award in services, software and telecommunication and best.om extension at Oman Web Awards 2004
mosaICT	http://www.mosaict.net	Winner of Gold Award in Education at Oman Web Awards 2004
Omran	http://www.omran.com	Winner of Gold Award in travel and tourism at Oman Web Awards 2014
Ominvest	http://www.ominvest.net	Winner of Gold Award in Banking and Finance at Oman Web Awards 2004
Duqm	http://www.duqm.gov.om	Winner of Gold Awards in Corporate, Ministries/ Government organizations, logistics and best.om extension and finance at Oman Web Awards 2004
Eyecomms	http://www. eyecomms.com	Winner of Gold Award in Advertising, Media and Events, Silver Award in Software and Telecommunication at Oman Web Awards 2004

4. Analysis

The state of quality of the selected websites was explored using the selected web diagnostic tools by evaluating two dimensions—accessibility and performance—for more than one time frame. The detailed results of the tests conducted to evaluate the accessibility and performance dimensions are in the sections below.

4.1. Analysis of Accessibility Dimension

To measure the performance of the selected e-Government websites in Oman, multiple tests were conducted at four different trial periods/times of day(s)/week(s) to grasp performance at various hour(s) of the day(s)/weeks(s). The trial periods were 9:00 a.m.–10:00 a.m., 12:00 p.m.–1:00 p.m., 1:00 p.m.–2:00 p.m., and 4:00 p.m.–5:00 p.m. As illustrated in Table 5, the metrics considered were errors, including priority 1, 2, and 3 errors, warnings, navigation, and orientation; scripting styling; HTML standard; WAI priority 1, 2, and 3; total elements; number of pages; accessibility issues/problems, *etc.* The results analyzed in Table 5 shows the mean value of all observed data (the four observations) as the mean gives a measure of the central tendency [35]. The variance among the test results in three trials was mostly zero, except on two websites using the TENON (follows the WCAG2.0 (A) guideline) for errors and warnings, indicating that these websites are accessible regardless of time frames; there was no difference in the accessibility.

Table 5. Analysis of Accessibility Metrics on Websites using Web Diagnostic Tools

Quality Matrices	Web Diagnostic Tools	Guidelines	Oman Air	Nawars (Ooredoo)	mosaICT	Omran	Ominvest	Duqm	Eyecomms
Errors	Wave	WCAG 1.0 Section 508 BITV Guidelines	22	4	8	20	3	5	24
	Achecker	WCAG 1.0 (A)	24	8	12	17	1	6	19
		WCAG 2.0 (A)	184	6	8	95	3	3	25
	TAW	WCAG 2.0 (AA)	199	28	17	38	2	27	97
	EvalAccess Priority 1	WCAG 1.0	3	0	1	8	0	3	16
	EvalAccess Priority 2		37	21	2	12	5	13	10
	EvalAccess Priority 3		1	1	1	1	1	0	1
	HERA	WCAG 1.0	15	8	5	12	9	6	9
	W3C Validation Service	W3C Guidelines (While Checking this Document for HTML5)	129	5	5	11	2	2	95
	W3C CSS Validation Service	W3C Guidelines (CSS Level 3)	138	44	90	54	10	0	354
	Mauve	WCAG 2.0 (A)	98	12	20	41	3	18	75
		WCAG 2.0 (AA)	320	368	45	475	94	224	289
	TENON	WCAG 2.0 (A)	110.25	8	25.5	27	6	43	46
	VAMOLA	WCAG 2.0 (A)	179.25	6	13	48.75	3	4	25
Warnings	TAW	WCAG 2.0 (AA)	623	46	483	154	53	351	820
	EvalAccess Priority 1	WCAG 1.0	342	154	138	138	94	78	166
	EvalAccess Priority 2		525	191	121	121	120	175	231
	EvalAccess Priority 3		560	205	89	89	87	174	249
	W3C Validation Service	W3C Guidelines (While Checking this Document for HTML5)	5	3	7	29	14	2	9
	W3C CSS Validation Service	W3C Guidelines (CSS Level 3)	262	51	602	125	29	415	555
	TENON	WCAG 2.0 (A)	0.5	0	0	0	0	0	0
	VAMOLA	WCAG 2.0 (A)	618	258	160	152	141	172	297

Navigation and Orientation	FAE	iCITA HTML Best Practices	81	74	88	66	88	74	87
Scripting	FAE	iCITA HTML Best Practices	100	100	100	1000	75	100	87
Styling	FAE	iCITA HTML Best Practices	100	100	100	100	83	100	75
HTML Standards	FAE	iCITA HTML Best Practices	100	100	50	50	50	100	75
WAI Priority	ETRE Priority 1	WAI Priority Guidelines	0	0	0	0	0	0	1
	ETRE Priority 2		33	2	7	10	0	6	26
	ETRE Priority 3		36	0	2	2	0	0	1
Total Element	HERA	WCAG 2.0	1132	347	326	450	230	405	511
No. of Pages Accessibility Issues	Power Mapper	W3C WCAG1, WCAG2(WAI) and Section 508	9	3	9	2	6	10	4

The HTML standards are complete for a few of the websites, styling is complete (100% pass) for most of the websites, and scripting is also complete for most of the selected websites as indicated in Figure.1(a). The priority 1 errors are 0 for almost all the websites; refer to Figure.1(b). Navigation and orientation is partially implemented on all the sites with a majority of the sites having 80% completion or higher. The test results indicate different outcomes for different timings and domains mainly due to Internet speed, time to page load, response time, guideline, and overall performance of a website. Since most websites satisfy priority 1, users will not face problems with accessibility [36]. Although the results of accessibility tests indicate that there are pages with accessibility issues, half of the websites have less than five pages with such issues.

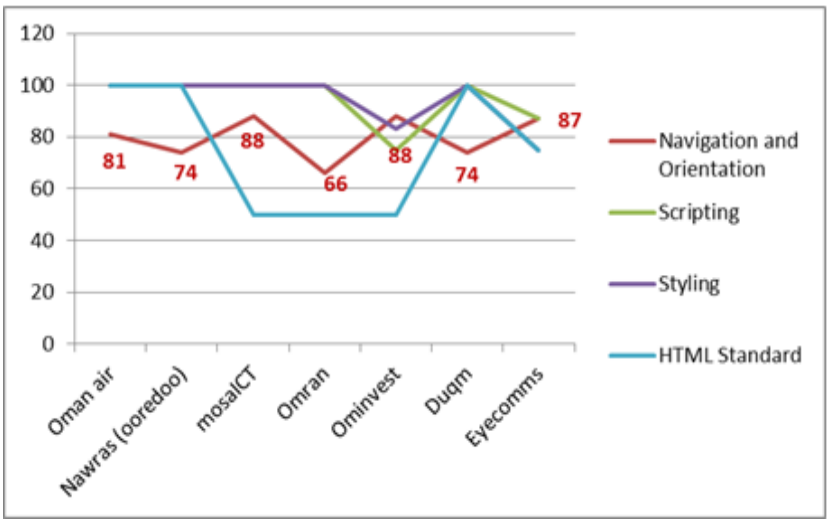

Figure 1. (a) Accessibility Metrics Implemented

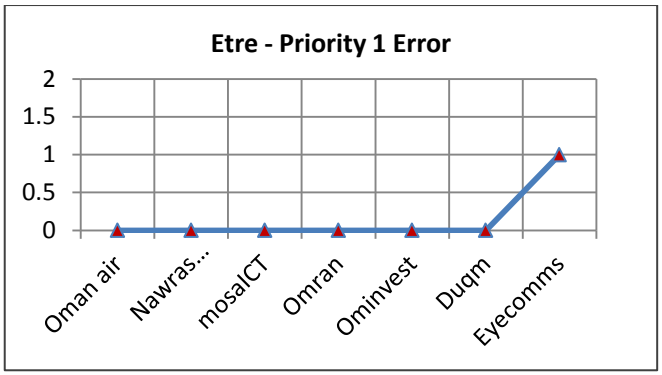

Figure 1. (b) Priority 1 Errors

The results indicated no difference when tested in different time frames for each tool. However, comparison of the results across different tools indicated a conspicuous difference. This difference is dependent on factors such as the guidelines each tool follows and the manner in which each tool evaluates the guidelines. The variation in results may also be attributed to sporadic activities of the developers at the backend when updating websites. Each tool is used to conduct tests and provide solutions for websites for more accessibility for the individual, organization, and government by implementing the guidelines by following its own functionality.

4.2. Analysis of Performance Dimension

The metrics tested for the performance dimension were load time, page size in kilobytes, total page size in megabytes, performance grade, number of requests, average speed, total number of requests, speed, and response time (as illustrated in Table 6). Performance was evaluated in three time frames 8:45 p.m.–9:55 p.m., 11:00 p.m.–12:00 a.m., and 7:00 p.m.–8:00 p.m. from two different domains, a total of six test cases. The results were analyzed based on the mean value of the two observations. There exist variances between the test results, indicating that the time frames selected may have affected the performance of the websites at these specific hours. The reason behind the difference and similarities in the test results of different tools is discussed in Table 7.

All selected websites satisfied the value standardized by IBM for the load time (<30 seconds) and the value standardized for webpage size (<64 KB) [37]. Bouch *et al.* [38] concluded in their research that the acceptable value for mean download time is 8.57 seconds. Akamai and Jupiter proposed four seconds as the acceptable load time for e-commerce sites [39]. The selected websites seem to fulfill this load time, except for three tools. This could be attributed to the total number of requests at that instance. The least number of simultaneous requests for websites during testing was 45, and the maximum was 104. The load time and the page size metrics of the websites of certain business domains seemed to have a higher number of requests, and speed was higher on such. The overall performance grade of majority of the websites was over and about 70%, which is considered to be in an acceptable range. The test indicates different results for the different timings and domains mainly due to Internet speed, time to page load, response time, and overall performance of a website.

Table 6. Analysis of Performance Metrics on Websites using Web Diagnostic Tools

		Selected Websites						
Quality Metrics	*Web Diagnostic Tools*	Oman air	Nawras (ooredoo)	mosaICT	Omran	Ominvest	Duqm	Eyecomms
Load Time in Seconds	Webtoolhub	1.435	2.54	1.18	1.46	0.97	1.435	0.42
	Webwait	6.26	1.72	3.975	2.73	2.82	5.44	2.855
	Speedchecker	1.45	2.1	1.93	1.24	1.155	0.625	0.365
	PageScoring	13.705	24.77	13.135	9.7	3.09	2.975	4.41
	Gtmetrix	5.025	15.795	2.725	4.12	3.015	3.55	6.86
	Pingdom	9.41	6.06	4.395	5.815	4.175	2.895	2.715
Page Size in Kb	Webtoolhub	46.69665	14.9299	17.18215	15.87085	6.7267	20.04	21.2412
	Speedchecker	46.70165	14.9349	17.1972	15.87585	6.7267	20.04	21.2512
	PageScoring	7.4875	14.9349	17.1972	3.29825	6.7267	3.8238	3.3884
Total Page Size in MB	Gtmetrix	1.785	1.115	1.675	2.58	1.065	0.875	1.89
	Pingdom	1.6	1.2	1.7	4.415	1.435	0.885	1.7
Performance Grade	Pingdom	83%	83%	87%	71%	77%	69%	76%
	Yahoo Y!Slow	74%	78%	67%	74%	71%	71%	70%
	Google Page Speed Insights	83%	88%	72%	83%	87%	89%	87%
Avg. Speed	*Webtoolhub (in s/KB)*	0.095	0.0765	0.035	0.0535	0.074	0.03	0.01
	PageScoring(in Mb/s)	0.01	0.0115	0.0265	0.01	0.025	0.01	0.0185
Total No. of Requests	*Gtmetrix*	103.5	50.165	50.165	53	47	59.815	81
	Pingdom	104.515	56	48	58.315	49	61.315	83.165
Speed (Kb/s)	*Speedchecker (in Kb/Sec)*	64.72	14.19	22.42	30.28	9.935	98.095	92.575
Response Time (ms)	*Speedchecker*	147.835	673.5	211.185	278.015	138.185	442.515	189.15

Table 7. Comparison of Tools Test Results Regarding Performance Factors

Performance Factor	**Performance Evaluation Tools**					
	WebToolHub	**Web Wait**	**Site Speed Checker**	**Page Scoring**	**GTmetrix**	**Pingdom**
Load Time	1.These three tools have similar results with little variance in different timescales 2. The variations in results are due to server overloading, Internet speed, network performance and website response time, and connection time			1. This tool analyzes different factors and files as compared with other tools, hence, huge imbalance in the result 2. Internet speed, network performance, website response time, server overloading, and backend issues are also causes for change in the result	1. Both tools measure almost the same factors; therefore, the difference in the test results of two tools is so less. But there were insignificant differences in the results of other tools 2. The variations in the results are due to network performance, Internet speed, website response time, and backend issues	

<table>
<tr><td>Page Size</td><td>WebToolHub</td><td>Site Speed Checker</td><td>Page Scoring</td><td>GTmetrix</td><td>Pingdom</td></tr>
<tr><td></td><td colspan="2">1. These two tools have same results at different timescales

2. The test results of these two tools have a huge difference with the results of other tools

3. The two tools have the same nature and measure almost the same factors, hence, not much difference in the test results when compared with each other.</td><td>1. The result of this tool is similar to WebToolHub and Site Speed Checker for three websites on different timescales

2. But for the other four websites, the results are the same on different timescale if we compare with its own test results, but if we compare with others, there were a lot of variations in the test results

3. The reason in variations in the result is the nature of the tool. This tool analyzes a lot of website files and different factors as compared with other tools</td><td colspan="2">1. The results of these two tools have little difference by comparing the test results with its own test results on different timescales, but by comparing with others, there is a huge difference

2. The reason behind the increase in page size as compared with other tools is that these two tools include HTML documents, JavaScript file, CSS file, image file, flash files, plain text files, and any other files that may cause increase in page size</td></tr>
<tr><td>Overall Performance Grade</td><td colspan="2">Yahoo! Yslow</td><td colspan="3">Google PageSpeed Insights</td></tr>
<tr><td></td><td colspan="2">1. There is a slight variation in the result of the Yahoo! Yslow tool with its own test results at different timescales. This is due to server overloading, network performance, Internet speed, website response time, connection time, and backend issues

2. There is a lot of difference in the test results if we compare the result of each tool with the others. This is because Yslow is built by Yahoo! and has its own guidelines for measuring performance, which may cause the difference in test results</td><td colspan="3">1. There is a slight variation in the result of the Google PageSpeed Insights tool with its own test results at different timescales. This is due to server overloading, network performance, Internet speed, website response time, connection time, and backend issues

2. There is a lot of difference in the result if we compare the result of Yslow with PageSpeed Insights. This is because PageSpeed insights has its own guidelines—Google guideline to measure the overall performance grade of the website</td></tr>
<tr><td>Speed</td><td colspan="5">Site Speed Checker</td></tr>
<tr><td></td><td colspan="5">1. There are variations in the result at different timescales of the Site Speed Checker for speed factor

2. This difference is due to network performance, Internet speed, server overloading, backend issues, website response time, connection time, and load time</td></tr>
<tr><td>Avg. Speed</td><td colspan="2">Site Speed Checker</td><td colspan="3">Page Scoring</td></tr>
</table>

	1. There are little variations in the results of this tool with its own results of different timescales. This is due to Internet speed, connection time, website response time, network issues, and server overloading 2. There is a difference in the result of this tool with other tools because these tools are measuring different factors	1. There is a little bit of variation in the results of this tool with its own results at different timescales. This difference is due to Internet speed, connection time, website response time, network issues, and server overloading 2. The main reason for the difference in the results between these two tools may be Page Scoring's measure of factors like file size and load time
Response Time	**Site Speed Checker**	
	1. There is a difference in the test results at different timescales 2. This difference is due to factors like network performance, Internet issues, connection time, load time, server response time , website response time, server overloading, and backend issues	

5. Conclusion

Although the availability, usage, and augmentation of e-Government services in Oman have increased in terms of quality, as a measure of continuous improvement to quality of e-service, it is essential to benchmark for quality by considering key quality factors and internationally accepted guidelines and standards. In this paper, authors evaluated the quality of the websites of business entities that are key leaders in the perspective of e-Government and e-services in Oman using web diagnostic tools. The study considered two indispensable dimensions of quality in the context of Oman: accessibility and performance. The results indicate that selected e-services in Oman performed with adequate or superior levels in some metrics; however, they performed inadequately in a few metrics. The study indicated that although much attention is given to the quality of e-services, auxiliary tailoring is required to meet the advancements in technology and expectations. However, these findings may have limitations due to factors such as variance in the interpretation of quality by the web diagnostic tools. The comparative demographics of local e-services might be influenced by factors such as business domain, time of testing, guidelines of the specific tools, and usage of the websites. The results of certain websites (like Oman Air) might have been influenced by the seasonal demand of their service as compared with other websites, which could affect the overall measure of quality. The overall performance grade indicates that majority of the websites have room for further improvement.

Performing this type of self-assessment on some quality factors (accessibility and performance) in the case of this paper will continuously help e-service providers to pinpoint areas of improvement and benchmark the level of e-service provided to meet the internationally accepted level. Authors intend to include other features of the quality dimension, as discussed earlier, in extension of this work. The comprehensive analysis will help organizations benchmark their e-services against international standards and be continually proactive to contrive a sharpened quality of e-services in the Sultanate of Oman.

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