

Usability and Accessibility of Greek Mobile e-Government Websites

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Abstract: *The early success of citizen-facing mobile initiatives highlights the opportunity for the government to improve the way that does its business by adopting a mobile digital strategy internally. The high utilization of public websites intensifies the need for efficient and effective speed service delivery. Mobile government websites' usability and accessibility are the main dimensions that determine the quality and functionality of mobile e-government. Through this research, the main goal is to analyze selected public sector websites in terms of accessibility and usability. This study contains some evaluation techniques focused on the assessment of Greek government websites from mobile devices. The main tool used for the elaboration of this research is "Dareboost". The findings revealed the most common usability and accessibility problems that affect the performance of government websites. The study also includes suggested recommendations for the improvement of usability and accessibility of Greek Public Websites with the ultimate goal of increasing citizens' satisfaction with services provided to them.*

Keywords: Accessibility, usability, e-government, mobile website, public sector

1. Introduction

Nowadays mobile technology has been developed to such an extent that it has penetrated more than anything else in people's daily lives. It is a real fact that, in modern society, more people have access to mobile phones than to proper sanitation. Mobile technology can be advantageous and if used optimally could be a significant connection between citizens and government.

It would be beneficial for the government to invest in m-government to improve communication and interaction with citizens. Government websites should be mobile-friendly and provide easy access to citizens. Citizens should easily find all needed information and services through m-government.

Accessibility and Usability are efficient tools for measuring the performance and success of public mobile websites. Website usability means creating a site that is centered around the needs of users. On the other hand, accessibility means all citizens regardless of any disability or impairment to be able to access the site. Both are critical to ensure that citizens are satisfied with the service provided. Government should take action to focus on the improvement of m-government and use any opportunity to enhance the usability and accessibility of public websites.

2. Usability and Accessibility of Mobile Websites

Usability and accessibility address different issues, but they are similar in principle. Usability means ease of use focused on the way that site is organized, the structure, the virtual design, the page layout, and the content included. Accessibility means making the content of the websites clear and simple enough so that most people can use it. Adequate

usability and accessibility are the most important requirements of mobile websites.

It is in every government's interest to improve public services making them more efficient and available to citizens at any time. Improvement in the quality of m-government concerns both citizens and government as well. It will lead to the perception that public services will focus more on providing services to citizens (citizen-centered) and this will also increase citizens' satisfaction.

The basic tool used to examine the usability and accessibility of the Greek government's and public sector's mobile websites is Dareboost. Dareboost is a web page that measures the performance and quality of websites and in case it is necessary, delivers some optimization tips and advice. Through Dareboost, it is easy to test the overall page score, the number of weaknesses, the required improvements, and the success in terms of usability and accessibility. Dareboost provides various metrics and according to these, scores the sites as "excellent", "good", "average", "below average", or "bad"). It also provides some useful suggestions for improvement.

The results for all these checkpoints are split into 3 categories:

- Issues: all the applied - and critical - checkpoints from Dareboost's best practices repository that has not been respected by the tested web page.
- Improvements: all the applied checkpoints that have been only partially respected.
- Successes: all the successful checkpoints for the tested web page.

The test was being performed based on two different settings: browser and test location. The browsers selected for each mobile website are for Android (Galaxy) or IOS

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(iPhone) platforms. The location of the test is Washington D.C.; Android and IOS represent the two most popular mobile platforms in Greece. The sample includes 23 government websites and public sectors. The first step was to upload the URL of each website in Dareboost. The selected site would then appear in the viewport and a list of mobile devices would be available for users to select.

A. Mobile Usability Analysis

The results for each usability performance factor are included in Tables 1 and 2. Tables include the percentage of websites with identified Issues, improvements, success practices, website load time, and total page size for IOS (iPhone) and Android (Galaxy), respectively. A sample of 23 government websites and public sectors have been taken into consideration.

Table 1: Mobile usability performance analysis (IOS)

	Issues		Suggested Improvements		Sucesses		Load Time		Page Size	
	No of sites %	No of Issues	No of sites %	No of Improvements	No of sites %	No of Success Practices	No of sites %	Seconds	No of sites %	MB
Excellent	17,4%	0-10	8,7%	0-10	26,1%	70≥	21,7%	≤4	21,7%	≤1.0
Good	30,4%	11-13	39,1%	11-13	65,2%	69-60	8,7%	5-6	26,1%	1.0-2.4
Average	43,5%	14-17	52,2%	14-17	8,7%	59-50	13,0%	7-8	4,3%	2.5-3.4
Below Average	8,7%	18-21	0,0%	18-21	0,0%	49-40	0,0%	9-10	17,4%	3.5-4.0
Bad	0,0%	22≤	0,0%	22≤	0,0%	39≥	52,2%	11≤	30,4%	4.5≤

Table 2: Mobile usability performance analysis (Android)

	Issues		Suggested Improvements		Sucesses		Load Time		Page Size	
	No of sites %	No of Issues	No of sites %	No of Improvements	No of sites %	No of Success Practices	No of sites %	Seconds	No of sites %	MB
Excellent	8,7%	0-10	8,7%	0-10	21,7%	70≥	17,0%	≤4	17,0%	≤1.0
Good	26,0%	11-13	55,0%	11-13	4,0%	69-60	17,0%	5-6	26,0%	1.0-2.4
Average	43,0%	14-17	47,0%	14-17	8,7%	59-50	8,0%	7-8	9,0%	2.5-3.4
Below Average	0,0%	18-21	0,0%	18-21	17,0%	49-40	13,0%	9-10	13,0%	3.5-4.0
Bad	0,0%	22≤	0,0%	22≤	0,0%	39≥	43,0%	11≤	26,0%	4.5≤

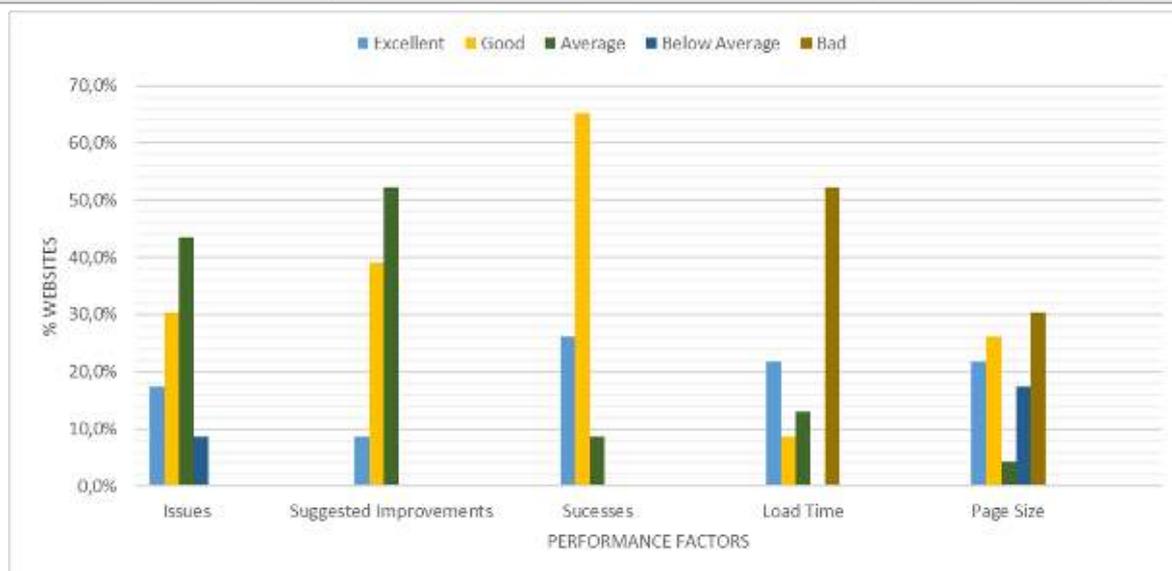


Figure 1: Mobile usability performance analysis (IOS)

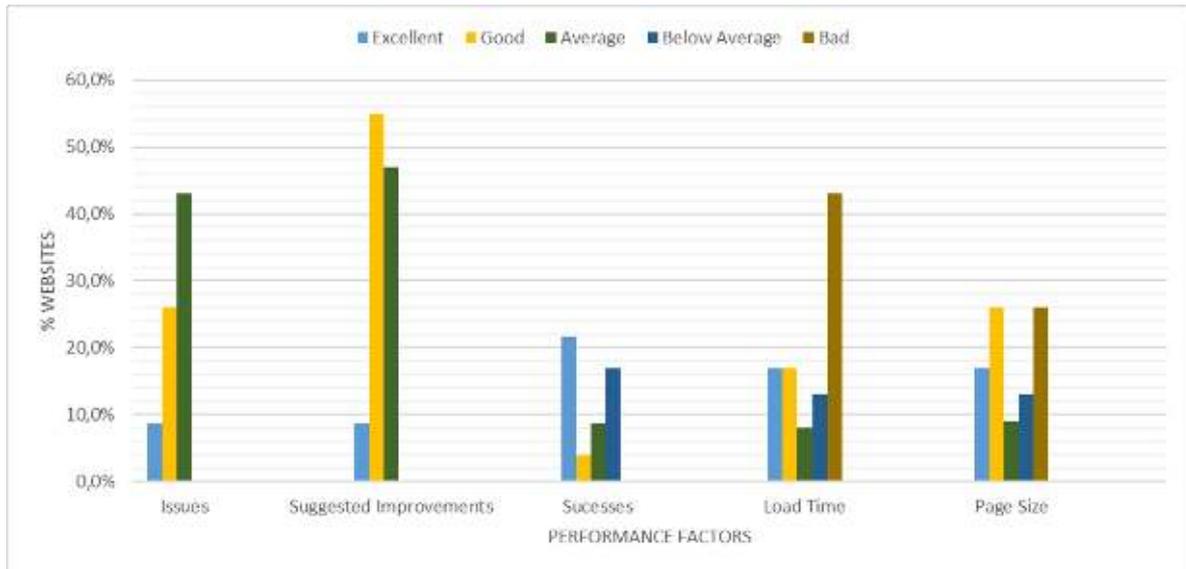


Figure 2: Mobile usability performance analysis (Android)

a) Analysis of Usability Issues (Weaknesses):

The first two columns of Table 1 include the usability issues (weaknesses) for IOS devices. From statistics, it appears that

- An excellent result has been achieved by 17.4% of the tested websites. These websites appeared in less than 10 issues.
- A good result has been reached by 7 websites (30.4%). These websites reached 11-13 issues.
- An average result has been reached in most websites (10 from 23 in total) with less than 17 weaknesses which is a good rate.

The good news is that only 2 (8.7%) websites are rated as below average and no websites have reached a bad result.

Results for Android devices are included in Table 2. From statistics, it appears that

- An excellent score has been achieved by only 2 of the websites (8.7%), which appeared less than 10 weaknesses.
- Average score has been achieved by the majority of websites (43%) with 14-17 weaknesses.
- No website reached the below average and worst level of compliance.

Table 3 includes the most common weaknesses for both Android and IOS devices. The top 5 issues and their frequencies are listed in Table 4.

Table 3: Common usability Issues

Common Usability Issues	
IOS	Android
Large page weight Some Images are loaded but not displayed Some Images are loaded too early Images are resized on browser side Critical dependencies detected The number of DOM elements is high The server response time is too slow Set a far future cache policy Some images need optimization IDs are duplicated within your HTML Some resources do not define their content type Search engines may not use page description Defer parsing of JavaScript The format of some images needs to be amended	CSS properties are overridden by shorthands The !important declaration is used many times Separate the CSS styles from the HTML tags IDs are duplicated within your HTML Avoid HTML code in comments You should not gzip/deflate PNG images CSS selectors are duplicated Some resources does not define its content type

Table 4: Top 5 usability Issues

Top 5 Usability Issues					
IOS			Android		
Issues	Frequency	Frequency%	Issues	Frequency	Frequency%
Large page weight	18	78%	Separate the CSS styles from the HTML tags	15	65%
Critical dependencies detected	15	65%	The !important declaration is used many times	13	56%
Some images need optimization	14	61%	CSS selectors are duplicated	12	52%
Images are resized on browser side	13	57%	CSS properties are overridden by shorthands	11	47%
Search engines may not use page description	12	52%	Avoid HTML code in comments	9	39%

b) Analysis of Usability Improvements:

Term Improvements refers to all the applied checkpoints that have been only partially respected (meaning a specific score below 90/100). In the case of IOS, based on results as stated in Table 1, we conclude that 21 websites achieved a good and average rating with less than 17 noticed improvements. 2 websites (8.7%) have received an excellent rate and no websites have more than 18 partially respected checkpoints.

Similarly, a test on Android devices showed that 12 websites (55%) achieved good results with fewer than 13 suggestions for improvement, 11 websites (47%) reached an average score and only 2 of the websites reached an excellent rate with less than 10 suggestions of improvement. No website received more than 22 warnings.

The most common improvements for both Android and IOS devices are listed in Table 5. The top 5 issues and their frequencies are listed in Table 6.

Table 5: Common usability improvements

Common Usability Improvements	
IOS	Android
Separate the CSS styles from the HTML tags	This page defines a lang
The !important declaration is used many times	Each form field explains its purpose
Do not use too long inline scripts	No 'refresh' <meta> tag
CSS properties are overridden by shorthands	This page only uses secure content
CSS selectors are duplicated	The secure version is used systematically
CSS properties are duplicated	No empty "src" attribute detected
Your site doesn't use Open Graph properties	You specify a consistent label on your links
CSS selectors are too complex	All labels refer to an element
Use a better file format for your fonts	This page is not exposed to "clickjacking" type attacks
You should reduce the number of DOM elements	The auto detection of resource type is disabled
Your site should use more Open Graph properties	The main title of the page is the first stated title
Avoid excessive specificity on jQuery selectors	Each form defines a submit button
Avoid HTML code in comments	All cookies are secure
Avoid DOM manipulation inside loops with jQuery	Your server only communicate in HTTPS with your web users
robots.txt file should be defined	No empty element detected
This page does not specify a breadcrumb for search engines	<noscript> tag detected
Minify JavaScript	
Avoid http-equiv <meta> tags	
Defer parsing of JavaScript	

Table 6: Top 5 usability Improvements

Top 5 Usability Improvements					
IOS			Android		
Improvements	Frequency	Frequency %	Improvements	Frequency	Frequency %
Separate the CSS styles from the HTML tags	22	96%	No 'refresh' <meta> tag	22	96%
The !important declaration is used many times	19	83%	This page defines a lang	19	83%
Do not use too long inline scripts	19	83%	No empty "src" attribute detected	19	83%
CSS properties are overridden by shorthands	17	74%	You specify a consistent label on your links	19	83%
CSS selectors are duplicated	12	52%	The secure version is used systematically	15	65%

c) Analysis of Success Practices:

Table 1 includes also the successful checkpoints for the tested web pages for both IOS and Android.

In the case of IOS, the majority of websites have received a very good number of successful practices. More specifically, 21 of 23 websites (91.3%) include more than 60 successful practices, while 6 of these websites have received an excellent result with more than 70 successful points. Only two websites are rated on average and there are no websites with successful practices less than 49.

In the case of Android, we conclude that 5 sites had a positive percentage above 70, 3 were above average and 4 were below average. Finally, a positive element is that no website had a negative scale (below 39) which means, that the websites responded positively to the arrival of customers.

d) Analysis of Load Time:

Table 1 includes also the values of load time for mobile websites tested on IOS and Android devices.

Loading Time results between IOS and Android have many similarities. The main conclusion is that approximately half

of the websites tested on both devices reached very low results with loading time of more than 11 seconds. More specifically:

In the case of IOS:

- 5 websites have received an excellent result with a load time of fewer than 4 seconds.
- 6 websites are rated as good and average with load time from 5-8 seconds.
- 12 websites reached bad results with a loading time of more than 11 seconds.

In the case of Android:

- 4 websites have received an excellent result with a load time of fewer than 4 seconds.
- 6 websites achieved a good and average ranking with load time from 5-8 seconds.
- 3 websites achieved below average results with load times of 9-10 seconds
- 10 websites achieved very low results with more than 11 seconds.

e) Analysis of Total Page Size:

The total page size of the mobile websites tested by IOS and Android devices is included in the last two columns of Table 1.

Results for IOS show excellent score for 5 websites with page size less than 1.0 MB. 6 websites have received a good result with page size range 1.0 MB – 2.4 MB. 5 websites have reached average and below average results and 30,4% of websites (7) had page size more than 4.5 MB with a totally bad score. Large page size may increase the loading time of the page and as a result, this is a weak point that needs improvement.

Similarly, in the case of mobile websites used by Android, it was found that 4 (17%) websites received excellent results because their page size was less than 1MB. Ten websites (22%) were graded as average and below average, as the size of their page was 2.5-4.0 MB and 6 websites (26%) had bad results with page sizes higher than 4.5 MB.

B. Mobile Accessibility Analysis

Table 7 displays the listing of the most common accessibility issues for both Android and IOS platforms, based on the outcomes of the Dareboost evaluation tool. The top 5 Accessibility issues and their frequencies are listed in Table 8.

Table 7: Common Accessibility Issues

Common Accessibility Issues	
IOS	Android
Some labels do not refer to an element	Do not open new window or tab
Each form must define a submit button	Users should be able to specify www in the URL, or not
Set a lang for your page	Each form must define a submit button
Users should be able to specify www in the URL, or not	Some labels do not refer to an element
Empty Elements	Explain the purpose of each form field

Table 8: Top 5 Accessibility Issues

Top 5 Accessibility Issues					
IOS			Android		
Accessibility Issues	Frequency	Frequency %	Accessibility Issues	Frequency	Frequency %
Some labels do not refer to an element	4	17%	Do not open new window or tab	9	39%
Each form must define a submit button	7	30%	Users should be able to specify www in the URL, or not	4	17%
Set a lang for your page	3	13%	Each form must define a submit button	3	13%
Users should be able to specify www in the URL, or not	3	13%	Some labels do not refer to an element	2	9%
Empty Elements	1	4%	Explain the purpose of each form field	2	9%

C. System Scoring

Based on the Overall System Scoring Results as stated in Table 9, 35% of public websites tested on the IOS platform and 39% of public websites tested on the Android platform received a very good rate (70% - 78%) which, based on evaluation from Dareboost, means that these websites have better scores than the average.

For both IOS and Android, 9 websites (39%) include the basic requirements and for 5 websites (22%) the basic requirements are missing. Only 1 in 23 websites per case was found to have enough features missing, which could deeply affect the user's experience.

Table 9: Overall System Scoring

Overall System Scoring					
Score	Percentage Range	IOS		Android	
		No of Sites	%	No of Sites	%
Beware, basic requirements are missing	56% - 58%	5	22%	4	17%
Basics are there	60% - 67%	9	39%	9	39%
Better than most pages, keep going!	70% - 78%	8	35%	9	39%
The user experience is deeply affected	49%	1	4%	1	4%

3. Discussion

This section discusses the results of the research on the usability and accessibility of the Greek public sector websites using Dareboost. The objective of this discussion is to establish prospects for the improvement of mobile e-government websites. Using Dareboost, we examined to what extent Greek ministries and various public sector mobile websites comply with accessibility and usability guidelines. Below are described the most common usability and accessibility issues among IOS and Android and the most effective ways of improvement based on Dareboost analysis.

A. Usability

Research indicated few differences in Usability Issues between IOS and Android. As shown in Table 6, the most common usability problems for IOS are associated with performance indices and focus on full load time and total page size. As a result, the basic recommendation for website usability improvement is to reduce the page size, optimize, resize or amend the format of some images which will also lead to a decrease in full load time. Furthermore, Dareboost detected the existence of critical dependences on third-party content. Such dependencies might block the entire display of web pages in case of failure of the content provider. Excluding dependencies, even from renowned providers, could be the most effective solution to avoid this problem.

Talking about Android and as shown in Table 6, the most common usability issues focus on CSS (Cascading Style Sheets). CSS is a stylesheet language used to describe the presentation of a document written in HTML or XML [9]. Dareboost detected the existence of duplicated CSS Properties and Selectors, some CSS Properties which are overridden by shorthands, and CSS Styles included in HTML tags. Generally, the CSS properties allow the application of a style to a set of elements. Using fewertimes the same property within the same CSS rule can improve the readability of the CSS. Furthermore, when a property is used more than one time within a CSS rule, the second one overrides the first. Things are more complicated when CSS provides shorthand properties. The use of shorthand properties is risky because it comes with an implicit override. Avoiding duplicated CSS properties, and shorthands and separating the CSS Styles from HTML Tags could effectively improve code readability and promote factorization. It will also effectively reduce the file size of the website.

B. Accessibility

The main purpose of both IOS and Android should be to facilitate users' experience and let users quickly understand the page. Research indicated that IOS and Android have some common accessibility issues. The most common accessibility problems for both Android and IOS devices detected by Dareboost (as listed in Table 7) and recommendations for improving the situation are described as follows:

- "Some labels that do not refer to an element": When a label is associated with an element, screen readers understand better the content of the website, improving their testing experience.
- "Each form must define a submit button": HTML forms are used to send data. It would improve accessibility if a submit button was included in all forms.
- "Users should be able to specify www in the URL, or not". Using a (permanent) way of redirecting one address to another could improve the user experience.

Websites tested in IOS devices also contained some empty elements or did not define a lang which could disturb screen readers or cause difficulty in understanding the page. Removing empty elements and defining a lang could allow screen readers correctly understand the website.

On the other hand, Android could facilitate user experience on the website by limiting navigation to a single tab (users should not have the option to open a new window or tab) and clarifying the purpose of each form field.

4. Recommendations

Based on the results presented and the recommended improvements suggested by Dareboost, Developers must proceed with major improvements to Public Websites to make them more useful and accessible for all citizens and especially for elderly people and people with disabilities. Citizens must have easy access and take advantage of public websites through their mobile phones. This will strengthen their relationship and interaction with the government.

The usability and accessibility of public websites should be followed by standard guidelines. The compliance of public websites with these standards should be monitored regularly (i.e. every one or two years) to identify any deficiencies and proceed with improvements or corrections if required.

M-government is a trend that is in its early stages but is expected to be established in the future. For that reason, it could be useful to insert new courses and more evaluation models at universities related to website design. Developers

should receive appropriate training during their studies. They should also be aware of citizens' needs.

5. Conclusion

Despite the differences between accessibility and usability, both are extremely important for the efficiency and effectiveness of public websites. The combination of the two has a significant impact on citizens' satisfaction and their interaction with the government and public sector.

In this study, Dareboost was used as a tool for the evaluation of the Greek m-government in terms of usability and accessibility. The system evaluated the overall performance of public websites and their compliance with standards. Issues, warnings, and a set of recommendations that can be used to improve further the experience and satisfaction of users were also identified.

This research could be a good addition to the literature in the field of assessment of usability and accessibility of mobile e-government in Greece. It contains some limitations because the sample included only 23 public websites, but could be considered representative as we tried to collect the most popular ones used in the most two popular mobile platforms used in Greece (IOS and Android).

Future research on more Greek public websites could be considered a useful tool and source of information for Developers to be aware of system weaknesses and find effective technical solutions for improvement.

Appendix

See Tables 1 – 9.

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