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An Assessment Framework for the Websites Effectiveness in Iraqi e-Government

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Abstract: The information technology, communications and internet websites have been become one of the most important requirements of the modern countries that are still developing the infrastructure and providing best performance locally and internationally. The Iraqi Government represented by both e-Gate and e-Citizen portal (egov.gov.iq, ca.iq) emphasizes the optimal employing of information technology and internet services by the ease of access and utilizing of e-Government websites. Also, diagnosing all things is a hindrance without it. The main target of this research is to estimate both of the accessibility and also, security of e-Government websites by utilizing many automated diagnostic tools like Pingdom and Google's speed insight checker and Aconites, this research evaluates usability, web accessibility and web vulnerabilities in nearly) 50 (websites from selected government sites in Iraq. The findings reveal several issues related to access to and security of Iraqi Government websites. The usability problems have been found with large numbers discovered 100% of websites that have been cut off links and 35 out of 50 websites have loaded time of more than 5 sec for the main interface. Access outcomes indicate that all 50 selected sites take access errors and violate the W3C Web Content Accessibility Guidelines (WACC) 1.0. The results indicate that the internet security vulnerabilities 50.6% sites have one or more severe vulnerability (injection of SQL or cross-site scripting-XSS) while 57.4% have one or more of the weaknesses the request for fraud through the site or denied service. Relied on the findings there are several recommendations supplied for security and accessibility of Iraqi general establishments.

Key words: Usability, security of web, vulnerabilities, ICT, e-Government, WACC

INTRODUCTION

The Iraqi Government, especially, after it was formed after 2003, works side by side with the private profit institutions in the success of the process to delivering the internet and advanced. Applications to Iraq were through working on the contract with many manufacturers and providers. Services used hardware and software and from various developing and developed world countries with the widest experience in this field (Al-Hammadany and Heshmati, 2011). According to the statistics published after the Italian Government has been developing the technology of information and communication infrastructure in Iraq and training the human resources is to master use and the best employment (Al-Hammadany and Heshmati, 2011). Despite the fact that Iraq has demonstrated a significant increment in internet it is joined from 12,500-2,750,000 in the years between 2000 and 2008, respectively. Nevertheless, it represents just 10% of Iraq's inhabitance that has internet access. Although, the Iraqi Government has introduced e-Government as an effective and effective means of delivering services to its citizens, corporations, governments and employees. In the last few years, the Government of Iraq has adopted the use of ICTs to accelerate and strengthen communication with citizens. In order to access the online services provided by governments to their users, web pages are the main interfaces. Despite the proliferation of e-Government services, online services always face major challenges such as usability issues, access issues and security breaches that may be frustrating to users. For example, a study to investigate user usability and user location in Egyptian Government sites revealed that government sites are partially usable in design perspectives while user experiences have been weak and most users only reconsider sites as a commitment or lack of a better choice (Karunasena, 2012). Transforming government to e-Government attends advantages, for example, cost-efficient delivery of

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services decrease in regulatory costs, complementary of services, a single integrated perspective of nationals across all government services and quicker modification to address inhabitant's demands (Isa *et al*., 2011). Websites and internet facilitate e-Government in disseminating information and services to the users in today's information societies.

Country profile-Iraq

Location: Iraq country is existed in the Middle East at the Northern most extent of the Arabian Gulf, Northern Saudi Arabia, Eastern Syria, Western Iran and Southern Turkey.

Size: The total area of Iraq is 437,072 km^2 including 432,162 km^2 of land surface.

Land boundaries: Iraq has joint borders with the following:

Country borders: Iran has common borders with 1,458 km. Also, Jordan has 181 km; Kuwait is 240 km; Saudi Arabia also has 814 km; Syria is 605 km and Turkey has 352 km (Youngblood and Youngblood, 2013).

Telecommunications: In 2003, the war robustly damaged telecommunication infrastructures in whole Iraq regions.

From that time, the United States of America Agency for International Development has been supervised rehabilitation processes by USA contractors but destruction has postponed reestablishment in a few of regions. Iraq had approximately, 1 million lines of traditional telephones. In 2004, around half of this number is found in the Baghdad capital. The magnificent percentage of service was retrieved step by step to the total lines that were not in service in 2003. There are 25 traditional telephones substituted until 2005 and 14 satellite-linked switching stations were in running but internationally calling stayed complicated. An insufficient technical infrastructure also has postponed the replacement of traditional telephone lines with fiber-optic lines. A mobile-phone system construction started in the last months of 2003 and an approximated value was 2.8 million mobile phones in 2005. There are three consortia taken contracts to set up the service of mobile phone in the North, Center and South (Amin *et al*., 2009). Between 2004 and 2005 it works in the Northern Region proceeded fastest in spite the regional approach left gaps in service. Between 2004 and 2005 it works in the Northern area which is proceeded fastest in spite the regional approach left gaps in service. Internet access expanded quickly after 2003 war while the internet was entirely controlled by Saddam Hussein regime. In 2005, an estimated 36,000 people utilized the internet and four hosts were in operation. In the same year, the essential access points were hotels and internet cafes in Baghdad, Basra and Kurdistan. Domestic Internet landlines remained unreliable in that time (Amin *et al*., 2009).

Literature review: A couple of studies on assessment the related issues of e-Government websites in various areas in the world have been conducted (Youngblood and Youngblood, 2013). All of these feedbacks in these studies may assist web improver for websites of e-Government to pay attention on particular security, accessibility and usability features which are often being neglected. Website usability increases trust in e-government but according to researchers, e-Government web portals tend to have usability and accessibility problems (Amin *et al*., 2009). Analyzed the usability and accessibility of Iraqi university websites and the results reported that the accessibility needs improvement to comply with W3C guidelines. A survey to investigate webpage security, availability, accessibility, utilization of government sites in Egypt was hold by Bouch *et al*. (2000). The result reported that government sites in Egypt own about 46.3 % error rate in usability, 69.38 % error rate of accessibility and security vulnerabilities in these sites were revealed. Another study was launched to tests and analyze issues such as broken links, download times, time, since, last update, style sheets, server-side image maps, inline multimedia components and metadata components, browser conveniently issues, HTML validator matters and etc., for several e-Government web sites (Singapore, Finland, Canada, Hong Kong and Australia) for best practices (Al-Khouri, 2013). By using Watchfire WebXACT Bobby, W3C HTML validator and viable NET LIFTA, a study was conducted to evaluate access to the web for e-Government websites of Kingdom of Saudi Arabia and Oman by adjusting the W3C Web Content Accessibility Guidelines. The result reported that, accessibility of websites in both countries is low and need improvement. In a different study conducted in Jordan using Bobby tool to evaluate the accessibility of government web sites reported the accessibility to be very low and required an immediate improvement to reinforce user's trust. Utilizing tools of automated testing, for example, website optimization, Axandra and EvalAccess 2.0 (Youngblood and Youngblood, 2013) examined the convenience and accessibility of 155 government websites in Malaysia and found that there are significant issues regarding usability and accessibility. Online testing tool was used for checking

the accessibility for 130 sites of government in the United Kingdom agreeing to the ripeness levels stated by WCAG. The results of this study demonstrate that about 23% of the web sites satisfied the WCAG first level standard and 5% accomplished WCAG second level conformance. By Youngblood and Youngblood (2013) accessibility of banking websites in India was evaluated using the automatic evaluation tool depends on WCAG 1.0 and WCAG 2.0 guidelines. It was found that none of the banking websites evaluated were completely accessible to people with disabilities, i.e., all violated web accessibility guidelines.

Proposed framework: The proposed framework for this study is include the following:

MATERIALS AND METHODS

This study assessed framework for the websites effectiveness in Iraqi e-Government. In particular the focus was on the related issues with security which are loading speed, page size, loading time, broken links, accessibility errors as well as high, medium and low severity vulnerabilities. The websites assessment time was from October 1st 2017-Dec 9th 2017. A total of seventy nine (50) e-Government websites were selected from Iraqi e-Government represented by both e-Gate of Iraq, e-Citizen portal (egov.gov.iq, ca.iq) to be examined and assessed based on usability, accessibility and web security to determine their current status. Evaluating of these issues will provide a clear insight on the current situation for e-Government web portals and what should be done to improve the situation in general while maintaining information security. The selection criteria of the websites to be examined and assessed are criteria used by Youngblood and Youngblood (2013) such as:

- The e-Government websites which provide extra online services to the audience
- The e-Government sites which are accessed by a various clients
- The websites which joined to public management and services

To gather data for the study, automatic usability and accessibility evaluation tools were used such as Google page speed insights for loading speed analysis, Pingdom for web loading time calculation, sortsite (powemapper) for broken links and errors evaluation while web application vulnerabilities were assessed using Acunetix Web Vulnerability Scanner. To complement the results obtained using these online automatic evaluation tools, further assessment was done using WAVE tool for usability and accessibility errors, W3C link checker for broken links evaluation. In this study, online versions of these tools were used except sortsite/powemapper and Acunetix Web Vulnerability Scanner which have the standalone applications that were installed on a desktop (window) computer. Sort site offers the ability to estimate the website's accessibility, usability, compatibility with W3C standards, broken links and search engine optimization. An Acunetix web Vulnerability Scanner finds more security vulnerabilities than other scanner and maintains few numbers of false positives.

RESULTS AND DISCUSSION

In this study, the usability was assessed by considering the loading speed, loading time and page size of the main page and amount of broken connections as suggested by Nielson usability instructions. Web Content Accessibility Instructions 1.0 (WCAG) such as errors present on the web pages and conformance to W3C 2.0 are used to measure the accessibility. The web application vulnerabilities measures were assessed to determine the presence of high, medium or low severity vulnerabilities mostly due SQL injection, XSS, CSRF and Denial of Service (DoS). The results of the assessment are studied in the following sub-sections.

Broken links: Broken links are found in a website when some pages contain links that don't research. Whenever clicked, this links will fetch the client to a page that no longer occurs. In all likelihood, clients will arrive on a 404 error page which shows that the web server be interrogated but the particular page could not be found. A link may end up broken for many reasons. The elementary and widely prevalent reason is that the website it links to doesn't exist any longer. The number of broken links present in 50 websites has been evaluated using sort site and W3C link checker and the consequences of those sites are categorized into four groups depend on the number of broken links presents in Table 1.

The presence of broken links in a website causes navigational problem. Figure 1 depicts each assessed websites with the corresponding number of broken links. This result indicates that 100% of 50 selected e-Government websites have navigational problems due to presence of broken links.

Table 1: Broken links

No. of broken links	No. of e-Government websites
0	0
1-5	21
6-10	15
More than 10	14

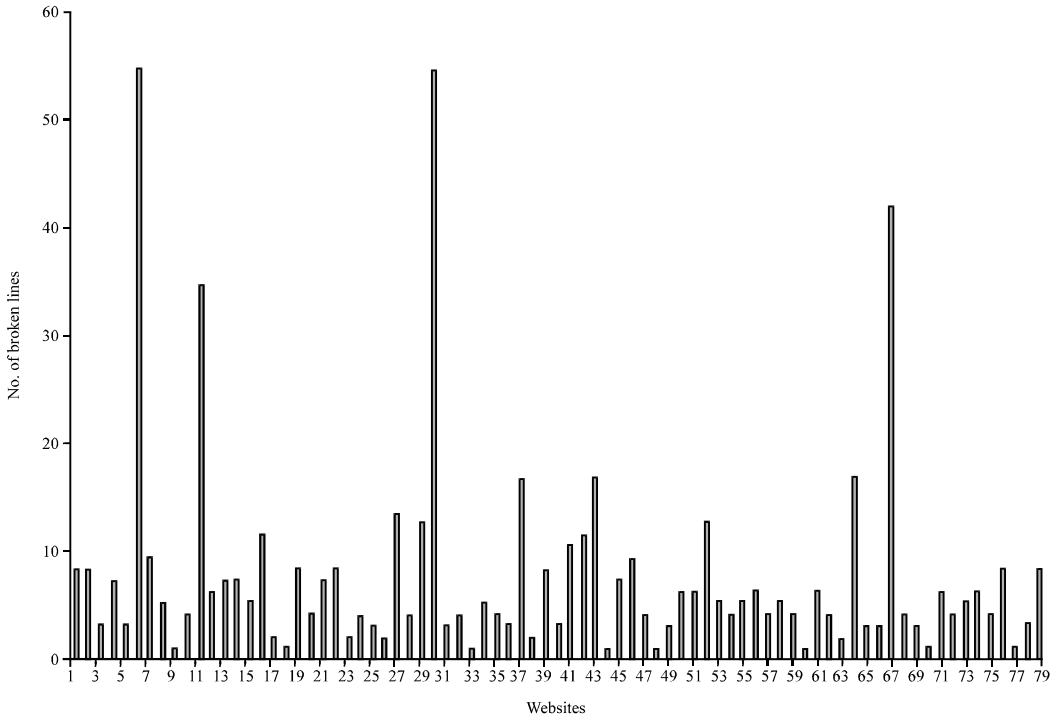

Fig. 1: Broken links on government websites (Horizontal Website, Vertical; Number of broken links)

Accessibility errors: The accessibility errors are encountered by user when using a website to access the services intended for them, especially by the government. Presence of errors in a website can make it difficult for user to access the services for both abled and disabled users (Al-Zuabi and Mahmud, 2011). Accessibility errors assessment was done with sort site and WAVE website testing tools. These tools can identify errors present in a website. The following are errors which were found to be present in the assessed websites:

- Images without "alt" attribute
- Images with empty "alt" attribute
- Images that require a long description
- Form controls without associated label
- Reading texts on the move
- Moving or blinking content
- Links with same link text but different destinations

The total number of errors present in 50 websites is categorized into four groups depending on the number of accessibility errors present as given in Table 2. Some errors appeared to be due to inconsistency in the language of the interface. After identifying the pages with spelling errors, the researcher tried to open these pages manually and found that, link at the English interface opened the page that displayed Arabic and English contents or Arabic contents only. There are two major accessible results for sort site tool, better than average or worse than average, relied on global standards. In this study, the majority of website's accessibility is worse than average (62%). Figure 2 shows the distributions of selected e-Government websites and the number of accessibility errors present.

Table 2: Accessibility errors

No. of errors	No. of e-Government websites
0	0
1-20	13
21-50	27
more than 50	10

Website loading speed: The loading rate of 50 chose websites has been assessed and examined using Google speed insight online tool. The result of the loading speed assessment can be classified into three categories (rating) as presented in Fig. 3. The speed score of page loading rates between 0 and 100%. A highest score is indicated to the best situation and the percentage with 90% or above is represented to good implementation (Al-Ahmary, 2010). The result indicates that, the vast majority of websites (36 out of 50) have a low loading speed for their main page.

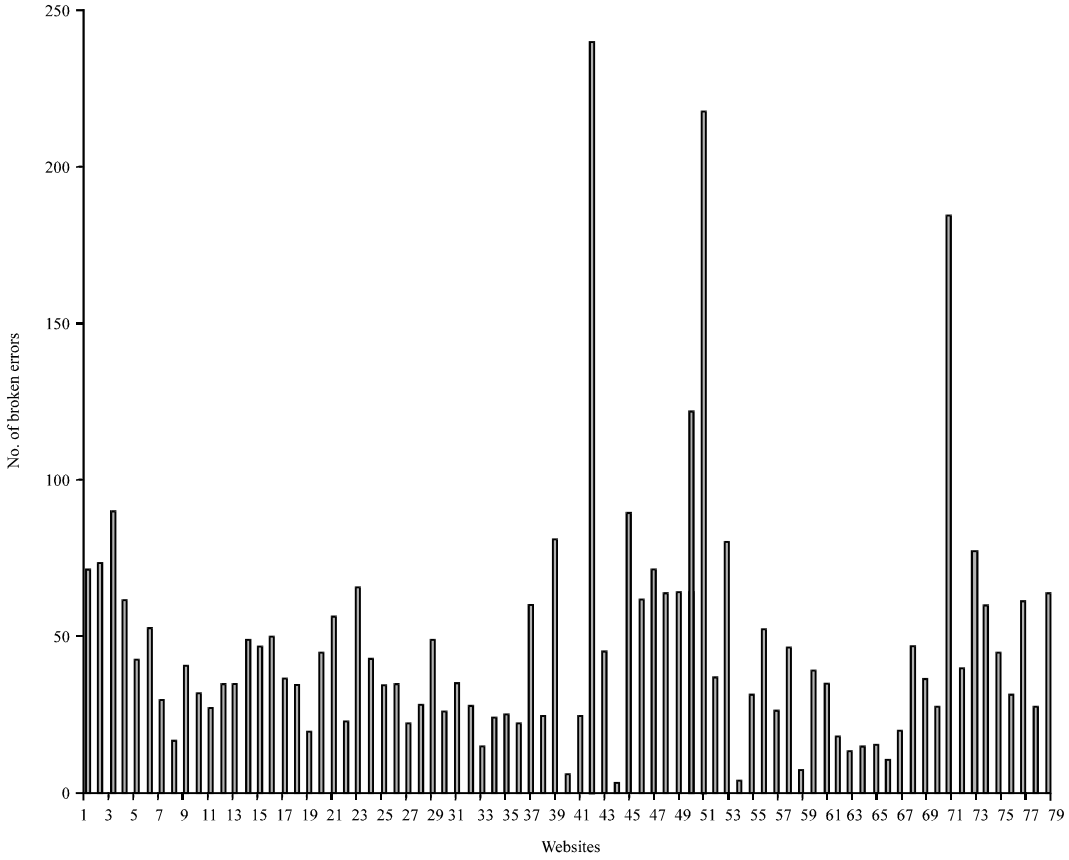

Fig. 2: Accessibility errors on government websites (Horizontal: Website; Vertical: Number of errors)

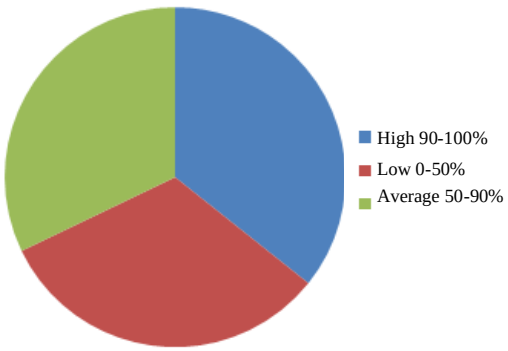

Fig. 3: e-Government websites main page loading speed

Website loading time: The loading time of 50 selected website has been assessed by using Pingdong online tool. Loading time is the time taken to download to the browser the web pages of chose websites. Very slow websites (of 10 sec and more) negatively impact the user of the website. The loading time is major contribution factor to page abandonment by the user as they lose patience for a page that takes too long to load. Slow web pages response time results in increased page abandonment. Computer system reaction time to a client inquiry or request at a terminal was proposed to be 2 sec back by 1960's Al-Khouri (2013) In the today's information society, computer and internet speed is improved as compared to the past years. By Al-Zuabi and Mahmud (2011) a study conducted came up with findings that indicate the amount of time a user can wait for a web page to load. Therefore, this study uses the results obtained by Al-Zuabi and Mahmud (2011) to set up the cluster for comparing different web loading time. Rating for loading time is divided into three rating as shown in Table 3.

Table 3: Loading time

Rating	Loading time (sec)	Websites (%)
High (good)	≤5 sec	34.18
Average	≤10sec	27.85
Low (poor)	>10 sec	37.97

According to Al-Khouri, 2012, high loading speed lead to faster response time to the user and simplify browsing. The researchers, here, also stressed that, the average loading rate produces the client wait a bit

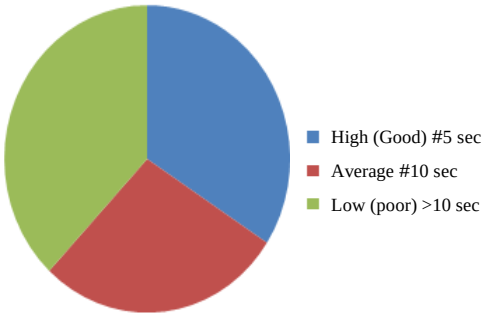

Fig. 4: e-Government main page loading time

Table 4: Page size

Ratings	Page size	No. of e-Government websites
High (fast)	≤12KB	0
Average (good)	≤2MB	39
Low (slow)	More than 2MB	11

but still the client be contented with speed. Uploaded time duration for more than 37% (17 out of 50) in the e-Government websites in Iraq which more than 10 sec as shown in Fig. 4. The essential substantial factors which participated to the poor loading speed of websites are server response time, page size, large embedded multimedia contents, incompatible images, etc.

Web page size: The web page size of selected 50 websites shown in Table 4 has been assessed by using Pingdong online tool. A small web page average is roughly about 12 KB (Al-Ahmary, 2010) and it will be loaded quite rapidly. The more media on any page, the larger the size cause a website to load slowly. Reasons for slower website may be due to media shapes such as images, audio, graphics, loaded videos and flashes that raise the size for a page of a website. A website with a page size of up to 2MB is said to have an average size (Al-Ahmary, 2010).

A fast website gives a good user experience and satisfies users while a very slow websites is a bad user experience. Figure 5 shows the percentage distribution of the page sizes for the main page of 50 selected e-Government websites. How fast a website loads is critical in maintaining user. The results indicate that, 19 out of 50 of the Iraq e-Government websites have main page size, uploaded in more than 12 KB. These results prove that usability issues are less than being considerate in e-Government web designed by enhancer of website.

Web security vulnerabilities: Number the security vulnerabilities present in 50 selected website has been assessed by using Acunetix Web Vulnerability Scanner tool and the result is shown in Table 4. As it can be

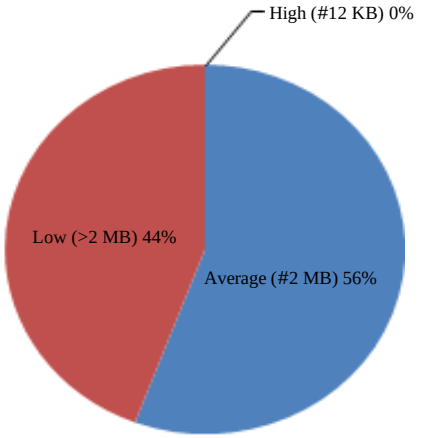

Fig. 5: e-Government web sites main page size

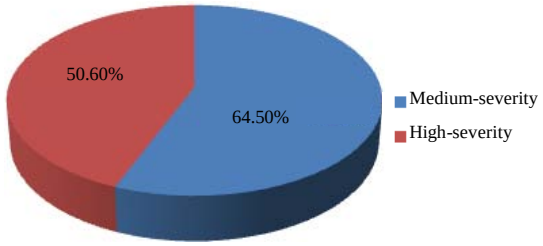

Fig. 6: Vulnerabilities in the e-Government web sites

Table 5: Website vulnerabilities

Type of vulnerabilities	No. of e-Government websites	Vulnerable websites (%)
XSS only (high)	15	29.11
SQL injection only (high)	4	5.06
XSS and SQL injection (high)	7	16.46
CSRF and DOS (medium)	24	64.56

Table 5, 26 out of 50 (50.6%) assessed websites have one or more high-severity vulnerability (SQL injection-SQLI, Cross Site Scripting-XSS) whereas 21 out of 50 (64.5%) have at least one medium-severity vulnerabilities (Cross Site Request Forgery-CSRF, Denial of Service-DoS). Therefore, some sites appeared to have both high-severity and medium-severity vulnerabilities as shown in Fig. 6 high-severity vulnerability gives an attacker ability to infringement the privacy, integrity or availability of a website without specific access, client interaction or conditions that are beyond the attacker's control. This makes it very possible for an attacker to gain access to other systems on the internal network of the vulnerable website. Medium severity vulnerabilities cause an attacker to have a partial ability to compromise the confidentiality, integrity or availability of a target system. Attacker can use this weakness together with high-severity vulnerability to simplify the attack.

Iraq public institutions should to be evident about what this denotes. High-severity vulnerability could enable attackers to increase unapproved access to data and systems, potentially to sensitive financial, customer, health data and trade secrets. They could likewise, move to different systems to escalate the attack considerably further. Web application (high-severity) lowers user's trust and willingness of using e-Government websites.

An assessment framework for the websites effectiveness in Iraqi e-Government should be the key features for the services provided to the citizens. In this study, the selected government websites have been assessed utilizing online evaluation tools. Assessments were conducted based on usability, accessibility and web security of a particular website. Each type of assessment was conducted using a specific online diagnostic tools and/or desktop tools. Assessment included broken links, accessibility errors, loading speed and time for the main page, page size of the main page and severity of web vulnerabilities (high, low and medium). In general, considering the selected government websites, it can be mentioned that usability is allowed to a very low priority in Iraq e-Government websites with 100% of site having broken links, 15 out of 50 of the Iraq e-Government website's essential page size is more than 12 KB, 26 out of 50 have a low loading speed for their main page and more than 37% of the Iraq e-Government websites have uploading time duration of more than 10 sec. The accessibility assessment showed that 100% of government websites have accessibility errors and do not conform to W3C 1.0/2.0. None of government websites found to have conformance level A of W3C. Nevertheless, 100% of government websites failed to pass priority 1 checkpoints for accessibility errors as 100% have errors. These results propose that W3C Guidelines WCAG 1.0 and 2.0 should be considered. Thus, during development, improvement has to be made to make e-Government websites usable and accessible and convenient to use by their users. e-Gate of Iraq should come up with frameworks that every public institution must follow in developing their websites. The main security concern about government web sites is that 50.6% have one or more high-severity vulnerability (SQL injection-sqli, cross site scripting-XSS) while 64.5% have one or more medium-severity vulnerabilities (Cross Site Request Forgery-CSRF, Denial of Service-DoS). Some sites appeared to have both high-severity and medium-severity vulnerabilities and have passwords transmitted over HTTP. Government websites are often the target for hackers, therefore, these vulnerabilities are real threats to the security and privacy of information shared by users and the government. If an attacker takes advantage against these weaknesses it could simplify the attack. Therefore, web developers should make sure that passwords are encrypted over HTTP and there is proper input validation to safeguard websites against SQL injection and XSS.

CONCLUSION

The results of this research show that there is a need to improve a couple of issues that related to the Iraqi e-Government websites such as security, usability and accessibility as it saves all kind of citizens (both with and without disabilities). Although, some of the problems identified such as broken links, loading speed and time of the home page could be fixed after deployment, problems such as accessibility errors and web vulnerabilities must be fixed during design and development stages. Fixing these problems during development cost less and is simpler as compared to fixing it after deployment. Accessibility errors identified by sort site tool can be solved by following design procedures that could eliminate these errors and conform to W3C. Errors such as images without "alt" attribute, images with empty "alt" attribute and reading texts on the move, moving or blinking content and links with same link text but different destinations should be removed during development stages. Since, the results revealed that web developers do not consider accessibility and usability during development stages there is a need for training and awareness for web developers and designers on how to develop websites that comply with usability and accessibility standards. All websites that comply with these standards are easier to develop, maintain and update. As the number of smart phone user's increase in Iraq, the future works is to evaluate and analyze the usability and accessibility of Iraq e-Government web sites in mobile devices. Also from these results, user experience on accessibility of Iraq e-Government websites need to be evaluated.

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development of e-Government in Iraq. Also, found that the number of people who use the Internet in Iraq about 11 million people and this number is the same for those who have accounts on face book this indicates that most who use the internet will certainly browsing their accounts on Facebook or use internet only for Facebook. This point must be taken into consideration by those officials on the government exploit it to promote for e-Government and urge people to use their applications. As well as, the officials of the e-Government program should increase their activities and provide better online services to the Iraqi people to improve the rank of Iraq in globally classification.

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