Procedia Computer Science 27 (2014) pp. 281–291

DOI: 0.1016/j.procs.2014.02.031

Toward an integration of Web accessibility into testing processes

Mary-Luz Sánchez-Gordón[a,] * Lourdes Moreno[a]

[a] *Computer science department,Universidad Carlos III de Madrid, Av. Universidad 30, Leganés 28911,Spain*

Abstract: The goal of this paper is to review the literature in order to understand the implications of accessibility testing processes with the objective to detect potential improvements and developments in the field. Thus, a brief review is presented of the fundamental test processes proposed by the International Software Testing Qualification Board (ISTQB) and the currently available literature about testing processes for evaluating the accessibility of web applications. The result of the review reflects an array of proposals to incorporate accessibility requirements and evaluation tools, but they do not describe a comprehensive testing process at each phase of the development lifecycle of accessible web applications.

Keywords: testing, accessibility, ISTQB, test process.

1. Introduction

Whilst accessibility is widely agreed as an essential requirement for promoting universal access of information, many web sites still fail to provide accessible content. Ensuring to conform to accessibility should be a concern at each phase of the development process and consequently it should be integrated as soon as possible in the lifecycle [1]. Nevertheless, the goal of equal accessibility will not be easy to attain [2]. A way to ensure the achievement of objectives in each phase of the development process is to apply a testing process.

* Corresponding author.
E-mail address: mary_sanchezg@hotmail.com

In fact, testing is an essential activity in software industry because it allows one to control and improve the quality of the software product. Also, a well-qualified staff is necessary to develop tasks in an efficient way [3]. There's no reason to think those same ideas couldn't be employed in creative ways for web applications [4]. The goal of testing Internet-based applications is no different from that of traditional applications. We need to uncover errors in the application before deploying it to the internet. However, compared with traditional software, web applications have many special properties, such as accessibility. Therefore, additional efforts are needed in web testing [5]. The purpose of the present study is to identify if there is a well-defined test process that it ensures the web accessibility development.

This paper is structured as follows: Section 2 gives a brief introduction on web accessibility. Section 3 describes software testing and several software testing certifications. Section 4 presents an overview on ISTQB certification foundation level. In Section 5 we discuss how to integrate accessibility on testing software process, and finally in Section 6, we present the conclusions and future work.

2. Web accessibility

In web environments, the growth in the number and variety of web applications has placed the Web as one of the most important technologies for the development of the so called "Information Society" [6]. Tim Berners Lee, W3C Director and inventor of the World Wide Web, has stated that "*The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect*".

Web accessibility encompasses all disabilities that affect access to the Web, including visual, auditory, physical, speech, cognitive, and neurological disabilities [7]. While access to people with disabilities is the primary focus of web accessibility, it also benefits people without disabilities. Thus, accessible technology is technology that users can adapt to meet their visual, hearing, dexterity, cognitive, and speech needs and interaction preferences [7], [8].

In order to achieve comprehensive web accessibility, a significant number of initiatives, legislation and standards exist which identify problems and suggest new, accessible designs. Among accessibility standards, the World Wide Web Consortium (W3C) along with the Web Accessibility Initiative (WAI) both deserve special mention [9] . The Web Content Accessibility Guidelines (WCAG) [10] are the most important component of the WAI and for which two versions currently exist, namely, WCAG 1.0 and WCAG 2.0. While the former version is still that named in many legislative and regulatory frameworks, in other contexts it has been supplanted by WCAG 2.0 since as early as its publication date as a W3C Recommendation in December of 2008. In the European Union and following Digital Agenda and the standardization mandate 376 [11], [12], WCAG 2.0 is considered the official standard. WCAG 2.0 is also referenced in the legislation of many other countries. Australia, Canada, Hong Kong, Japan and New Zealand, for example, have already adopted WCAG 2.0. Other important WCAG 2.0-based initiatives include BITV 2 [13] in Germany, RGAA [14] in France, AODA [15] in Ontario, JIS X 8341-3 [16] in Japan, UNE 139803 in Spain [17] and Section 508 (29 U.S. Code § 794d) in the United States [18]. The requirement to fulfill the WCAG 2.0 has been finally resolved with the recent appearance of the ISO / IEC DIS 40500 which includes the same content as WCAG 2.0 [19]. This web standard can be extrapolated to other software standards [20], since many of its requirements apply to user interfaces in interactive systems software. Moreover, there are general software standards such as ISO 9241-171:2008 (Guidance on software accessibility) [21] which provides specifications for the design of accessible software. Likewise, ISO 9241-171:2008 covers issues associated with designing accessible software for people with the widest range of physical, sensory and cognitive abilities, including those who are temporarily disabled, and the elderly. Furthermore the British Standards Institute developed BS 8878: 2010 Web Accessibility Code of Practice [22]. According [23] this document provides: "... a framework that allows definition – and measurement – of the process undertaken by organisations to procure an optimally accessible web site, but is at present a copyrighted work and not freely available. In comparison to a purely technical WCAG conformance report, the nature of the data being gathered for measurement means that inevitably the measurement process is longer; but it also provides a richer set of data giving context – and therefore justification – to current levels of accessibility."

Although there are many techniques for supporting the development of accessible web applications, many developers are not aware of them [24] and many organizations do not properly apply them. web developers mostly

were considering accessibility at the end of the development process, often the last "check" before they published the website [25].

While it is true that the incorporation of accessibility criteria in early web development phases may be linked with higher cost predictions and longer development processes, these costs become significantly higher, to the point of rendering the endeavour virtually impracticable, when accessibility is taken into account at later stages [26]. It has been the perception of web developers that methodologies are needed which incorporate web accessibility throughout the entire development process [24].

Understanding that web accessibility is a social issue can help position it within an organization, particularly an organization committed to corporate social responsibility (CSR). Providing an accessible website is one way an organization can demonstrate its commitment to providing equal opportunities [7].

Despite there are a lot of accessibility documentation addressed to assess, it is necessary to develop further training programs and helpful resources to support evaluators such as the documentation provided by the W3C [27], [28]. In this sense, there are papers that highlight the difficulty of non-expert evaluators to know how to test some compliance criteria. It indicates the need to provide more resources for beginners as support material and tools to help and assist them in their processes assessment, and obtain consistent results [29]. Even more, there is a web accessibility knowledge management tool to help beginner evaluators in the assessment accessibility process [30].

3. Software testing

In today's software development industry, software testing is one of the most important processes, because it allows one to ensure the quality of software products [31]. The most visible part of testing is test execution. But to be effective and efficient, test plans should also include time to be spent on planning the test, designing test cases, preparing for execution and evaluating results [32]. Moreover, proper alignment between the testing processes and other processes in the life-cycle is critical for success; this is especially true at key interfaces and hand-offs, such as: Requirements engineering and management, project management, configuration and change management, software development and maintenance, technical support, and technical documentation [33].

Furthermore, software test specialists are required to have communication skills to talk to development engineers to avoid any unwanted defects in quality of products, as well as specific test skills [3], [34]. Finally, from the viewpoint of risk management, it is required to have management skills to consider the influence of inconvenience due to the society in large [34].

Due of lack of professionals in software testing, several organizations that offer certifications have emerged, such as: Global QA, QAI Global Institute and International Software Testing Qualification Board (see Table 1).

Global QA offers certification programs for software testing that will allow professionals to obtain the specialized knowledge needed and be able to close the gap between empirical and studied skills.

QAI Global Institute was established in 1980, the workforce development division of QAI, focuses on creating education and training products and services to address competence development, assessments and professional IT certifications. The Institute conducts industry research, houses the software QA, Testing, Business Analyst and PM Bodies of Knowledge and administers the professional certifications in these domains.

International Software Testing Qualification Board (ISTQB) was founded in November 2002. The ISTQB is an organization that provides a scheme for certifying software testers. This scheme relies on a body of knowledge formed by a syllabus and a glossary. This certification schema considers three levels: foundation level, advanced level and expert level . These syllabuses provide the knowledge that testers require in order to carry out testing activities at different expertise levels, along with the time needed to acquire it.

According to its Website, the ISTQB certification is becoming popular in the global scale, having over 265,000 certifications issued (as of September 2012). As of March 2012, ISTQB consists of 46 member boards worldwide representing more than 70 countries. The Spanish Software Testing Qualification Board (SSTQB) is the Spain national branch of the ISTQB.

Table 1. Software testing certification

Organization	Certifications	Reference
Global QA	GQA for Engineers	http://www.global-qa.com/default.aspx
	GQA for Managers	
	GQA for Architects	
QAI Global Institute	Certified Associate in Software Quality (CASQ)	http://www.qaiglobalinstitute.com/
	Certified Software Quality Analyst (CSQA)	
	Certified Manager of Software Quality (CMSQ)	
	Certified Associate in Software Testing (CAST)	
	Certified Software Tester (CSTE)	
	Certified Manager of Software Testing (CMST)	
	Certified Software Project Manager (CSPM)	
	Certified Associate Business Analyst (CABA)	
	Certified Software Business Analyst (CSBA)	
	Certified Software Process Engineer (CSPE)	
	Certified Quantitative Software Process Engineer (CQSPE)	
ISTQB	Expert Level (CTEL)	http://www.istqb.org/
	Advanced Level (CTAL)	
	Foundation Level (CTFL)	

4. ISTQB

The ISTQB is a world-wide organization widely accepted among practitioners. The ISTQB provides a fundamental test process. It considers aspects that could be integrated into the web application development. The following briefly describes the Foundation Level (CTFL) [32].

4.1. Fundamental test process

The ISTQB syllabus provides a fundamental test process: planning and control; analysis and design; implementation and execution; evaluating exit criteria and reporting; and test closure activities, as depicted in Figure 1. Tailoring these main activities within the context of the system and the project is usually required.

4.1.1. Test planning and control

Test planning is the activity of defining the objectives of testing and the specification of test activities in order to meet the objectives and mission. Test planning takes into account the feedback from monitoring and control activities.

Test control is the ongoing activity of comparing actual progress against the plan, and reporting the status, including gaps.

4.1.2. Test analysis and design

Test analysis and design is the activity during which general testing objectives are transformed into tangible test conditions and test cases.

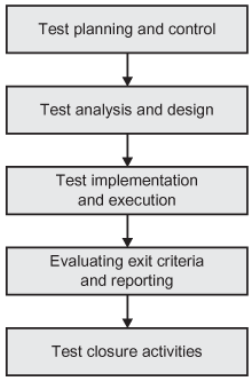

Figure 1. Fundamental Test Process

4.1.3. Test implementation and execution

Tests implementation and execution is the activity where test procedures or scripts are specified by combining the cases in a particular order and including any other information needed for test execution, the environment is set up and the tests are run.

4.1.4. Evaluating Exit Criteria and Reporting

Evaluating exit criteria is the activity where test execution is assessed against the defined objectives. This should be done for each test level (see Section 4.3).

4.1.5. Test closure activities

Test closure activities collect data from completed test activities to consolidate experience, testware, facts and numbers. For instance, these occur at project milestones such as when as software system is released.

4.2. Testing within a life cycle model

Testing does not exist in isolation: test activities are related to software development activities. In any life cycle model, there are several characteristics of good testing:

- For every development activity there is a corresponding testing activity
- Each test level has test objectives specific to that level
- The analysis and design of tests for a given test level should begin during the corresponding development activity
- Testers should be involved in reviewing documents as soon as drafts are available in the development life cycle.

Test levels can be combined or reorganized depending on the nature of the project or the system architecture.

4.3. Test Levels

For each of the test levels, the following can be identified: the generic objectives, the work product(s) being referenced for deriving test cases, the test object, typical defects and failures to be found, test harness requirements and tool support, and specific approaches and responsibilities. Test Levels are component testing, integration testing, system testing and acceptance testing.

4.4. Test Types

A test type is focused on a particular test objective, which could be any of the following: Functional Testing, Non-functional Testing, Structural Testing and Re-testing and Regression Testing. It is the testing of "how" the system works.

Non-functional Testing includes accessibility testing to determine the ease by which users with disabilities can use a component or system.

4.5. Maintenance Testing

The scope of maintenance testing is related to the risk of the change, the size of the existing system and to the size of the change. Depending on the changes, maintenance testing may be done at any or all test levels and for any or all test types. Determining how the existing system may be affected by changes is called impact analysis, and it is used to help decide how much regression testing to do.

Maintenance testing can be difficult if specifications are out of date or missing, or testers with domain knowledge are not available.

4.6. Static techniques

Reviews, static analysis and dynamic testing have the same objective "identifying defects". They are complementary; the different techniques can find different types of defects effectively and efficiently.

Static Techniques rely on the manual examination (reviews) and automated analysis (static analysis) of the code or other project documentation without the execution of the code.

Benefits of reviews include early defect detection and correction, development productivity improvements, reduced development timescales, reduced testing cost and time, lifetime cost reductions, fewer defects and improved communications.

4.7. Test design techniques

The test development process can be done in different ways, from very informal with little or no documentation, to very formal. The purpose of a test design techniques is to identify test conditions, test case and test data. Test design techniques are specification-based or black-box techniques, structure-based or white-box techniques, experience based techniques.

4.8. Tool support for testing

Test tools can be used for one or more activities that support testing. These include:

1. Tools that are directly used in testing such as test execution tools, test data generation tools and result comparison tools.
2. Tools that help in managing the testing processes such as those used to manage test, test results, data, requirements, incidents, defects, etc., and for reporting and monitoring test execution.
3. Tools that are used in reconnaissance, or, in simple terms: exploration (e.g., tools that monitor file activity for an application).
4. Any tool that aids in testing (a spreadsheet is also a test tool in this meaning).

5. ISTQB and Accessibility

5.1. Review of research on Web accessibility

This section describes several studies about research on web accessibility but anyone explicitly discloses a testing process (see Table 2).

Moreno [35] and Greeff et al. [36] proposed methodologies to include Web accessibility. Furthermore Arrue et al. [37] proposed a framework, its basis is the Unified Guidelines Language (UGL). The main components of the framework are the guidelines management tool and the flexible evaluation module. Xiong et al. [1] described the support given by currently available tools for taking care of accessibility at different phases of the development process. To Gunderson [25], the best practices are essentially effective techniques to implement Web accessibility standards like Section 508 or guidelines like the W3C Web Content Accessibility Guidelines. In Section 6 of BS 8878, the British Standards Institute [22] presented the core of the standard. It makes recommendations for accessibility being addressed across a 16 Step Model of the web product development and maintenance process. Section 8 of BS 8878 treats assurance of accessibility not as something achieved by testing towards the end of the development phase, but as requirements gathering and a series of testing made throughout the life-cycle of the product. It makes recommendations for: gathering requirements from disabled users; creating an accessibility test plan; accessibility testing methods; post-launch programme of accessibility testing. It should be noted that BS 8878 makes no direct reference to accessibility metrics [38].

Thatcher et al. [7] and Grieves et al. [8] were intended to be an introduction to create accessible software products. Grieves et al. [8] also presented how to map out the logical hierarchy for one product and plan for implementation using UI Automation (UIA), Microsoft's accessibility API. Finally, Moreno et al. [2] described applications, standards, and tools that increase accessibility.

Torkey et al. [5] described a testing methodology for web applications. The web application components decompose into many components like images, links, text, etc. Then the process of testing become first testing each component of the applications and records the result of testing. This methodology is cost-effective, maintainable, and user friendly because it improves the total quality for performance testing of web applications. Bailey et al. [30] described the design and development of a web accessibility knowledge management tool, which was designed to assist novice auditors in the process of an accessibility evaluation. Brajnik [39] reviewed and discussed several evaluation methods, then he presented a simple taxonomy, and differences that occur when evaluating accessibility rather than usability are pinpointed. Moreover, Freire et al. [6] presented a systematic review that indicate a growth in research on techniques for design and evaluation of web applications, they also indicate that several development activities have been poorly addressed by scientific research efforts. Finally, W3C [28] described one possible approach for evaluating the conformance of existing websites to the Web Content Accessibility Guidelines (WCAG) 2.0.

Table 2. Types of studies in research on web accessibility

Types of study	Surveys
Development methodology	[35], [36], [37], [1], [25], [38]
Accessible technologies	[8], [7] , [2]
Evaluation methods	[5] , [30], [39], [6], [28]

On one hand, some proposals to incorporate accessibility requirements and accessibility evaluation methods and tools; however these do not describe explicitly the testing processes, which ensure the verification and validation of the integration of Web accessibility. On the other hand, accessibility test is only mentioned in the ISTQB glossary and it does not explain how to integrate accessibility testing. Consequently, there is a gap between them.

5.2. Test process on the requirements phase of accessibility development lifecycle

Due to the scope of this paper, a proof of concept for the test process (Figure 1) has been developed for the requirements phase of Accessibility Development Lifecycle proposed by Microsoft (see Figure 2) [8].

The accessibility development lifecycle defines how accessibility fits into each stage of the development cycle—requirements, design, implementation, verification, and release. However this model could be adapted to another development cycle. Figure 2 provides a comprehensive view of a traditional software development cycle proposed by Microsoft and activities to incorporate accessibility into some product.

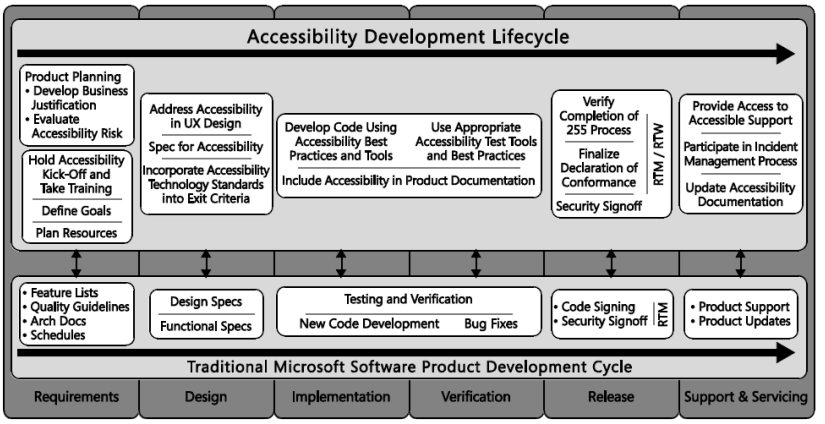

Figure 2. Accessibility Development Lifecycle proposed by Microsoft [8]

5.2.1. Requirements stage

There are many reasons to incorporate accessibility into the product, for instance: to create software that's accessible for a loved one, a hope to sell a product to the U.S. government, to expand your market base, several company or the law requires it, or the desire to do things right. When you decide to create a new product or update an existing one, you should know whether you will incorporate accessibility into your product.

According to [8], once you have set your requirements, you could generate personas that exemplify users of varying types of abilities. Create scenarios to determine what design features will delight and assist your users, and illustrate how your users will accomplish tasks with your product. Then, prioritize your features, and make sure that all users can complete your use cases. Beware of blanks in your specifications; the goal is to ensure that your product will be usable by people of varying abilities.

5.2.2. Test process proposed

The following describes the test process proposed to include technology accessibility standards within the requirement stages of the development lifecycle (see Figure 3). Note that the test plan should be considered as another element in the development lifecycle such as "Feature List". Thereby, the test process proposed is also closely related with the accessibility development lifecycle, which it is shown below.

- Planning and Control imply preparing the test to incorporate technology accessibility standards. Accordingly, in this phase, a test strategy is reviewed.
- Analysis and design suggest deciding what should be automated, to what degree and how the accessibility technology standards are incorporated into exit criteria.
- Implementation and execution mean creating the test specification to accessibility technology standards.
- Evaluating exit criteria and reporting imply the verification and validation of the incorporation of accessibility technology standards within the plan.

- Test closure activities involve the execution of test summary reports based on the information gathered during testing and lessons learned.

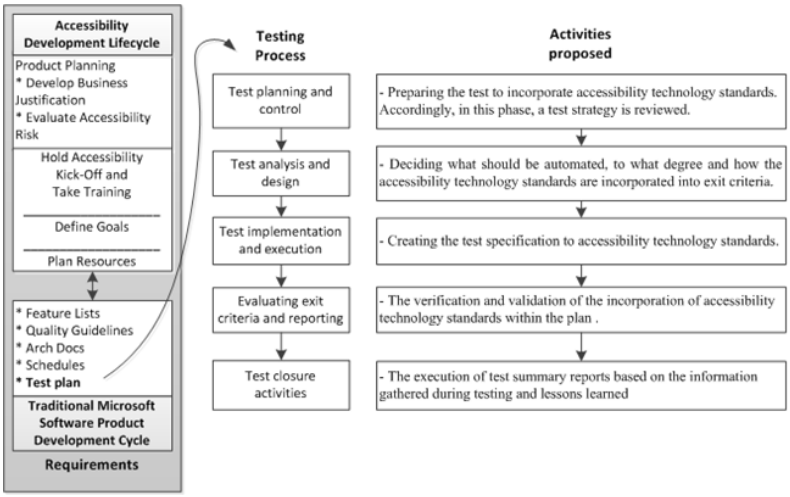

Figure 3. Test process proposed

Some activities may be seen obvious to be carried out by many development teams; however, testing processes should be created to ensure that they have been executed and controlled with in order to obtain the desired results as are expected. Therefore, it is necessary to define each test process activity according to the activities of the development cycle in order to achieve better product quality.

6. Conclusions

This study recognizes that retrofitting the product for accessibility can be extremely costly and sometimes impossible because part of the accessibility development requires attention at the early stages of the development lifecycle models. Furthermore, different development lifecycle models need contrasting approaches to test Web accessibility. Today most people in the software business agree that testing is important, but there is still a very diverse understanding of what testing is all about and what its value is. Hence, testing is always done differently in different contexts and domain expertise is important in software testing because the person who has domain knowledge can test the application better than others. Thus, accessibility and testing should be integrated from the beginning of the product development cycle, when the application or product is in the planning or design phase.

The panorama obtained from this study is key to guide further research about test processes on web accessibility beyond evaluations tools and assistive technology such as BS 8878 has done. However, it is still necessary that researchers clearly and explicitly set the testing processes for better support practitioners because a well-defined test process is necessary to assure required quality and accessibility within any development lifecycle.

For the following steps, it is intended to carry out a review on other certifications. Another line of research could be identifying technical competences for testing teams on Web accessibility.

Acknowledgements

This research work is supported by the Research Network MAVIR (S2009/TIC-1542) and MULTIMEDICA project (TIN2010-20644-C03-01).

References

[1] J. Xiong, C. Farenc, and M. Winckler, "Analyzing tool support for inspecting accessibility guidelines during the development process of web sites," in *Web Information Systems Engineering – WISE 2007 Workshops*, M. Weske, M.-S. Hacid, and C. Godart, Eds. Springer Berlin Heidelberg, 2007, pp. 470–480.

[2] L. Moreno, P. Martinez, B. Ruiz, and A. Iglesias, "Toward an Equal Opportunity Web: Applications, Standards, and Tools that Increase Accessibility," *Computer*, vol. 44, no. 5, pp. 18–26, May 2011.

[3] J. Saldaña-Ramos, a. Sanz-Esteban, J. García-Guzmán, and a. Amescua, "Design of a competence model for testing teams," *IET Software*, vol. 6, no. 5, p. 405, 2012.

[4] G. Goth, "'Googling' Test Practices?," *IEEE Software*, pp. 92–94, 2007.

[5] F. a Torkey, A. Keshk, T. Hamza, and A. Ibrahim, "A new methodology for Web testing," *2007 ITI 5th International Conference on Information and Communications Technology*, pp. 77–83, 2007.

[6] A. P. Freire, R. Goularte, and R. P. de Mattos Fortes, "Techniques for developing more accessible web applications," in *Proceedings of the 25th annual ACM international conference on Design of communication - SIGDOC '07*, 2007, p. 162.

[7] J. Thatcher, M. R. Burks, C. Heilmann, S. L. Henry, A. Kirkpatrick, P. H. Lauke, B. Lawson, B. Regan, R. Rutter, M. Urban, and C. D. Waddell, *Web accessibility: Web standards and regulatory compliance*. friends of ED, 2006, p. 696.

[8] J. Grieves and M. Kaneko, *Engineering Software for Accessibility*. Redmond, Washington: Microsoft Press, 2009, p. 98.

[9] W3C, "Web Accessibility Initiative (WAI).," 2011. [Online]. Available: http://www.w3.org/WAI/.

[10] W3C, "WAI," *Web Content Accessibility Guidelines (WCAG) Overview*, 2012. [Online]. Available: http://www.w3.org/WAI/intro/wcag.php.

[11] C. J. W. G. M. 376, "European Accessibility Requirements for Public Procurement of Products and Services in the ICT Domain (European Commission Standardization Mandate M 376, Phase 2)." [Online]. Available: http://www.mandate376.eu/.

[12] E. Commission, "Europe's Digital Agenda, Web Accessibility." [Online]. Available: http://ec.europa.eu/ipg/standards/accessibility/index_en.htm.

[13] "Bundesministerium der Justiz (BMJ)," *Barrierefreie Informationstechnik-Verordnung. (BITV) 2.0*, 2011. [Online]. Available: http://www.gesetze-im-internet.de/bitv_2_0/index.html.

[14] "Référentiel Général d'Accessibilité pour les Administrations (RGAA)," *Le portail de la modernisation de l'Etat*. [Online]. Available: http://www.references.modernisation.gouv.fr/rgaa-accessibilite.

[15] "Ontario- e-Laws," *Integrated Accessibility Standards made under the "Ontario Regulation 191/11" (Accessibility for Ontarians With Disabilities Act, 2005), June 7, 2011, Ontario.ca.* [Online]. Available: http://www.elaws.gov.on.ca/html/source/regs/english/2011/elaws_src_regs_r11191_e.htm.

[16] "INSTAC (Information Technology Research and Standardization Center, JAPAN)," *JIS X 8341-3 Web Accessibility International Standards Research Working Group*. [Online]. Available: http://waic.jp/docs/jis2010- understanding/.

[17] Aenor, "UNE 139803:2012, Web content accessibility requirements." [Online]. Available: http://www.aenor.es/aenor/normas/normas/fichanorma.asp?tipo=N&codigo=N0049614.

[18] "Section 508 of Rehabilitation Act." [Online]. Available: http://www.section508.gov/.

[19] ISO, "ISO/IEC 40500:2012. Information technology : W3C Web Content Accessibility Guidelines (WCAG) 2.0." [Online]. Available: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=58625.

[20] "Guidance on Applying WCAG 2.0 to Non-Web Information and Communications Technologies (WCAG2ICT) W3C Working Draft 11 July 2013." [Online]. Available: http://www.w3.org/TR/wcag2ict/.

[21] ISO, "ISO 9241-171:2008 - Ergonomics of human-system interaction -- Part 171: Guidance on software accessibility." [Online]. Available: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39080.

[22] British Standards International, "BS 8878," 2010. [Online]. Available: https://www.access8878.co.uk/.

[23] D. Sloan and B. Kelly, "Web Accessibility Metrics For A Post Digital World," in *RDWG Symposium on Website Accessibility Metrics*, 2011.

[24] J. Lazar, A. Dudley-Sponaugle, and K.-D. Greenidge, "Improving web accessibility: a study of webmaster perceptions," *Computers in Human Behavior*, vol. 20, no. 2, pp. 269–288, Mar. 2004.

[25] J. Gunderson, "Functional Accessibility Testing Using Best Practices," in *Universal Access in Human-Computer Interaction. Addressing Diversity5th International Conference, UAHCI 2009, Held as Part of HCI International 2009*, vol. 5614, C. Stephanidis, Ed. Springer Berlin Heidelberg, 2009, pp. 506–514.

[26] L. Moreno, F. Valverde, and O. Pastor, "Supporting accessibility in Web engineering methods: a methodological approach," *Journal of Web Engineering*, vol. 12, no. 3, pp. 181–202, 2013.

[27] W3C, "Accessibility Evaluation Resources." [Online]. Available: http://www.w3.org/WAI/eval/.

[28] W3C, "Website Accessibility Conformance Evaluation Methodology (WCAG-EM) 1.0 W3C Working Draft 26 February 2013." [Online]. Available: http://www.w3.org/TR/WCAG-EM/ .

[29] F. Alonso, J. L. Fuertes, Á. L. González, and L. Martínez, "On the testability of WCAG 2.0 for beginners," in *Proceedings of the 2010 International Cross Disciplinary Conference on Web Accessibility (W4A) - W4A '10*, 2010.

[30] C. Bailey and E. Pearson, "Development and trial of an educational tool to support the accessibility evaluation process," in *Proceedings of the International Cross-Disciplinary Conference on Web Accessibility - W4A '11*, 2011.

[31] D. Jeya Mala, V. Mohan, and M. Kamalapriya, "Automated software test optimisation framework – an artificial bee colony optimisation-based approach," *IET Software*, vol. 4, no. 5, p. 334, 2010.

[32] T. Müller, D. Friedenberg, and ISTQB WG Foundation Level, "Certified Tester: Foundation Level Syllabus." ISTQB, p. 76, 2011.

[33] R. Black, *Advanced Software Testing - Vol. 2*. Rocky Nook, 2008, p. 200.

[34] T. Kurokawa and M. Shinagawa, "Technical trends and challenges of software testing," *Science & Technology Trends*, vol. 10, pp. 34–45, 2008.

[35] L. Moreno, "AWA, Methodological Framework in the Accessibility Domain for Web Application Development," Universidad Carlos III de Madrid, 2010.
[36] M. Greeff, P. O. Box, and P. Kotzé, "A Lightweight Methodology to Improve Web Accessibility," pp. 30–39, 2009.
[37] M. Arrue, M. Vigo, and J. Abascal, "Including Heterogeneous Web Accessibility Guidelines in the Development Process," pp. 620–637, 2008.
[38] M. Cooper, D. Sloan, B. Kelly, and S. Lewthwaite, "A challenge to web accessibility metrics and guidelines," in *Proceedings of the International Cross-Disciplinary Conference on Web Accessibility - W4A '12*, 2012, p. 1.
[39] G. Brajnik, "Beyond conformance: the role of accessibility evaluation methods," in *Web Information Systems Engineering – WISE 2008 Workshops*, 2008, pp. 63–80.