

Web Accessibility of Mobile and Desktop Representations

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This paper presents an experimental study designed to understand the accessibility differences between the desktop and mobile representations of a Web page. We performed an automatic evaluation of both representations of the home pages of 474 Web sites, using the QualWeb evaluator. We also categorized the pages according to their building methodology to understand its impact on the accessibility quality. The results show that, even if there are differences in the pages of the two delivery contexts, there are no substantial differences in the accessibility quality between both representations. An interesting result emerged when looking specifically at the building methodology of the pages. Mobile representations have better accessibility quality when developed following the non-dedicated pages building methodology. Looking at the problems of each building methodology, we were able to suggest accessibility improvements to developers/designers of Web pages.

Mobile devices, Mobile accessibility, Web accessibility, Automated evaluation, Web page building methodology.

1. INTRODUCTION

“About 15% of the world’s population lives with some form of disability” (World Health Organization 2011). It is not surprising that designing for people with disabilities has become a very important topic (World Health Organization 2011). To support and maintain this idea, several countries have enforced laws and created projects or initiatives concerning the accessibility of Web sites (European Commission 2010). As a result, accessibility is an extra factor to be taken into account in Web sites development.

Mobile devices have been changing the way users interact with and access the Web. A shift has occurred from the use of desktop and laptop computers to mobile devices. These are currently the most used equipment to access the Web in many parts of the world (Johnson and Seeling 2013). This shift brought new challenges for Web designers and developers. Pages developed for desktop devices became frequently unusable in most mobile equipment. New pages needed to be created or old pages adjusted to fit the new requirements.

Notwithstanding, mobile devices provide great opportunities for people with disabilities (W3C WAI Research and Development Working Group 2012). For instance: vibration to facilitate blind interaction,

and the usage of incorporated screen readers, etc. Therefore, it is mandatory to understand how mobile Web pages score on accessibility, because some of the pages used in desktop version are also used in the mobile counterpart (Kane et al. 2009). But are developers forgetting the accessibility requirements when developing for mobile? Has the simplification of mobile pages an effect over their accessibility quality (Nielsen 2012; Johansson 2013)? Answers to these questions could guide developers; or define trends in accessible building methods; or even shift definitively the use to mobile representations whether or not a mobile device was used.

This paper focuses on comparing Web accessibility of mobile and desktop Web representations. We performed accessibility evaluations on 474 homepages from Alexa Top 500¹, using the QualWeb evaluator (Fernandes et al. 2012). Since this tool is able to evaluate pages after browser processing, it was possible to cope with client scripting thus rendering more accurate outcomes.

2. RELATED WORK

Developing Web pages with mobile devices as targets is not an easy task (Nielsen 2012). They should accommodate the mobile device requirements and

¹<http://www.alexa.com/topsites>

diversity and the cost of developing pages completely different from the desktop counterpart carries serious maintenance and synchronization problems. Recently some orientations to cope with mobile representations have been put forward (Nielsen 2012; Johansson 2013). For example: redirect mobile users from desktop Web site to the mobile version (if available); offer a clear link to mobile and other for desktop to allow easy access to both; provide links to the desktop page, so users can access complete information if required.

Based on these orientations, three main methods to building mobile-optimized Web sites have been proposed (Johansson 2013):

- **Dedicated Mobile site** – uses a separate mobile site; synchronization between mobile and desktop versions is hard and usually requires an adequate development environment to be effective.
- **Responsive Web Design (RWD)** – uses CSS queries to adapt page layout taking into consideration the screen area and other features; normally uses a unique HTML source and often also CSS and javascript client technologies; adaptation occurs mainly in the client side.
- **Responsive Web design with server-side components (RESS)** – specific CSS and HTML for different mobile devices (same URL); adaptation is mostly decided in the server that responds with the adequate client code; often includes different CSS files for each delivery context.

It is very difficult to distinguish pages developed with *RWD* and *RESS* (Podjarny 2014). This leads us to only consider dedicated and non-dedicated pages in our study. Non-dedicated pages, includes pages developed with *Responsive Web Design* and *RESS*.

Johnson and Seeling (2013) performed one of the first studies comparing desktop and their correspondent mobile Web pages/representations. The goal was to compare the pages over time. They observed that: 1) desktop pages request significantly more objects when the page is accessed by the first time; 2) the average page size is higher for desktop Web pages; and 3) the major contributions of page components in both delivery contexts are images and javascript content. However, no analysis was made about the accessibility of the pages.

2.1. Accessibility of the Mobile Web

Regarding the mobile delivery context there is not a universally accepted guidelines standard (W3C WAI Research and Development Working Group 2012). Nevertheless, Mobile Web Best Practices (MWBP) (Rabin and McCathieNevile 2008) and

Web Content Accessibility Guidelines (WCAG) 2.0 (Cooper et al. 2010) certainly have to be taken into consideration. The first establishes the best practices for delivering Web content to mobile devices. The latter provides orientation for web accessibility evaluation and can help develop mobile “user-friendly” Web pages (Harper and Yesilada 2008). The relation between MWBP and WCAG has been established (Yesilada and Chuter 2009) revealing a fair level of overlapping.

2.2. Accessibility Evaluation of the Web

Web accessibility evaluation is an assessment procedure to analyse how well the Web can be used by people with disabilities (Harper and Yesilada 2008). Using Web accessibility guidelines is a way to perform that evaluation. It can be carried out by experts or be automated through specific software applications that implement (part of) those guidelines. The major benefits of the later are scalability and objectivity (Lopes and Carrico 2010). The advantages of the first are accuracy. User studies are also a common means to assess accessibility. However, they are usually costly and often limited on scope and coverage. We will focus on guidelines and on the automated process for scalability purposes. Nevertheless, researchers argue the usage of automation and the guidelines itself, some also encourage the usage of automatic and manual evaluations (Power et al. 2012; Vigo et al. 2013).

Guidelines mostly address user presentation and interaction features, which are, naturally, the most relevant issues for users and user’s access. If we consider the building methods, it is clear that coping with responsive web designed sites implies considering rich internet applications and substantial client processing. The final look and feel of this kind of pages is rendered by the browser mostly at the end of the processing pipeline. The presented content can be considerably different from the initially loaded by the browser.

Most of the current automated evaluators² work on the source or on server delivered code, before browser processing. Only recently some tools emerged that address the code after browser processing (Fernandes et al. 2012). To our knowledge QualWeb (Fernandes et al. 2012), is the only one that does so, while considering WCAG 2.0.

Regarding the mobile specificity, some tools have been proposed that usually consider MWBP³. None of them provides evaluation mechanisms for fully rendered pages.

²<http://www.w3.org/WAI/ER/tools/complete>

³<http://www.w3.org/WAI/mobile/>

3. EXPERIMENTAL STUDY

We devised an experimental study to compare the accessibility of mobile and desktop representations of Web pages. The following hypothesis were defined:

- H1** Mobile representations are more accessible than their desktop counterparts.
- H2** The relative accessibility of mobile and desktop representations is influenced by the building method.
- H3** The accessibility of mobile representations is influenced by the building method.

H1 is suggested by the fact that mobile representations tend to be simpler than their desktop counterparts (Nielsen 2012). Moreover, if developers follow the W3C recommendations for mobile Web pages then they will try to comply with MWBP. Since MWBP overlaps with WCAG (Yesilada and Chuter 2009), some WCAG guidelines will also be respected. Therefore, we can expect that mobile representations have less accessibility violations.

The remaining hypotheses are a consequence of the web design methodology implications. The design methodology used may result in the creation of a completely new page for the mobile platform or in the adaptation of a pre-existing one to the mobile device used (Johansson 2013). We expect that this will lead to different accessibility scores. This might impact the relative accessibility of desktop and mobile pages when comparing dedicated and non-dedicated strategies (**H2**), but also the accessibility of the mobile pages that result from the two building methods (**H3**).

3.1. Setup and Procedure

The study held the following steps:

1. **Site and page selection:** we picked the 500 most used Web sites from Alexa Top 500 (in March 2013); from those we were able to perform 474 evaluations in both contexts. In the other 26 pages we were not able to obtain the mobile version, because it was necessary to generate cookies to obtain it (not only changing user agent).
2. **Javascript redirection:** identification of the final URL of the pages which executes javascript redirection.
3. **Web accessibility evaluation:** the evaluation of both delivery contexts was performed in sequence. QualWeb was upgraded to allow page requests simulating mobile delivery

contexts (changing the user agent of the requested pages to a mobile user agent).

4. **Building method analysis:** comparing the URL of the mobile and desktop representations, we verified if the page has a mobile specific URL. Based on this, we divided the pages in two sets of dedicated and non-dedicated pages. For the non-dedicated pages set, we further explored if the page content for desktop and mobile representations was the same (same page set) or not (dynamically altered pages set). When the URLs were the same (non-dedicated), but the pages present different number of elements, the page suffered adaptation to its mobile version (dynamically altered pages).
5. **Data analysis:** Metrics were applied and different factors were considered.
6. **Sample validation:** A sample of the most relevant results, covering specific WCAG techniques, representations and building method results were double checked manually by expert re-evaluation of the pages.

3.2. Data Acquisition

Applying the building method analysis described above, we obtained the building method of the 474 pages. We manually inspected 30 pages and verified that the building-method automatically assigned was correct. The distribution of the pages was the following: 32% of the pages have *dedicated mobile* pages (154 pages); 48% of the pages are non-dedicated pages similar for both contexts (226 pages); 20% of the pages are non-dedicated pages dynamically altered (94 pages).

Table 1 summarizes the number of elements per delivery context, considering the design methodologies used. The pages present more elements in the desktop delivery context. The only, obvious, exception is the non-dedicated same pages category. In the mobile delivery context, dedicated pages present the lowest number of elements and dynamically altered pages the highest.

3.3. Accessibility Analysis

Accessibility results are presented in terms of *pass*, *warning* and *fail*. A *pass* or a *fail* occurs if the element verified by the technique is in agreement or disagreement with the W3C recommendations for the technique, respectively. A *warning* occurs if it is not possible to identify certain characteristics of an element as right or wrong, without the need of an expert intervention.

Regarding the accessibility metric, we adopted the strict rate proposed by Lopes and Carrico (2010).

Table 1: Element count average per delivery context and design methodology.

Design Methodology	Element Count (average)	
	Mobile	Desktop
All methodologies	800.63 (sd= 944.55)	1328.41 (sd=1426.88)
Dedicated Pages	539.92 (sd=633.80)	1741.91 (sd=16820.43)
Non-dedicated Pages	926.10 (sd=1038.83)	1129.41 (sd=1241.81)
Same pages	848.16 (sd=894.41)	847.33 (sd=894.33)
Dynamically altered pages	1113.49 (sd=1309.96)	1807.61 (sd=1642.17)

This metric was used in previous accessibility studies, and it can be used as comparison between our vectors. The strict rate is defined as: $Rate_{strict} = pass / (pass + fail)$

3.3.1. Evaluation Outcomes

Table 2 reports the average percentage scores of the metric per delivery context. The results, independent of the building methodology, are similar and no statistical differences were verified.

To better characterize this result, we analysed the results per delivery context of the 474 evaluated pages, using the strict metric: 163 pages denoted better accessibility quality for the desktop representation (34% of the pages). For better mobile representations we found 282 pages (59% of the pages). The remainder had similar scores.

For the comparative analysis of the quality of the pages, we subjected the results to the Shapiro-Wilk test of normality. Taking in consideration the normality of the data, comparisons between two groups were performed using paired t-tests. Only to compare mobile dedicated and non-dedicated pages was used a unpaired t-test, because there are no matches between the groups.

3.3.2. Evaluation Outcomes by Building Method

Table 2 presents the metric scores per building method. *Dedicated pages* present worst accessibility quality for mobile representation and Dynamically altered pages present better quality for mobile representation. The other cases present the same quality. There was a significant difference for mobile dedicated (M=8%, SD=11%) and desktop dedicated (M=12%, SD=14%) pages; $t(153)=-3.04$, $p=0.00277$. However, there was no significant difference for mobile and desktop dynamically altered pages. Consequently, dedicated mobile pages are less accessible than its desktop counterpart. We found a significant difference between mobile dedicated (M=8%, SD=11%) and mobile non-dedicated pages (M=13%, SD=15%); $t(394.11)=-3.77$, $p=0.00018$. There was no significant difference for the corresponding desktop pages. In consequence, mobile

non-dedicated pages are more accessible than dedicated, but the same is not true for desktop pages.

In the following analysis, we will not consider the pages with the same representation for desktop and mobile delivery context (same pages in Table 2). We do this because, being the same pages, they present the same quality and problems.

3.3.3. Distribution of Fails

To understand the distribution of the problems by delivery context and by building methodology, we analysed the number of fails per element. The fails represent the problems that disabled users can encounter and the number of elements the quantity of the information of the page. Table 2 shows this data for dedicated and dynamically altered pages, respectively. In both cases the mobile context present higher number of fails per element.

Significant differences were detected for mobile (M=0.18, SD=0.09) and desktop (M=0.13, SD=0.06) dedicated pages; $t(153)=7.23$, $p=2.06e^{-11}$. This confirms that mobile dedicated pages have more problems per element, consistent with less accessible pages than its desktop counterpart. No statistical significance was found for dynamically altered pages, despite mobile dedicated pages presenting higher average value of fails per elements.

To verify the origin of those problems, we analysed the accessibility techniques applied for each delivery context. We conclude that more types of problems were identified for the desktop representation. For mobile dedicated pages, the data shows that HTML techniques with lower failure rates consider: presence of textual descriptions; and structural problems of *embed* and *noembed* no longer detect problems. Manual inspections were performed, to understand the causes of this facts. We verified that those elements were not present on the mobile dedicated version of the pages.

For mobile dynamically altered pages, HTML techniques with lower failure rates consider: correct definition of the *title* of the page; correct structure

Table 2: Summary of average percentage scores per delivery context and for design methodology; and number of fails per number of elements.

Design Methodology	Strict Metric (avg %)		Nr. fails / Nr. elements (avg)	
	Mobile	Desktop	Mobile	Desktop
All methodologies	12% (sd=14%)	13% (sd=15%)	-	-
Dedicated Pages	8% (sd =11%)	12% (sd=14%)	0.18 (sd =0.09)	0.13 (sd=0.06)
Non-dedicated Pages	13% (sd=15%)	13% (sd=15%)	-	-
Same pages	14% (sd=17%)	14% (sd=17%)	-	-
Dynamically altered pages	11% (sd=12%)	9% (sd=10%)	0.15 (sd=0.07)	0.13 (sd=0.07)

of *object* and its textual descriptions. For instance in *title case*, we confirmed that for some desktop pages with its correct usage, its correspondent mobile representation did not use it, or put *title* elements empty.

Techniques which present more problems are common in all methodologies, but are especially high for mobile dedicated pages: correct usage of *forms* and forms components, correction of the *meta-refresh*, textual descriptions in links and images. In dynamically altered pages, the more expressive increase was verified in the *meta-refresh* fields. This may be correlated with the dynamic of the pages. In some cases parts of the elements of meta-refresh disappear.

4. DISCUSSION

The outcomes of our experimental study on the evaluation of Web accessibility of mobile and desktop delivery contexts led us to make some considerations about our hypothesis.

4.1. Impact on Web accessibility

The results of the strict metric revealed very similar levels of accessibility problems in both desktop and mobile contexts, when design methodologies were not considered. In part, we refuted *H1* showing that mobile dedicated pages are less accessible than their desktop counterparts. However, we are able to sustain that mobile non-dedicated pages have better quality than dedicated ones (*H3*); and that relative accessibility of mobile and desktop representations change when considering building method (*H2*).

This means that we were not able to confirm that mobile representations are more accessible in general, which prompts us to, in the future, perform a deeper analysis of the reasons for this result. Nevertheless, we can suggest, albeit preliminary, some possible reasons:

- mobile specific accessibility issues are not considered when developing mobile versions of Web sites, and developers take only into account the same accessibility solutions that they are familiar with from desktop sites development;
- mobile versions are often reduced versions of their desktop counterparts, which may lead to a proportional decrease of the accessibility issues in the mobile version, ending with similar levels of accessibility problems in both versions;
- independently of the building method employed, it must be expected that code will be reused between desktop and mobile pages, meaning that accessibility problems that are solved in one context, get solved in the other context as well.

4.2. Impact on Designing Web pages

Our results provide evidence that the building method chosen to deploy sites in both contexts does impact the accessibility quality of the sites.

Interestingly, we found that some methods result in Web sites with higher accessibility on the desktop, while other have mobile versions with higher accessibility. However, we were able to identify the more accessible mobile design methodology (i.e., dynamically altered pages, as we called it).

Having sites with dedicated versions for mobile and desktop, seems to currently translate to lesser accessibility on mobile, as larger differences between mobile and desktop pages were identified (*H2*). This might be linked to the first point presented above, that is, developers have less experience in designing accessible mobile Web sites than they have designing their desktop counterparts.

Having the same code base being adapted on the client device (non-dedicated pages) seems to result in mobile versions with higher accessibility than dedicated mobile pages. This might be the result of having lesser content displayed in the mobile rendering of the page, which is a frequent result of the adaptation performed in responsive designs.

In the future, we plan to inspect more deeply these results, if possible, by looking at the different development frameworks used when building a Web site with the different methodologies, and their accessibility concerns.

The observation of the techniques results allow us to identify some of the more common problems, which are aggravated in the mobile delivery context. The more important points that developers/designers should consider to improve.

4.3. Limitations of the experiment

Our experiment has faced some limitations on the type of results that can be extrapolated, including: 1) it would be important to have included new techniques that will, most likely, emerge from the conformance to HTML 5 and ARIA new features and in some cases be more “mobile-friendly”; 2) since this experiment is centred on automated evaluation of Web accessibility quality, it shares all of the inherent pitfalls; 3) the design identification of the pages was performed a posteriori. We were not able to identify the pages using *RWD* or *RESS*.

5. CONCLUSIONS AND FUTURE WORK

This paper presented an experimental study of automated Web accessibility evaluation in two delivery contexts: *desktop* and *mobile*. For this experiment, we analysed the accessibility quality of the home pages of 474 of the 500 most visited Web sites in the world. We provided evidences of: 1) differences between delivery context; and 2) influence of design methodologies in accessibility quality. We were not able to prove that mobile delivery context is more accessible than desktop.

Moreover, we are able to recommend developers to create mobile pages using *non-dedicated* methodologies, since this methodology results in more accessible web pages, when compared with mobile dedicated ones.

As for the future, we will perform a large scale study comparing mobile and desktop pages, in which we will use more specific mobile guidelines. This will result in a better understanding of the differences found on this work. Although, we will also intend to perform a expert analysis to validate the results.

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