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LONG PAPER

The accessibility of Saudi Arabia government Web sites: an exploratory study

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Abstract This study is intended to provide an exploratory evaluation of Saudi Arabia government Web sites based on the Web Accessibility Guidelines 2.0 provided by the W3C. The results indicate that the Saudi government Web sites have made many of the accessibility mistakes as predicted. In the light of the study findings, this paper will present some recommendations for improving Saudi government Web sites, as well as discuss future implications.

Keywords Web accessibility · WCAG 2.0 · Accessibility evaluation · Arabic Web sites · e-Government · Saudi Arabia

1 Introduction

Nowadays, Web accessibility is becoming a main principle in many countries, especially for government agencies that rely on the Web for providing full range of easily reached services for their citizens. Additionally, electronic government (aka e-government) services are expected to expand; thus, it is imperative to guarantee equal access for everyone regardless of their disability. In a 2007 study by the UK Office for Disability Studies, it was found that one of the clear reasons for using the Internet by the disabled users was to access government Web sites and official services [1].

Certainly, ensuring Web accessibility for government Web sites is not a commodity, it is a necessity to ensure inclusion for all people and to provide the protection of equal human rights. In fact, in 2006, the UN Assembly passed a Treaty on Rights of Disabled that would guarantee persons with disabilities equal access to ICT. To respond to this Treaty, Saudi Arabia in June 2008 has signed and ratified this UN Treaty [2].

Given the fact that the number of disabled people in Saudi Arabia, based on the Central Department of Statistics and Information, was 134,956 by year 2007 [3], the Saudi government has put in place legislation related to general disability issues that address employment and skills development. However, under the current law, nothing specific related to Web accessibility has been enacted.

Without Web accessibility guidelines, the number of people who will be excluded from the benefits of e-government or even the basic government services will increase in the future. Therefore, this paper looks at the current accessibility state for a sample of Saudi government Web sites and highlights the accessibility issues recurring on them. The paper will also shed the light on the state of e-government in Saudi Arabia, as well as present a comprehensive review of research studies conducted to evaluate the accessibility of e-government Web sites worldwide. Finally, the paper discusses the methodology carried out in this research along with the findings.

2 Web accessibility legislation and standards

Governments around the world have been setting up legislations and laws to make the Web more accessible for people with disabilities. According to the World Wide Web Consortium (W3C) Web site [4], more than 19 countries have established their own policies, laws, and legislations relating to Web accessibility.

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For instance, in the United States, there are the American's with Disabilities Act, the Reauthorized Rehabilitation Act, and the Telecommunications Act. These legislations came out of the Office of Civil Rights and the Department of Education. The U.S. government has also Section 508 of the Rehabilitation Act that requires all federal agencies' services to be accessible to people with disabilities.

In the United Kingdom, there is the Disability Discrimination Act (DDA), and in Canada, there is the Government of Canada Internet Guide with a section on Universal Accessibility. Japan as well has its own accessibility legislations called e-Japan Priority Policy Program.

However, for countries who have not yet established their own policies and legislations regarding Web accessibility, the well-known and prominent guidelines suggested by W3C can be tailored and applied. These accessibility guidelines help Web developers and designers in building Web sites that conform to the provided accessibility specifications and guidelines, thus enabling the assistive technologies used by disabled users to better interact with a Web site. To give an example, in Thailand, the Thailand Web Content Accessibility Guidelines (Th-WCAG) have been developed. The guideline is a modified version of Level 1 conformance of WCAG2.0 to suit the Thailand country circumstance [5].

2.1 Overview of WCAG 2.0

W3C has proposed a set of guidelines for accessing the Web under the name of Web Accessibility Initiative (WAI), and this initiative has published the Web Content Accessibility Guidelines, WCAG 1.0 and WCAG 2.0. The latter is the current recommendation.

WCAG 1.0 is primarily HTML-oriented, while WCAG 2.0 is language-agnostic and technology-independent. A detailed discussion of what these Guidelines mean, their comparison and why they are important for Web accessibility can be found on the W3C's Web site [6]. A detailed overview of WCAG 2.0 is discussed next.

In December 2008, the Web Content Accessibility Guidelines 2.0 (WCAG 2.0) became a W3C recommendation. This guideline is designed to be applied on various Web technologies and to include future technology changes. WCAG 2.0 consist of four general principles abbreviated in the word (POUR) with twelve guidelines (see Table 1) that comprise a series of 61 Success Criteria (SC).

The principles constitute the basis of Web accessibility. Under each principle, can a set of guidelines and success criteria that tackle these principles be provided. The guidelines provide a wide description of one or more accessibility requirements. Success criteria represent a testable entity that forms the basis for accessibility level conformance. Each success criterion is written as a true or false statement. Some can be tested automatically using software evaluation programs, while others require human testers. The success criteria are written to be "technology neutral".

Table 1 Overview of WCAG 2.0 principles and guidelines

Perceivable (*users must be able to perceive the information being presented*)
Provide text alternatives for non-text content
Provide captions and alternatives for audio and video content
Make content adaptable, and make it available to assistive technologies
Use sufficient contrast to make things easy to see and hear
Operable (*users must be able to operate the interface*)
Make all functionality keyboard accessible
Give users enough time to read and use content
Do not use content that causes seizures
Help users navigate and find content
Understandable (*users must be able to understand the information as well as the operation of the user interface*)
Make text readable and understandable
Make content appear and operate in predictable ways
Help users avoid and correct mistakes
Robust (*users must be able to access the content as technologies advance*)
Maximize compatibility with current and future technologies

Source: W3C.org

WCAG 2.0 also provide examples of techniques or combinations of techniques for meeting the success criterion of the guidelines.

Moreover, there is a complement document to WCAG 2.0, which provides additional guidance for evaluating conformance to WCAG 2.0. This includes sufficient techniques, advisory techniques, and common failures.

The sufficient techniques are those which are testable and are considered sufficient to meet the success criteria. Each success criterion has one or more sufficient techniques that can be used to meet the success criteria. The advisory techniques are those that can enhance accessibility but are not considered for meeting the requirements of the success criteria. The common failures list examples of bad practices that cause Web pages to be inaccessible.

WCAG 2.0 levels of conformance are similar to those of WCAG 1.0, and they are divided into: Single-A (minimum level of conformance with minimum level of accessibility), Double-A (intermediate level of conformance with enhanced level of accessibility) and Triple-A (high level of conformance with additional accessibility enhancements). However, WCAG 2.0 has five conformance level requirements, which are [7] as follows:

- One of the levels of conformance must be met in full to claim for an accessibility level.

- Complete Web page: "Conformance is defined only for Web pages. However, a conformance claim may be made to cover one page, a series of pages, or multiple related Web pages."
- Complete processes: If a page is part of a process or a transaction, all pages or steps in the process must conform at the specified Success Criterion Level.
- Only Accessibility-Supported Ways of Using Technologies: "Only accessibility-supported ways of using technologies are relied upon to satisfy the success criteria."
- Non-Interference: "If technologies are used in a way that is not accessibility supported, or if they are used in a non-conforming way, then they do not block the ability of users to access the rest of the page."

Therefore, to reach the highest level of conformance (Level AAA), a web page must satisfy all Level A, Level AA and Level AAA Success Criteria (Fig. 1).

What reason why WCAG 2.0 was used as the instrument of this study over WCAG 1.0 is that WCAG 2.0 success criteria gave clearer guidance over WCAG 1.0 checkpoints. Besides, each success criterion is more easily testable by a human expert.

3 Background on e-Government in Saudi Arabia

Saudi Arabia is the largest Information and Communication Technology (ICT) market in the Middle East. According to SAGIA [8], the Saudi telecommunications and information technology industries represent over 55 and 51% of the total Middle East markets. As a result, the government has paid special attention to ICT, both in its periodically updated 5-year development plans and long-term national development plans.

The Internet service became officially available in the Kingdom in 1997. According to Internet World Stats [9], the number of Internet users in the Kingdom has risen exponentially. In March, 2008, there were approximately 6.2 million users and a 22.0% penetration rate, and in September 2007, there were 218,200 broadband connections [9]. It is foreseen that Internet usage will keep growing rapidly as the infrastructure improves, access costs reduce, the population increases, and the 60% of the population comprising teenagers and young adults adapt to the new technologies [10].

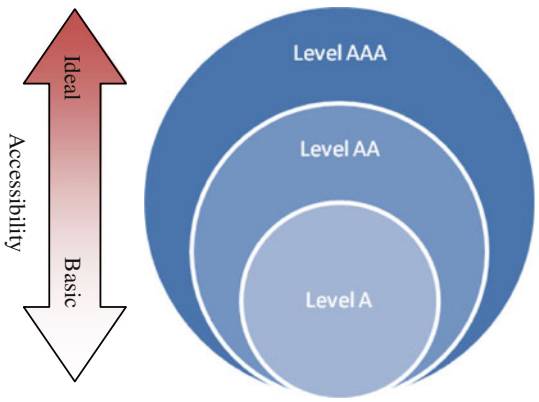


Fig. 1 The level of conformance and their reliance on each other

Saudi Arabia's state of 'e-readiness' is evidenced in developments in e-government. A number of e-government projects have been implemented or are under development. Examples include the e-government portal, e-government network, public key infrastructure (PKI), national smart ID cards, e-Payment gateway (Sadad), Social Insurance System, and electronic information exchange. Also a set of government institutions and agencies have provided some of their services electronically. These include the Ministry of Interior (Fig. 2), Ministry of Foreign Affairs, Ministry of Hajj, Ministry of Labor, Finance, and General Investments Commission.

In 2005, the Ministry of Communications and Information Technology embarked on the e-government program in conjunction with the Ministry of Finance and Communications and Information Technology Commission (CITC). One of the main goals was to develop a governmental portal for services and to work on the presence of the government infrastructure. This program was called 'Yesser'. The key objectives of this program were to raise the public sector's productivity and efficiency, to provide better and more easy-to-use services for individual and business customers, to increase the return on investment (ROI), and to provide the required information in a timely and highly accurate fashion [11].

By 2009, there was 238 governmental Web sites registered with (.gov.sa) according to the Saudi Network Information Center (http://www.nic.net.sa). Only 137 government Web sites were listed on the official e-government portal (http://www.saudi.gov.sa). And around 400 e-services were provided by various governmental entities, categorized as follows:

Economy and business (110)	Training and education (87)	Communication and IT (11)
Personal documents (25)	Health and environment (14)	Transport (6)
Tourism and travel (37)	Utilities (39)	Insurance (4)
Labor and employment (35)	Complaints (61)	
Municipal services (76)	Hajj and Umrah (10)	

Source: saudi.gov.sa

It is worth mentioning that these services are in their initial stages and are still not working together collaboratively.

Fig. 2 The Arabic version of the Ministry of Interior Web site with eServices listed on the *right* and *left* columns (date 20/4/2010)

4 Review of the literature

Over the past few years, many research studies have been carried out to measure the accessibility of government Web sites, particularly in the United States and United Kingdom. The first study for evaluating the accessibility of e-government Web sites can be tracked down to year 2001, when Kurniawan and Zaphiris conducted a study to compare governmental, organizational, educational, and commercial aging/health-related Web sites for their accessibility and usability. They used two automatic evaluation tools, Bobby and LIFT. Their results show that the group of government Web sites has the highest compliance with the W3C WCAG compared to the other types of Web sites [12].

After Kurniawan and Zaphiris study, many studies have appeared to measure and evaluate the accessibility of US state-specific government Web sites, e.g., [11–18]. Consequently, by the end of year 2002, the momentum of measuring the accessibility of government Web sites worldwide has apparently increased.

In this section, an exhaustive list of research conducted for evaluating the accessibility of government Web sites is presented.

4.1 Web accessibility in the United States

The United States was one of the first countries that researched the Web accessibility of their governmental Web sites. In 2002, Andrew Potter examined the accessibility of 67 Alabama government Websites using an automatic evaluation software tool called Bobby. His results indicated that 19% of the evaluated sites passed WCAG 1.0 Conformance Level A, and 16% achieved section 508 approval [13].

One year later, Lazar et al. [14] studied 50 organizational homepages in the Mid-Atlantic region in the United States. The evaluation process relied on manual evaluation using both the U.S. government's Section 508 guidelines as well as WCAG 1.0. The results show that 49 out of 50 homepages were found to have accessibility problems.

Similarly, Jim Ellison in his study, "Assessing the accessibility of fifty United States government Web pages: Using Bobby to check on Uncle Sam", checked 50 homepages of well-known agencies of the Federal government. Using Bobby to evaluate the accessibility of the Web sites, he found that most U.S. government homepages have met the minimum accessibility requirements [15]. Also, Fagan and Fagan examined selected Web pages of 50

US states' legislatures using Bobby. The results show only four states which had no Priority 1 errors [16].

In another study by Loiacono and McCoy entitled "Website accessibility: a cross-sector comparison", they compared the homepages of 100 federal government, non-profit organization (NPO), and corporate Web sites in the United States using the Bobby tool. Their study was conducted to determine the accessibility of the examined Web sites and to compare the Web sites to each other. The results showed that 23% of the federal homepages are significantly more accessible than 11% of NPO and 6% of corporate homepages [17].

Another study looked at the homepages of the states and the District of Columbia. Goette, Collier, and White analyzed the accessibility of 50 homepages of the states and the District of Columbia using Bobby for evaluation. The results show that 29% of the homepages do not meet the requirements for Conformance Level A Web accessibility [18].

Moreover, in a recent study, Lazar et al. used human evaluators utilizing screen readers to evaluate 15 Maryland state government Web sites for accessibility. The results show that 14 out of 15 Web sites violated at least one of the Maryland state guidelines related to Web accessibility [19].

4.2 Web accessibility in Europe

On 24 November 2005 the UK cabinet office produced a report about the accessibility of 436 EU government service Web sites. It found that 97% of official Web sites across the EU are in some way inaccessible for disabled users and 70% failed completely [20].

In the same way, a recent study by Joanne Kuzma with a sample of 130 Web sites of the UK members of Parliament was evaluated using the Truwex tool. The results reveal that 23% Web sites met WCAG level 1.0 and DDA minimum accessibility requirements. However, the results for WCAG level 2.0 was much worse, with only 5% met the minimum requirements [21].

Similarly, Paris surveyed the accessibility of 26 Northern Ireland local council e-government homepages using Bobby. The results indicated that few local councils were adequately usable by people with disabilities [22].

From Greece, Basdekis et al. audit 256 Web sites (which include also government Web sites) in two time periods, 2004 and 2008. The Web sites were evaluated for their conformance to WCAG 1.0 (levels A and AA). The study utilized the Bobby software, the W3C's Markup Validation Service, the Color Contrast Analyser and the WAVE Toolbar. Their results show a 12% increase in the number of inaccessible Web sites in 2008 compared to year 2004; however, the number of partially inaccessible Web sites has decreased by 11% in year 2008, while the Web sites that were highly accessible remained the same [23].

Studies covering not only accessibility of e-government Web sites but also other factors such as findability were the topic of Kopackova, Michalek, and Cejna research. They analyzed 39 local e-government Web sites in the Czech Republic in two testing periods (March 2006 and April 2008) and focused on two perspectives: accessibility and findability. The tools used in their study were HiSoftware Cynthia Says, Fangs (for simulating screen readers), and Web Developer (a Firefox add-on for displaying Web pages on an alternative displaying device). The study results revealed fundamental deficiencies in the local e-government Web sites in the Czech Republic preventing users from finding and displaying the required information [24].

4.3 Web accessibility in Asia and Africa

Web accessibility has also gained recognition in both Asia and some countries in Africa. From china, Yuquan Shi examined the homepage of 324 Chinese local government Websites with reference to Web Content Accessibility Guidelines 1.0 (WCAG) using Bobby. Shi found that Chinese e-government Web sites have failed one or more WCAG 1.0 measures [25].

Likewise, Korea has been working toward achieving Web accessibility standardization for the Korean society through developing the Korean Web Content Accessibility Guideline 1.0 (KWCAG 1.0) [26]. Hyun, Choi and Sukil Kim have evaluated the homepage of 39 government Web sites against KWCAG 1.0. They used the KADO-WAH automatic tool, and they further used manual inspection (by checking the source code) to uncover undetected accessibility issues. Their results show that 97% of the agencies Web sites did not conform to the four major checkpoints of KWCAG 1.0 (which are alt-text, frame title, keyboard access and logical structure) [26].

Bimal Pratap Shah and Subarna Shakya, from Nepal, have examined 27 central government homepages of the government of Nepal. Using Bobby for evaluation, the results show 3.7% of the Websites of the Government of Nepal conform to the levels A and AAA of WCAG 1.0 and only 11.1% conform to the level A [27].

Chen, Chen, and Shao conducted diagnosis on 117 Taiwan governments' Web sites using Bobby and the Freego Validation Software Tool during July and August of 2005. The results show that 35 Web sites passed Priority 1, while 13 Web sites passed Priority 2 and 3 Web sites passed Priority 3 [28].

From Africa, Baguma et al. have examined the practice and perceptions of webmasters in Uganda on the accessibility of government Web sites. By distributing a survey among government webmasters, they found that all

government Web sites were not accessible to users even though 33% of the webmasters were familiar with one or more of the WCAG guidelines [29].

4.4 Cross-country web accessibility research

Cross-country comparative accessibility studies were also present in the literature. For instance, Kuzma, Yen, and Oestreicher analyzed the e-government Web sites of 12 countries in EU, Asia, and Africa to determine their adherence to WCAG 1.0 guidelines. For each country, they picked 6 different federal government agency Web sites and analyzed them using the TAW automated accessibly tool. The findings unfold that the vast majority of the 12 countries government Web sites do not meet WCAG 1.0 checkpoint standards [1].

Another study by Yuquan Shi [30] examined the accessibility of provincial government Web sites in China and state level websites in Australia in two time periods (December 2004 and September 2005). The research examined the accessibility of the homepages of the 30 province-level Chinese government websites and 8 state- or territory-level Australian government websites using Bobby. Moreover, the results show that 29 out of the 30 Chinese e-government homepages had WCAG Priority 1 accessibility errors, while there was only one Australian e-government homepage had WCAG Priority 1 accessibility errors [30].

Similarly, Choudrie et al. have conducted an evaluative study of a cross-section of Singapore, Canada, Finland, Hong Kong, and Australia e-Government portals using Bobby and other automated tools, and the results show that most e-Government portals failed WCAG 1.0 priority 1, 2, and 3 [31].

Hong, Katerattanakul, and Joo used an automated software tool followed by human judgment to evaluate the accessibility of four Korean government and four U.S. government Web sites published in year 2004 and 2007. Their results show that Korean Web sites had two times higher accessibility errors than US government Web sites [32].

Finally, from the Arab region, Saudi Arabia, and Oman e-government Web sites were the theme of Abdulmohsen Abanumy, Ali Al-Badi, and Pam Mayhew paper [33]. They evaluated the Web accessibility of e-Government Web sites of Saudi Arabia and Oman (13 from Saudi Arabia and 14 ministries' sites from Oman) using WCAG 1.0. They used a mix of manual and automated testing using tools such as Bobby, MutliWeb, Lynx, and W3C validator. The findings of their study showed that none of the Saudi Arabia and Oman government Web sites conform to WCAG priority1 checkpoints.

4.5 Summary of Web accessibility research

Most of the previously published studies share similar research techniques for evaluation; these techniques varied between manual, automatic, or combination of both. The guidelines used for evaluation are mostly WCAG 1.0, Section 508 or some variance of them based on the local context. Moreover, the popular automated software tools used were Bobby, TAW, Truwex or other custom made tools. However, most studies evaluated the homepages of a single country or compared the accessibility of multiple countries. What is noteworthy is that the number of evaluated Web sites ranged from 15 up to 350; also some studies were repeated in different time periods.

Building on the previous studies, our study will examine the conformance of the homepages of Saudi Arabia governmental Web sites against WCAG 2.0 and use human evaluation. Clearly, this study will be the first to use WCAG 2.0 to evaluate the accessibility of government Web sites.

5 Research methodology

A website's homepage is considered the entry point for the information and the services a website provides. Choosing to evaluate the homepage of a website will give more indication of the organization and content of a website than any other page. Besides, the homepage is the most important starting point for any website visitor.

Most Saudi government websites provide bilingual homepages (Arabic and English), with almost identical content, services and design. So, it was decided to examine only the Arabic version of the homepages, since the Arabic language is the official spoken and written language for Saudi citizens.

Websites covering different government sectors were selected from the Saudi national e-government portal (http://www.saudi.gov.sa) between March and April 2010. The selection was based on the Web site high-profile, importance and delivery of key services to Saudi citizens, residents, businesses, and visitors at that time.

The Web sites were first visited to check which are functional and which are still under construction. Websites that are not functional from a given sector were removed to ensure that a diverse group of government Web sites was included, covering all possible sectors.

Overall, 36 government Web sites from different sectors were chosen for evaluation (see Table 2). The homepages were evaluated manually for WCAG 2.0 conformance Level A, AA and AAA. Each conformance level has a set of success criteria that are evaluated using a number of sufficient techniques.

Table 2 Listing the number of government Web sites by sector, notice that the most functional Web sites were ministries

Government sector	Number of Web sites
Funds	3
Directorates	3
Ministries	13
Departments	4
Commissions	6
Authorities	7
Total	36

For each homepage, it was noted which accessibility guidelines were violated and the number and type of failed success criteria on each homepage was recorded. No attempt was made to evaluate other than the homepage.

Some tools were used to help in the manual evaluation, such as the WAVE toolbar and the Web developer toolbar. Also, each homepage download time was measured using YSlow Firefox addon.[1] The download time is not an explicit consideration in WCAG 2.0 guidelines; however, such a measure might hinder Web site accessibility for users with slow Internet connection. Besides, the Hyper-Text Markup Language (HTML) code of the homepage was validated using the W3C markup validator to ascertain code compliance with international standards.

All the examinations and evaluations were conducted using Internet Explorer 8 and FireFox 3.6 under Windows Vista and 7.

Automatic evaluation software tools were not used in this study, because existing automated tools for validating WCAG 2.0, such as aChecker, do not accept Arabic Web sites. Moreover, other automated tools are not perfect in detecting WCAG 2.0 accessibility problems due to their immaturity. For instance, the totalvalidator.com service was tried, and the reported number of errors and type of errors were the same for all government Web sites. Given these problems, it was decided to rely only on human intervention to determine WCAG 2.0 accessibility problems.

6 Findings

The validity of a Web site markup code is very important for its accessibility. Most assistive technologies will find difficulties while parsing a miscoded Web site. So the first step we followed was to validate the homepages using the W3C online validator. Figure 3 shows the average number of parsing errors in the different governmental sectors.

[1] http://developer.yahoo.com/yslow.

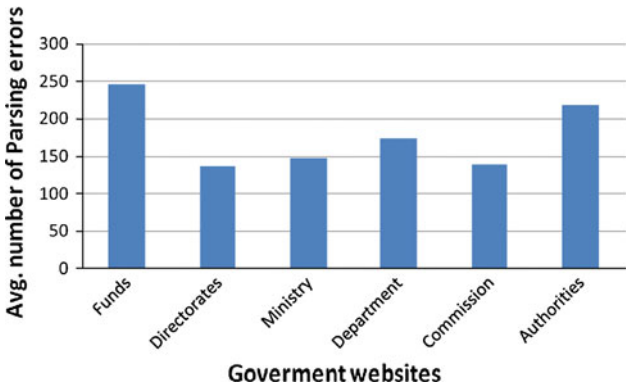


Fig. 3 Different sectors of Saudi government Web sites with corresponding average number of parsing errors

Most parsing errors have appeared in the Funds and Authorities Web sites (e.g., Fig. 4), with 245 and 218 average errors, respectively. Further investigating the types of parsing errors we found that most common problems were HTML elements that do not have proper opening or closing tags, tags that do not close properly, elements that are not properly nested and the use of browser specific elements and attributes which the validator does not recognize (e.g., "marquee" element).

On the other hand, Directorates' Web sites have the least parsing errors (Avg. 137); yet looking into the cause of the errors, it was found that they were similar to the types of errors found in the Funds and Authorities Web sites.

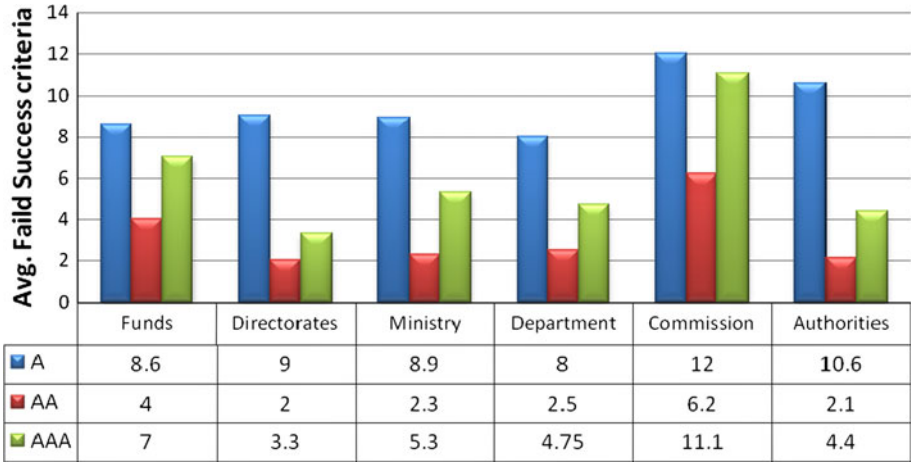
Moreover, measuring the homepage loading time, it was found that Saudi government Web sites have an average loading time of 1.87 s, which is considered reasonable in terms of Web design recommendations.

After evaluating the government Web sites using W3C markup validator, each Web site was manually checked against the WCAG 2.0 success criteria checklist.

Figure 5 shows the average failed success criteria in each category of the government sectors. Commission and Authorities Web sites are the highest in failing Level A conformance. Further inspecting the failed success criteria, it was found that the most failed success criteria include: SC 1.1.1 (missing appropriate Alt Text), SC 1.3.1 (improper use of semantic markups), SC 3.3.2 (missing labels), SC 1.3.2 (No logical reading sequence), SC 2.1.1 (No Keyboard access), SC 2.4.1 (no link is provided to skip navigation), and SC 4.1.1 (Significant HTML/XHTML validation/parsing errors). Furthermore, Department, Ministry, Directorates and Funds Web sites have almost the same failed Level A success criteria, with Department Web sites having the least failed success criteria.

Interestingly, Level AA conformance was the least in the number of errors occurring among all government sectors Web sites, compared to Level A and AAA. This might be attributed to the fact that most government

Fig. 4 The Saudi Railways Web site with key services such as booking and train schedule; however, this Web site has 533 Parsing errors



	Funds	Directorates	Ministry	Department	Commission	Authorities
A	8.6	9	8.9	8	12	10.6
AA	4	2	2.3	2.5	6.2	2.1
AAA	7	3.3	5.3	4.75	11.1	4.4

Fig. 5 WCAG 2.0 Results for the different sectors of Saudi government Web sites

homepages did not include time-based media or forms (i.e. auditory and interaction). It is known that about 38 of Level A and AA success criteria (which counts for 50% from all success criteria) impact the visual, auditory, and interaction design of a Web site [34]. Besides the number of success criteria in Level AA is smaller compared to Level A and AAA (AA SC(13) vs. A SC(25) and AAA SC(23)) [6]. For these reasons, the number of failed success criteria was small.

Failed success criteria in Level AA include: SC 3.1.2 (Language of Parts), SC 1.4.5 (Images of Text), and SC 1.4.4 (Resize text).

Again, in Level AAA conformance the Commission Web sites were the highest in failed success criteria. Also, the Funds Web sites appeared to have the second highest failed success criteria. On the other hand, the Directorates Web sites have the least number of failed success criteria. Some of the failed success criteria include: SC 1.4.6 (Contrast), SC 1.4.9 (Text is used within an image only for decoration), SC 2.4.9 Link Purpose (Link Only), and SC 2.4.10 (Section Headings).

Finally, Table 3 shows the best and the worst government homepage based on the level of conformance. From the results, it is clear that the Commission homepage was the highest in failing the three levels of conformance, which indicates the need for a quick remedy.

Table 3 Best and worst government homepages in terms of level of conformance

	Level A	Level AA	Level AAA
Best	Department	Directorates	Directorates
Worst	Commission	Commission	Commission

7 Discussion

From the previous findings, it is apparent that no single Saudi government Web site has passed the WCAG 2.0 conformance test. The findings also show that most Saudi government homepages, regardless of the sector, suffer from various accessibility issues.

The majority of government Web sites had on average ten or less types of failed success criteria. The average number of Level A failed success criteria for all homepages was higher than that of Level AA and Level AAA combined. This indicates a serious problem in reaching the minimum level of conformance required by any accessible Web site.

The most frequently failed success criterion was 1.1.1 (Non-text Content). Failing to provide text equivalents for non-textual content elements is the most serious problem identified in this study, 100% of all inspected Web sites suffer from this problem. The importance of alternative text lies on its ability to enable visually impaired people to perceive and understand the essence of non-textual content.

The second common and serious failed success criterion was 2.1.1 (No Keyboard access). This success criterion ensures that everything in a Web page is available from the keyboard. Failing to provide easy access to a Web site will affect users with mobile impairments who rely only on the keyboard to operate a Web site.

One repeating design practice in most government homepages is the use of tables for layouts. This in away violets SC 1.3.2 (Meaningful Sequence), where the content can be linearized without missing its logical reading order or/and focus order, which will help in preserving the meaning of the content. Nevertheless, a good practice found on most inspected governmental homepages is that no frames were used for the Web site layout. This good practice will help visually impaired people who are using software that cannot read frames to navigate the Web site easily.

Other common errors include: SC 2.4.1 (no link is provided to skip navigation), SC 4.1.1 (Significant HTML/XHTML validation/parsing errors), and SC 1.4.1, 1.4.3, 2.3.2 (Problems in color contrast and the use of flashes).

Surprisingly, around 30% of the examined homepages are without a <!DOCTYPE> tag. There is only one Web site with 'Strict' doctype, and almost 70% homepages uses 'Transitional' doctype. Correct <!DOCTYPE> tag ensures that the browser interprets the HTML correctly. In addition, the language of most homepages was not identified using the HTML "lang" attribute.

Lastly, 8% of the government homepages' titles were missing (failed SC 2.4.2) besides some Web sites have a few spelling mistakes. Also, it is worth mentioning a final pressing factor that affects indirectly the accessibility of any Web site, which is the page loading time. Using software tools for measuring page loading time, we found that Saudi government Web sites have on average a loading time of 1.87 s. This result indicates that the Saudi government Web sites need to take proper care of their homepage loading time to make sure that citizens with slower Internet access can benefit from the government Web site without any obstacles.

8 Conclusion, limitation and recommendations

Accessibility is considered an important factor in the quality of any Web site. Failing to meet the minimum level of accessibility conformance might hinder many disabled people from benefiting from the services provided by a Web site.

In this study, several accessibility errors that appeared in the sample of the government homepages were also found to be a problem in other surveyed studies. In fact, the study showed that the accessibility of Saudi government Web sites is disregarded and an immediate attention is needed. Besides it is apparent that the lack of awareness about the importance of Web accessibility on the managerial or development level is a key factor of accessibility problems.

Although no single homepage of Saudi government Web sites was found to pass the minimum WCAG 2.0 accessibility guidelines, yet the accessibility problem of the Saudi government Web sites is still underestimated in this research. Other problems might have been found if the study has gone beyond the homepage.

One of the difficulties encountered in evaluating for conformance to WCAG 2.0, was that some success criteria in level AA and AAA were quite harder to test compared to level A success criteria. To give an example success criteria 1.4.3 Contrast (Minimum), which says "*the visual presentation of text and images of text has a contrast ratio of at least 4.5:1*", required supported materials and tools to help in evaluating it. Another encountered problem was that some success criteria have clear and precise values to check (e.g. 1.4.3 Contrast) while others are not (e.g., 4.1.2 Name, Role, Value). Also in some success criteria the provided techniques were not sufficient for evaluation.

Similar to any other exploratory study, this study has certain limitations. The manual evaluation might be subjective and prone to error, so further in-depth research is necessary to uncover other types of accessibility barriers; this requires the evolvement of end user evaluation to reveal further accessibility issues. Moreover, we urge for the development of more automated accessibility software tools for WCAG 2.0.

Undoubtedly, the Saudi government needs to establish a formal Web accessibility laws and guidelines that are

appropriate for their local context or adapt the existing Web accessibility guidelines and oblige for legal enforcement or other additional mechanisms to follow these guidelines.

Finally, generalizing this research finding may be inappropriate. However, it might help in increasing the awareness of the importance of Web accessibility to e-government Websites and to the healthy development of accessible e-government services. A longitudinal study in the near future is also considered, in order to observe the progress of Web accessibility in the Saudi government websites.

References

1. Kuzma, J., Yen, D., Oestreicher, K.: Global e-government web accessibility: an empirical examination of EU, Asian and African Sites. In: Second International Conference on Information and Communication Technologies and Accessibility, Hammamet, Tunisia, pp. 83–90 (2009)
2. UN: Convention & optional protocol signatories & ratification. Available at: http://www.un.org/disabilities/countries.asp?navid=17&pid=166
3. In: Central Department Of Statistics & Information. Available at: http://www.cdsi.gov.sa/pdf/demograph1428.pdf
4. Policies Relating to Web Accessibility. Available at: http://www.w3.org/WAI/Policy/
5. Mitsamarn, N., Gestubtim, W., Junnatas, S.: Web accessibility: a government's effort to promote e-accessibility in Thailand. In : Proceedings of the 1st International Convention on Rehabilitation Engineering & Assistive Technology: in Conjunction with 1st Tan Tock Seng Hospital Neurorehabilitation Meeting, Singapore, pp. 23–27 (2007)
6. W3C: Comparison of WCAG 1.0 Checkpoints to WCAG 2.0, in numerical order. Available at: http://www.w3.org/WAI/WCAG20/from10/comparison/
7. W3C: Understanding Conformance. In: W3C. Available at: http://www.w3.org/TR/UNDERSTANDING-WCAG20/conformance.html
8. SAGIA Available at: http://www.sagia.gov.sa/english
9. In: Stats, Internet World. Available at: http://www.internetworldstats.com/middle.htm \l "sa"
10. Internet.gov Available at: http://www.internet.gov.sa
11. Yesser: Overview of Yesser. Available at: http://www.yesser.gov.sa
12. Kurniawan, S.: Usability and accessibility comparison of governmental, organizational, educational and commercial aging/health related Web sites. In : Proceedings of the 45th annual meeting of the human factors and ergonomics society, Minneapolis, MN, USA, pp. 260–210 (2001)
13. Potter, A.: Accessibility of Alabama government web sites. J. Gov. Inf. **29**, 303–317 (2002)
14. Lazar, J., Beere, P., Green, K.-D., Nagappa, Y.: Web accessibility in the Mid-Atlantic United States: a study of 50 homepages. Univ. Access Inf. Soc. **2003**(2), 331–341 (2003)
15. Ellison, J.: Assessing the accessibility of fifty United States government Web pages: using Bobby to check on Uncle Sam (2004)
16. Fagan, J., Fagan, B.: An accessibility study of state legislative Web sites. Gov. Inform. Q. (21), 65–85 (2004)
17. Loiacono, E., McCoy, S.: Website accessibility: a cross-sector comparison. Univ. Access Inf. Soc. **4**, 393–399 (2006)
18. Goette, T., Collier, C., Daniels, J.: An exploratory study of the accessibility of state government Web sites. Univ. Access Inf. Soc. **5**(1), 41–50 (2006)
19. Lazar, J., Beavan, P., Brown, J., Coffey, D., Nolf, B., Poole, R., Turk, R., Waith, V., Wall, T., Weber, K., Wenger, B.: Investigating the accessibility of state government web sites in Maryland. In : Designing Inclusive Interactions. Springer, London, pp. 69–78 (2010)
20. CabinetOffice: eAccessibility of public sector services in the European Union. Available at: http://www.cabinetoffice.gov.uk/newsroom/news_releases/2005/051124_eaccessibility.aspx
21. Kuzma, J.: Accessibility design issues with UK e-government sites. Gov. Inf. Q. **27**, 141–146 (2010)
22. Paris, M.: Website accessibility: a survey of local e-government websites and legislation in Northern Ireland. Univ. Access Inf. Soc. **4**, 292–299 (2006)
23. Basdekis, I., Klironomos, I., Metaxas, I., Stephanidis, C.: An overview of web accessibility in Greece: a comparative study 2004–2008. Univ. Access Inf. Soc. (2009) (online)
24. Kopackova, H., Michalek, K., Cejna, K.: Accessibility and findability of local e-government websites in the Czech Republic. Univ. Access Inf. Soc. **9**, 51–61 (2010)
25. Shi, Y.: The accessibility of Chinese local government Web sites: An exploratory study. Gov. Inf. Q. (24), 377–403 (2007)
26. Joonho Hyun, D.: Web accessibility compliance of government web sites in Korea. In : Universal Access in HCI, pp. 55–63 (2007)
27. Pratap Shah, B., Shakya, S.: Evaluating the web accessibility of websites of the central government of Nepal. In : Conference on Theory and Practice of Electronic Governance, pp. 447–448 (2007)
28. Chen, Y.-L., Chen, Y.-Y., Shao, M.: Accessibility diagnosis on the government web sites in Taiwan, R.O.C. In : Proceedings of the 2006 International Cross-Disciplinary Workshop On Web accessibility (W4A), pp. 132–142 (2005)
29. Baguma, R., Wanyama, T., Bommel, P., Ogao, P.: Web accessibility in Uganda: a study of Webmaster perceptions. In: Proceedings of the 3rd Annual International Conference on Computing & ICT Research (SREC'07), pp. 183–197 (2007)
30. Shi, Y.: E-government web site accessibility in Australia and china: a longitudinal study. Soc. Sci. Comput. Rev. **24**(3), 378–386 (2006)
31. Choudrie, J., Ghinea, G., Weer, V.: Evaluating global e-government sites: a view using web. Electron. J. e-Gov. (EJEG) **2**(2), 105–114 (2004)
32. Hong, S., Katerattanakul, P., Joo, S.: Evaluating government website accessibility: a comparative study. Int. J. Inf. Technol. Decis. Making (IJITDM) **7**(3), 491–515 (2008)
33. Abanumy, A., Al-Badi, A., Mayhew, P.: e-Government website accessibility: in-depth evaluation of Saudi Arabia and Oman. Electron. J. e-Gov. (EJEG) **3**(3), 99–106 (2005)
34. Reid, L., Snow-Weaver, A.: WCAG 2.0 for designers: beyond screen readers and captions. In Stephanidis, C. (ed.) Universal Access in HCI, pp. 674–682 (2009)
35. 35. Ceaparu, I., Shneiderman, B.: Improving web-based civic information access: a case study of the 50 US states. In: Proceedings of the 2002 International Symposium on Technology and Society (ISTAS'02), pp. 275–285 (2002)
36. 36. Kim, Y., Kang, B., Williams, R.: Measuring public accessibility of Australian Government web pages. In: Buchanan, G.M. (ed.) The 11th International Conference on Asia-Pacific Digital Libraries (ICADL2008), Bali, Indonesia, vol. LNCS 5362, pp. 402–403 (2008)