

# Specific Mobile Web Usability Aspects Comparing to Web Usability

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**Abstract.** In the modern world Web and its services have become integral part of our society. Web serves a lot in many ways, for example, information provider, for doing business and work, for shopping and leisure etc. In the past years a huge amount of Web sites were developed for these purposes. Most of them serve well for users' needs; however, Web usability issue takes a very important part in the Web sites lifetime. Low level of Web sites usability makes users to waste their time, lose loyalty to those Web sites and demotivates users. This aspect caused massive research efforts among the scientists and researchers to point out the most important cornerstones of the Web usability. We live at technology era and it brings new challenges in the field of Web usability. The rush in people life forced appearance of the mobile phones that nowadays are the part of people life. Step by step simple mobile phones turned into smartphones, where in addition to making trivial phone calls, they are capable of performing a variety of other functions. One of these functions is ability to access the Internet, so the Web sites. At this point starts the new challenge for Web usability, because even powerful smartphones have several limitations: relatively small screen, tiny buttons, slow connection speed etc. In the article authors show importance of the mobile Web usability because of indisputable predominance of smartphones against PCs according to smartphones penetration analysis. The most common Web usability evaluation methods are summarized. The mobile Web usability literature analysis suggests additional usability tips for mobile Web sites.

**Keywords:** Web usability, mobile Web, smartphone, Web site design.

## 1. Introduction

A primary function of all Web sites is to serve as a way for providers and the users of those Web sites to acquire information. Organizations know the importance of the Web sites as a means for acquiring information about their customers, partners or competitors. Their main goal is to provide Web sites for facilitate Web users' acquisition of information about company's products, services and activities. That is why it is so important for the providers of a Web sites (or mobile Web sites) to ensure that site is developed in a way that provides a high level of usability to people who seeks for knowledge through it (Fang, Holsapple, 2006).

According to the Web Communications and New Media Division in the U.S. Department of Health and Human Services, Web usability refers to how good users learn and use a product (Web page in this case) in order to achieve their goals and also how

satisfied they are with that progress (Lobo et al., 2011). In other words, usability is the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency, and satisfaction in specified context of use (ISO 9241-11, 1998).

One of the world's leading expert in Web usability Jacob Nielsen pointed out five quality components of usability that can be attributable to desktop applications as well to a Web sites (Lobo et al., 2011):

- **Ease of Learning:** How easy is it for average users of a product to be able to execute basic tasks?
- **Efficiency of Use:** How fast can experienced users of the system fulfil basic tasks?
- **Memorability:** When users starts to work with a product after a period of not using it, how fast and easily can they re-establish proficiency?
- **Error Frequency and Severity:** How often do users of the system causes errors and how they are serious. Is it easy to recover from these errors?
- **Subjective Satisfaction:** How much does the user like using the system?

These five components include countless recommendations and principles about Web site development to increase the level of usability. Nowadays when mobile Internet and smartphones are so popular and widespread, it is extremely important to find out if these principles of usual Web page development can be attributable to development of mobile Web sites. Largely usability assessment techniques for mobile Web sites are similar to those for usual Web pages; however it is admitted that testing practices of usability also could be different, because variety of smartphones and feature phones with Internet function rapidly complicates standard usability testing practices (Pendell, Bowman, 2012).

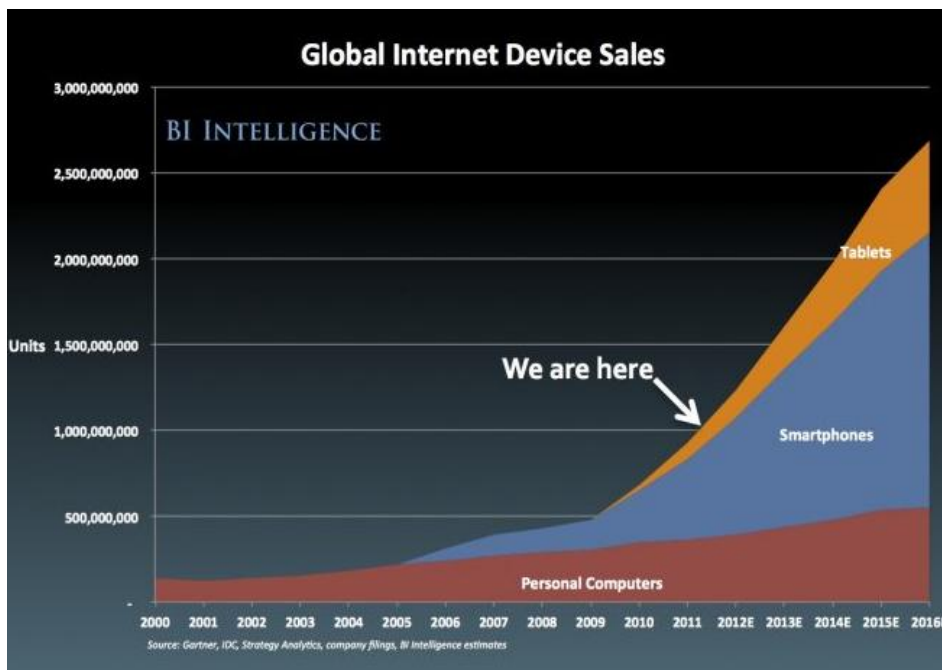
This paper is organized as follows. In Section 2, we analyse smartphone penetration in the human society and statistics clearly shows that smartphones are quantitatively used more than personal computer, thus the research is extremely important. In Section 3, we summarize the most common Web usability evaluation methods and criteria. In Section 4, we analyse literature regarding to mobile Web usability and point out the most often mentioned guidelines or tips for development of high quality mobile Web page. In Section 5, we show the results of our research and range the guidelines according to histogram analysis.

## 2. Smartphone penetration

A smartphone is a mobile phone running a mobile operating system (WEB(d)). Comparing to feature phone, it has more advanced computing capability and functions. The first smartphones were usual mobile phones with the functions of a personal digital assistant (email etc.) included, but later the functionality of portable music players, digital cameras, video cameras, GPS navigation, high-resolution touchscreens and Web browsers to display standard Web pages and different mobile sites was added.

The first smartphones have been around since 1993. The difference between then and now is that early smartphones were primarily used as enterprise devices and were too expensive for most potential consumers. Nokia released its first smartphone called Nokia 9000 in 1996. A later version of this model, the Nokia 9210, included the first colour screen (Lobo, 2011). In year 2002, after QWERTY keyboard was introduced (also Ericsson P300 was developed), smartphones started to become popular worldwide.

Popularity increased rapidly in year 2007 when Apple Inc. introduced the original iPhone. It was one of the first to be predominately controlled through its touchscreen. Smartphone sales increased in the last few years and in year 2011 sales account for almost 20% of total mobile phone sales (Lobo et al., 2011). Recent statistics regarding to smartphones are quite shocking. Infographics reports (Anson, 2013) that 97 percent of 18-29 year olds use smartphones to send text messages. Besides that, some of most common activities by all smartphone users are surfing (while traveling – 70% and while in a restaurant – 64%). For tablet users these numbers are even bigger. 88 percent of tablet users reveal that mostly their tablets are used for Web browsing. Nowadays there are already more than 1.08 billion smartphone users in the world (WEB(c)). Coda Research Consultancy forecasts that worldwide smartphone sales will be measurable of 2.5 billion units in the year 2010 till 2015. They also expect that mobile Internet use among smartphones' users will increase 50 times (Smith, 2010). According to Juniper Research the number of mobile Internet services users will reach the number of 1.7 billion by the year 2013 (Chard, 2008). The phones are being used for everyday needs such as making calls, emailing, scheduling, tweeting on the go, mobile advertising, online banking, online shopping etc. Moreover, in the year 2011 smartphones already had beat PC sales and according to John Denny (Denny, 2012) the number of sold units is going much higher for next years (see Fig. 1.).



**Fig. 1.** Comparison of global internet device sales (Denny, 2012).

At the end of the year 2009 there were 470000 smartphone users in Korea, but at the beginning of the year 2011 there already were more than 10 million smartphone users. The number of feature phone users in Korea reached 52 million at the end of the year 2011; meanwhile the smartphone user number reached the 20 million at the end of the year 2011 showing the fastest penetration rates of smartphones in the world. Moreover,

the mobile data traffic in Korea had been 11.2 times increased during the years 2010 and 2011 from 449 TB to 5463 TB. The average traffic per user in Korea (287 MB) is much higher than US (150 MB), Western-Europe (74 MB), and Japan (199 MB) (Lee et al., 2013). Authors (Lee et al., 2013) think that these facts show the dependency level on mobile portal service in Korea probably is higher than in the other big countries.

### 3. Web usability design and evaluation

There is a wide range of different Web usability design and evaluation methods. All of them can be divided into groups by considering main purpose of each method. Some methods are used to evaluate interface and design of Web sites but others refers to quality and architecture of information. It is up to developers to choose which method to use in their project. Some of usability design and evaluation methods are summarized in Table 1.

**Table 1.** Usability design and evaluation methods

Method	Description	Purpose
Card Sorting	Card sorting is a useful tool to determine how users categorize the information that will appear on a Web site. There are traditionally two types of card sort exercises used: open card sort, where participants are given a stack of cards and are asked to group them together as it makes sense to them and closed card sort where participants are provided group names, and are asked to place each of the cards into one of the pre-established groups	The results of a card sort exercise may be used to develop an application or Web site's Information Architecture.
Charrettes	A charrette is an intense generative exercise that takes place over multiple days, and involves a multi-disciplinary group of participants. They break into sub-groups to work on solving a small part of the design problem. Then all subgroups merge and decide which of proposed solutions the best is (Wharton et.al., 1994).	To efficiently generate design solutions.
Cognitive walkthroughs	One or more usability experts "walk" through a set of the most typical user tasks supported by the Web site, one-step-at-a-time and gathers their experience.	To determine the level of usability for a Web site.
Contextual task analysis	It is a user research method that applies ethnographic observation and one-on-one interviewing to understand the task procedures that users follow to reach their goals. The researcher silently observes the user at work in his or her natural work environment and notes any tools and people that support the user as they work toward task goals.	To understand the task procedures that users follow to reach their goals.
Facilitated brainstorming	It is a generative exercise, similar to a Charrettes method, but which a moderator involved who keeps the group focused on the exercise and tracks all of the participants' ideas	To efficiently generate design solutions.
Focus groups	This method is used as an evaluative tool, rather than a generative one (such as Facilitate Brainstorming and Charrettes). A Moderator facilitates a small group of 4 to 8 participants by demonstrating or showing them a product or concept. The participants are encouraged to freely give their honest opinions about the product, including suggestions to make it better	To evaluate Web site usability.
Heuristic evaluation	This method, also called as a usability audit, is an evaluation of an interface by one or more Human Factors experts. Evaluators measure the usability, efficiency, and effectiveness of the interface.	To evaluate Web sites interface.

One-on-one interviews	One-on-one interviews help researchers learn about users' attitudes and beliefs surrounding a Web site or application and specific tasks that the Web site or application supports. It is often best to first observe users in their natural work environment, and then use a one-on-one interview to follow up the observation and clarify what was witnessed.	To evaluate Web site usability.
Participatory design	Participatory design exercises engage stakeholders and end users in the process of solving a design problem. Participants bring their own perception of the problem and may offer unique ideas and design solutions based on user needs and preferences that were not evident to the researcher.	To generate design solutions.
Surveys	Surveys are best used as tools to rate user experiences and users' needs and preferences as they relate to system features. They are usually used to collect quantitative data about users' opinions about an application or Web site.	To evaluate Web site usability.
Usability testing	It is the best way to understand how real users experience Web sites or applications. To use this method, first of all the target audience has to be identified. Each participant should be given tasks to perform during testing that reflect their different usage patterns. Tasks usually represent the most common user goals.	To evaluate Web site usability.
Quality assurance testing	Quality assurance is a subset of the overall usability goal. After the site has been built, it should be put through a rigorous post-production process. User feedback functionality should be provided. That can influence the ongoing maintenance of the site.	To evaluate quality of Web site.
HCI Design Approaches	Ray E. Ebert described 4 Human-Computer Interaction (HCI) design approaches that may be applied to user interface designs to develop user-friendly, efficient, and intuitive user experiences (Eberts, 1994). These approaches are: <ul style="list-style-type: none"> <li>• Anthropomorphic</li> <li>• Cognitive</li> <li>• Empirical</li> <li>• Predictive Modelling</li> </ul>	To generate design solutions.

One of the most popular usability evaluation methods is Heuristic evaluation. It is widely accepted for diagnosing potential usability problems (Torrente et al., 2012). This method defines an inspection process in which expert evaluators investigate the interface to assess the level of compliance with widely known usability principles called "heuristics". The goal of heuristic evaluation usability method is to find usability problems in the design of the user interface so that to correct them. It can be applied in different phases of the development cycle, detecting a good percentage of the usability problems (Torrente et al., 2012).

#### 4. Mobile Web usability

At the first look it seems that Web usability evaluation is very well studied and a lot of criteria are developed for Web usability evaluation as we saw in the Section 3. However, mobile devices have several important limitations which introduce new challenges for Web site developers to ensure that users will visit Web sites. According to several information sources (WEB(a); Clarke, 2012; Everdell, 2012; Gatbonton; Holst, 2013;

Moth, 2013; WEB(b); WEB(e); Warsi) the limitations of mobile devices are the following:

- small screen comparing to desktop computers,
- relatively slow internet speed,
- tiny buttons,
- touchscreen and non-touchscreen versions,
- onerous typing.

To overcome these aspects specialists are offering several important recommendations or tips, and they are summarized in Table 2.

**Table 2.** Tips for mobile Web usability improvements

	WEB(a)	Moth, 2013	Clarke, 2012	Warsi	Holst, 2013	Gatbonton	WEB(b)	Everdell, 2012	WEB(e)
<b>Optimized navigation across site</b>	X			X	X	X		X	X
<b>Clearly distinguish selected items</b>				X	X	X			
<b>Simple data input</b>	X	X	X	X	X	X	X	X	X
<b>Show essential information</b>	X	X	X	X	X	X	X	X	X
<b>Single column layout</b>	X			X		X		X	X
<b>More than one mobile site</b>	X						X		
<b>Avoid small font, buttons, links etc.</b>	X	X				X			
<b>Use built-in functionality (GPS, calls, QR codes)</b>	X								X
<b>Avoid popups and page refreshes</b>		X				X			X
<b>Do not use desktop Web site links</b>		X						X	X
<b>Video compatibility</b>		X						X	
<b>Avoid animated carousels</b>					X				
<b>Adjust Web site to display resolution</b>						X		X	
<b>Option to view the full Web site</b>						X			X

## 5. Desktop Web usability and mobile Web usability evaluation criteria comparison

First of all to use Heuristic evaluation, assessment criterion has to be defined. By considering the experience and knowledge of usability experts, a list of the most important criteria were developed (Torrente et al., 2012). All criteria were divided into groups where each group describes some aspect of usability. During process of evaluation, the reviewer assigns a value to each criteria. All these Heuristic evaluation criteria are summarized in Table 3. Corresponding mobile Web usability recommendations are provided in the right column according to Section 4.

**Table 3.** Web usability evaluation criteria and mobile Web usability recommendations

Type	Heuristic evaluation criteria	Mobile Web usability recommendations
General aspects	Goals of the Web site are concrete and well defined.	Show essential information, Adjust Web site to display resolution.
	Contents and services are precise and complete.	
	General structure of the Web site is user-oriented.	
	General look & feel is aligned to the goals, features, contents and services of the Web site.	
	General design of the Web site is recognizable.	
	General design of the Web site is coherent.	
	User's language is used.	No additional recommendations.
	Other languages are supported	
	Translation of the Web site is complete and correct.	
	Web site is updated regularly.	More than one mobile site.
Identity and Information	Identity or logo is significant, identifiable and visible.	Show essential information.
	Identity of the Web site is present in every page.	
	Slogan or tagline is suited to the goal of the site.	
	Information about the Web site or company is provided	
	Contact mechanisms are provided.	
	Information about privacy of personal data and copyright of Web contents is provided.	
	Information about authorship, sources, creation and revision dates of articles, news and reports is provided.	

Type	Heuristic evaluation criteria	Mobile Web usability recommendations
Comprehensibility and ease of Interaction	Concise and clear language is used.	No additional recommendations.
	Language is user friendly.	
	Each paragraph expresses an idea	Simple data input.
	Interface controls are used consistently	
	Visible metaphors are recognizable and comprehensible by any user (e.g.: icons).	
	Coherent or alphabetic order in drop-down menus.	
Available options in a user-input field can be selected instead of written.		
Labelling	Labels are significant	No additional recommendations.
	Labelling system is precise and consistent	
	Page titles are planned and correct.	
	Home page URL is correct, clear, and easy to remember.	Do not use desktop Web site links.
	Inner page URLs are clear	
	Inner page URLs are permanent	
Search	If necessary, is accessible in every page.	Show essential information, Simple data input, Clearly distinguish selected items, Avoid small font, buttons, links etc.
	Easily recognizable.	
	Easily accessible.	
	Text box width is enough.	
	Simple and clear search system.	
	Advanced search is provided.	
	Search results are comprehensible for the user.	
User is assisted in case of empty results for a given query.		
Help	Help link is located in a visible and standard place.	No additional recommendations.
	Easy access to and return from the help system.	
	Context help is offered for complex tasks.	
	FAQ query selection and redaction is correct.	
	FAQ answers are correct.	
Layout of the page	Higher visual hierarchy areas of the page are used for relevant content.	Show essential information.
	Information overload is avoided.	Avoid popups and page refreshes, Avoid animated carousels.
	Clean interface with no visual noise.	
	White areas between information objects are provided for visual rest.	Show essential information, Single column layout.
	Visual space on the page is used correctly	
	Visual hierarchy is correctly used to express "part of" relationships between page elements.	
	Page length is under control.	No additional recommendations.
	Print version of the page is correct.	
	Page text can be read easily.	Avoid small font, buttons, links etc.
Blinking/moving text is avoided.	Avoid popups and page refreshes.	



Type	Heuristic evaluation criteria	Mobile Web usability recommendations
Structure and Navigation	Welcome screen is avoided.	Show essential information.
	Structure and navigation are adequate	Optimized navigation across site.
	Element organization is consistent with conventions.	
	Number of elements and terms per element is controlled in navigation menus.	
	Depth and breadth are balanced in the case of hierarchical structure.	
	Links are easily recognized as such.	
	Link depiction indicates its state (visited, active).	Do not use desktop Web site links, Option to view the full Web site.
	Redundant links are avoided.	
	Broken links are avoided.	
	Self links to the current page are avoided.	
	Image links indicate the content to be accessed.	
	A link to the home page is always present.	
	Elements hinting where the user is and how to undo the navigation (breadcrumbs, coloured tabs) exist.	Optimized navigation across site.
A map of the site to directly access contents without navigation exists.		
Control and Feedback	User controls the whole interface.	Simple data input, Avoid popups and page refreshes.
	User is informed about what is happening.	
	User is informed about what has happened.	
	Validation systems are in place to avoid errors before the user sends information.	
	Clear and non-alarmist information, and recovery actions are provided to the user when an error has occurred.	
	Response time is under control.	
	Web site windows cancelling or superimposing over browser windows are avoided.	
	Proliferation of windows is avoided.	
	User downloading of additional plugins is avoided.	
	In task with several steps, user is informed of the current step and the number of steps remaining to complete the task.	
	Multimedia Elements	
Images are comprehensible.		
Images have the correct resolution.		
Some added value is provided by using images or animations.		Avoid animated carousels.
Cyclical animations are avoided.		
Some added value is provided by using sound.		No additional recommendations.

## 6. Results and discussion

According to nine information sources we have summarized the most important tips for mobile Web usability and have performed histogram analysis (see Fig. 2.). The histogram shows how many times the particular tip was met in the nine information sources. We suppose that the more specific tip is mentioned in the literature, the more important it is, so the bigger disadvantage will be, if this tip would be ignored by mobile Web site developer. As a result, there are obviously several very relevant recommendations. Web site developer should ensure simple data input in the Web site forms and input fields. Mobile Web site should contain only essential information for user to reduce data transfer rates. The navigation across the site should be optimized to reduce navigation buttons and increase space for Web content. The mobile Web site content should be organized in the single column layout to avoid horizontal scrolling. Text font size should not be too small as well as buttons and links to other Web sites, because it is hard to read the text and properly click the buttons or links. On the desktop Web sites popups often are very annoying, so they are much more needless on the mobile Web sites. Rational tip is not to use links to desktop Web sites. Not so common and critical, however very useful recommendation is to use built-in functionality of smartphones like GPS, ability to make calls and ability to read QR codes.

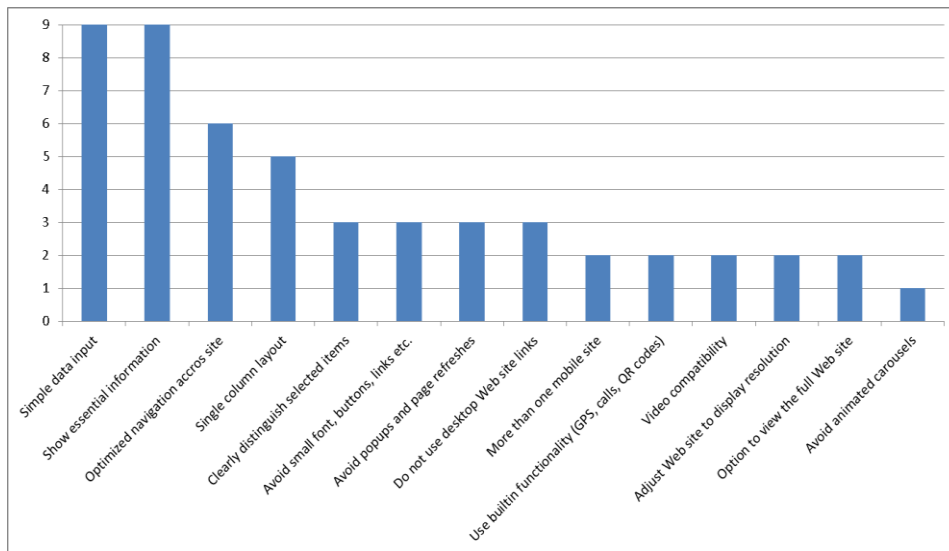


Fig. 2. Tips mention count across the nine information sources.

## 7. Conclusions

Web sites with a lot of different services are rapidly growing in the rush of modern life. It is integral part and many things nowadays could not be done anymore without internet. Every Web site developer is interested in the visitors' loyalty, while users prefer well organized and attractive Web sites. Users want to get precise information what they are looking for at that time and place. There are developed standards and

recommendations for successful Web site development, testing and evaluation. Along with rapid Web site growth the smartphones penetration level is getting higher every year and smartphones' sales rate beat PC's sales rate in middle of the year 2011. However, because of smartphones' limitation factors, there are additional recommendations for mobile Web site developers. So the Web usability standards cannot be applied to evaluate mobile Web usability completely. In order to provide top quality effective and attractive mobile Web site developers must follow to these recommendations and search for new ones not only from literature, but from thyself Web site testing, questionnaires and experience.

## References

- Anson, A. (2013) Smartphone usage statistics and trends [online] [accessed 28.11.2013] Available at: <http://ansonalex.com/infographics/smartphone-usage-statistics-and-trends-2013-infographic/>.
- Card, S., Moran, T., Newell, A. (1983) The psychology of human-computer interaction. USA, NJ, Hillsdale: L. Erlbaum Associates Inc. 469 p.
- Chard, I. (2008) Press Release: Mobile web users to top 1.7bn by 2013, driven by New Web 2.0 collaborative business models, says Juniper Research [online] [accessed 28.11.2013] Available at: <http://www.juniperresearch.com/viewpressrelease.php?pr=96>.
- Clarke, A. (2012) 5 Mobile Website Usability Rules You Cannot Afford to Break [online] [accessed 28.11.2013] Available at: <http://usabilitygeek.com/5-mobile-website-usability-rules-you-cannot-afford-to-break/>.
- Denny, J.H. (2012) The Explosion of Mobile [online] [accessed 28.11.2013] Available at: <http://johnhdenny.com/1474/primer-on-the-state-of-the-internet-2012>.
- Eberts, R.E. (1994) User interface design. USA, Englewood Cliffs, NJ: Prentice Hall. 649 p.
- Everdell, I. (2012) Ten Tips for MOBILE WEBSITE USABILITY [online] [accessed 28.11.2013] Available at: <http://blog.mediative.com/en/2012/03/02/ten-tips-mobile-website-usability/>.
- Fang, X., Holsapple, C.W. (2006) An empirical study of web site navigation structures impacts on web site usability. *Decision Support Systems*, Vol. 43(2007), p. 476–491.
- Gatbonton, A. Mobile Web Design: 10 Tips To Better Usability [online] [accessed 28.11.2013] Available at: <http://www.hongkiat.com/blog/mobile-web-design/>.
- Holst, C. (2013) Exploring Ten Fundamental Aspects of M-Commerce Usability [online] [accessed 28.11.2013] Available at: <http://uxdesign.smashingmagazine.com/2013/05/21/recommendations-mobile-commerce-websites/>.
- ISO 9241-11:1998. Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 11: Guidance on usability.
- Lee, J., Lee, D., Moon, J., Park, M. (2013) Factors affecting the perceived usability of the mobile web portal services: comparing simplicity with consistency. *Information Technology and Management*, Vol. 14, p. 43-57.
- Lobo, D., Kaskaloglu, K., Fox, H., Srisangkhajorn, T. (2011) A Synergic Approach to Web Usability for Smartphones. In: *2011 International Conference on Information and Electronics Engineering*, Vol. 6, p. 65-69.
- Moth, D. (2013) 12 usability flaws that are spoiling the mobile web [online] [accessed 28.11.2013] Available at: <http://econsultancy.com/lv/blog/62870-12-usability-flaws-that-are-spoiling-the-mobile-web>.
- Pendell, K.D., Bowman, M.S. (2012) Usability Study of a Library's Mobile Website: An Example from Portland State University. *Information technology & libraries*, p. 45-62.
- Smith, S. (2010) Worldwide Smartphone Sales Forecast to 2015. *Coda Research Consultancy*, p. 1-5.
- Torrente, M.C.S., Prieto, A.B.M., Gutiérrez, D.A., Sagastegui, M.E.A. (2012) Sirius: A heuristic-based framework for measuring web usability adapted to the type of website. *The Journal of Systems and Software*, Vol. 86, p. 649– 663.

- Warsi, A., 7 usability guidelines for websites on mobile devices [online] [accessed 28.11.2013] Available at: <http://www.itwales.com/997484.htm>.
- Wharton, C., Rieman, J., Lewis, C., Polson, P. (1994) The cognitive walkthrough method: A practitioner's guide. *Usability inspection methods*. New York, NY: John Wiley & Sons, Inc, p. 105-140.
- WEB(a) 7 usability guidelines for websites on mobile devices [online] [accessed 28.11.2013] Available at: <http://www.webcredible.co.uk/user-friendly-resources/web-usability/mobile-guidelines.shtml>.
- WEB(b) Overcoming mobile web usability challenges [online] [accessed 28.11.2013] Available at: [http://developer.nokia.com/Design/Overcoming\\_mobile\\_web\\_usability\\_challenges.xhtml](http://developer.nokia.com/Design/Overcoming_mobile_web_usability_challenges.xhtml).
- WEB(c) Smartphone Users Around the World – Statistics and Facts [Infographic] [online] [accessed 27.11.2013] Available at: <http://www.go-gulf.com/blog/smartphone/>.
- WEB(d) Smartphone [online] [accessed 24.11.2013] Available at: <http://www.phonescoop.com/glossary/term.php?gid=131>.
- WEB(e) Usability on the mobile Web: best practices and guidelines for designers and developers, 2013 [online] [accessed 28.11.2013] Available at: <http://mobiforge.com/design-development/usability-mobile-web-best-practices-and-guidelines-designers-and-developers>.

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