Assessment of User Experience with Responsive Web Applications using Expert Method and Cognitive Walkthrough
A Case Study

Malgorzata Plechawska-Wojcik[1], Sergio Lujan Mora[2] and Lukasz Wojcik[3]
[1]*Institute of Computer Science, Lublin University of Technology, Nadbystrzycka 36b, Lublin, Poland*
[2]*Deparment of Software and Computing Systems, Universidad de Alicante, Alicante, Spain*
[3]*Karo-Studio s.c., Lublin, Poland*

Keywords: Responsive Web Design, GUI Usability, User Experience, Expert Analysis, Cognitive Walkthrough.

Abstract: The paper presents a case study of Responsive web design GUI quality testing. The case study use specially designed web page and the adjusted testing procedure. The procedure is based on the expert method and cognitive walkthrough and is adjusted to web pages created using Responsive web design. The paper outlines contain the method description and results including questionnaire summary and experts opinion. The most important users remarks concerning GUI adjusting to different devices are also presented.

1 INTRODUCTION

According to a recent research (Mitchell et al., 2012), more than three-quarters of U.S. adults (77%) own laptop or desktop computers. However, the computer market has stabilized for the last four years, and what is growing now instead is the mobile market. Nearly 44% of U.S. adults own smartphones, and 18% of U.S. adults own tablets. This wide and rapid adoption of smart phones and tablets has shifted how U.S. people consume web content, and according to another study (comScore, 2012), mobile phones and tablets accounted for a combined 13.3 percent of total web page views in August 2012, nearly doubling their share of traffic in just one year. For many people, mobile devices are the last thing they touch before they go to sleep, and the first thing they use when they wake up. Users move from one device to another device smoothly and in patterns that cannot be predicted. The boundaries of the way people use the Web are blurring very fast.

Therefore, nowadays it is more important than never to design cross-channel websites (Resmini and Rosati, 2011), websites prepared to be accessed from a myriad of different devices. It is clear that continuity between platforms is quite important, but due to the lack of some features in some devices, it is totally impossible to offer the same experience between devices: the user experience must change with each device. Websites must be prepared to adapt to different users' scenarios. It has also an economical effect, because it can be calculated as the cost of time losses by users (Milosz and Milosz, 2005).

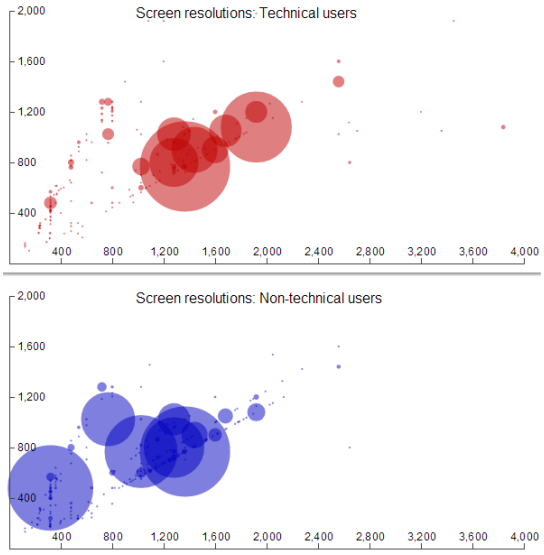

Figure 1: Screen dimensions for a sample of technical & non-technical users (Davies, 2013).

For example, a simple survey of screen sizes

Plechawska-Wojcik M., Lujan Mora S. and Wojcik L..
Assessment of User Experience with Responsive Web Applications using Expert Method and Cognitive Walkthrough - A Case Study.
DOI: 10.5220/0004443001110118
In *Proceedings of the 15th International Conference on Enterprise Information Systems* (ICEIS-2013), pages 111-118
ISBN: 978-989-8565-61-7

carried out in January 2013 (Davies, 2013) showed that there is no average screen resolution, as it can be seen in the scattered plot shown in Figure 1. This plot displays screen dimensions used by two groups of users, technical and non-technical users, and vertical scale is screen height, whereas horizontal scale is screen width. The survey was based on a sample of 5,000 unique visitors to two different websites: one aimed to technical users, and another aimed to non-technical users. The results of this survey confirm the importance of making a web page look good at different screen resolutions. And what is worst, the number of devices with the ability to access Internet and surf the Web is increasing day by day. This is just the beginning of a new era of access to the Internet and the Web. No one knows which devices will be used by users to access the Internet and the Web in the future, so websites should be prepared to be compatible with a plethora of current and new devices.

Therefore, nowadays it is needed to design web sites for different users' scenarios, not for different screens. Besides, the users' interaction patterns also change from one device to another device, and websites should adapt to these changes.

The current solution to this problem is to use "Responsive Web Design" (RWD), a new web design technique that has become very popular during the last two years. However, due to the novelty of this technique, it is not clear if it can santisfy the same user experience when applied to different elements in a web page. The goal of this paper is to assess the differences of user experience when this technique is used to adapt a website to different users' scenarios.

Two methods are applied to assess user experience in a controlled experiment: expert analysis and cognitive walkthrough were adapted to rate the GUI and the user experience on different kind of devices.

The rest of the paper is structured as follows. Section 2 provides a brief introduction to responsive web design. Section 3 contains the description of the method applied in the case study. The method is based on the expert analysis and cognitive walkthrough. Section 4 presents the RWD web application, which was used to perform the case study. Section 5 provides the details of the case study. It contains the description of the analysis process and presents the results of the case study using both methods: expert analysis and cognitive walkthrough. Conclustions are presented in Section 6.

2 RESPONSIVE WEB DESIGN

Responsive web design is a term coined by Ethan Marcotte in his seminal article in 2010 (Marcotte, 2010). The following year, Ehan Marcotte wrote his book "Responsive Web Design" (Marcotte, 2011), in which he explored new techniques and proposed some design patterns. .net magazine, one of the most famous magazines between professional and amateur web designers, declared "responsive design" as the second development trend of the year 2012 (Grannell, 2012).

The goal of RWD is to deliver a quality experience to users no matter how large or small the display they use is. But RWD is not only about changing the way elements are displayed in a web page: RWD is also about how to provide easy reading and navigation with a minimum of resizing, panning, and scrolling across a wide range of different devices.

Responsive web design mixes three different techniques, fluid grids, flexible images, and media queries, all of them based on the use of CSS (Cascading Stylesheets).

The RWD techniques have been compiled in design patterns, common solutions to different design problems (Wroblewski, 2012; Frost, 2013). For example, there are layout patterns, navigation patterns, menu patterns, form patterns, etc.

3 APPLIED METHOD

GUI of the responsive design web page needs to be checked and tested by users working on different type of devices. The site designed in this way should be adjusted to different kind of screen resolutions (computer monitors, smart phones, tablets, etc). It should be readable with a minimum of resizing, panning, and scrolling.

To check users' viewing experience GUI quality evaluating methods might be used. During such case study users experience also needs to be regarded.

Novice users interacting with a system for the first time prefer simple actions and ease of learning (Shneiderman, 1998), but their behavior and work quality changes as their experience with the system increases. This is an important point of view when evaluating GUI quality over time, but to setup such a study requires observation over time and lots of resources (Phung, 2007), which are often hard or even impossible to obtain.

An expert analysis in combination with cognitive walkthrough seems to be the most reliable method

for assessment of responsive design web page GUI quality. As it is shown in the studies (Krug, 2000) in most cases group of several experts using the adequate methodology is able to detect and correct over 85% of errors in software – this applies also to errors in GUI quality. It should be noted that testing can never completely identify all the defects within software (Pan, 1999).

Expert analysis is one of the most widely used method for application testing. Experts, while using the application, check predefined areas. Those areas are defined to help to examine application compliance with interface design guidelines (such as Nielsen-Molich heuristics (Nielsen and Molich, 1990)) and to detect potential problems.

Each of those predefined areas can be divided into several more detailed sub-areas. What is more, they usually have detailed questions assigned to help experts to cover more important aspects of GUI quality (Laskowski, 2012).

Simplified cognitive walkthrough is one of the expert methods of usability and GUI quality testing. It emphasizes the ease of interface learning as well as viewing experience during the initial contact with the system (Laskowski, 2012). This method might be successfully used in combination with the expert analysis method.

This method is based on few tasks, which user will perform during his work with an application (e.g. making a purchase) (Wharton et al., 1994). Each task is divided into individual steps. In the case study the analysis was performed according to the following three questions:

- Does the user know what to do during the analyzed step?
- If the action performed by user is correct, is he aware of it?
- If the action performed by user is correct, does he feel he is getting closer to reach the goal?

The difficulty of each step is usually evaluated using a Likert scale of 1 to 5, with 1 meaning 'very easy', 5 – 'very difficult'.

3.1 Proposed Criteria for GUI Quality Assessment

The web page was tested with the method using the expert analysis and cognitive walkthrough.

The expert analysis criteria consist of the detailed list of areas and subareas with questions assigned to each point. The list is a modified version of the list called "LUT list" which we proposed in (Milosz et al., 2013). Modification consists in adjusting sections concerning different devices and resolutions. The group of main areas contains: *Application interface*, *Navigation*, *Data structure* and *Data input*. Detail list of questions is presented in Table 2 in the paper's results sections. Table 1 presents the grading scale used to assess each evaluated assessed area.

Table 1: The grading scale applied to the LUT list.

Grade	Description
1	Critical usability errors were observed, preventing normal usage or discouraging user from using the application.
2	Serious usability issues were encountered, which may prevent most users from task realization.
3	Minor usability issues were observed, which if accumulated may have negative impact on user performance.
4	Single minor usability issues were observed, which may have negative impact on user work quality (e.g. poor readability).
5	No usability issues influencing either user performance or work quality were identified.

The cognitive walkthrough involves three scenarios containing tasks to perform. They are:

- Run the web page, find the specified article
- Find and display the specified photo in the gallery
- Fill out the data form

Users need to performed those task and answer several questions. They are:

- The type of used device
- The screen resolution
- The type of web browser
- Number of moves to accomplish the task
- Number of mistakes
- Additional remarks

The results of analysis performed using those two methods presents the users experience and GUI quality of prepared responsive design web page.

4 THE APPLICATION

The example web page was created using Foundation framework dedicated to responsive web design. The web page should be readable with a minimum of resizing, panning, and scrolling. It was created to present user interface navigation mechanism and to get know users viewing experience.

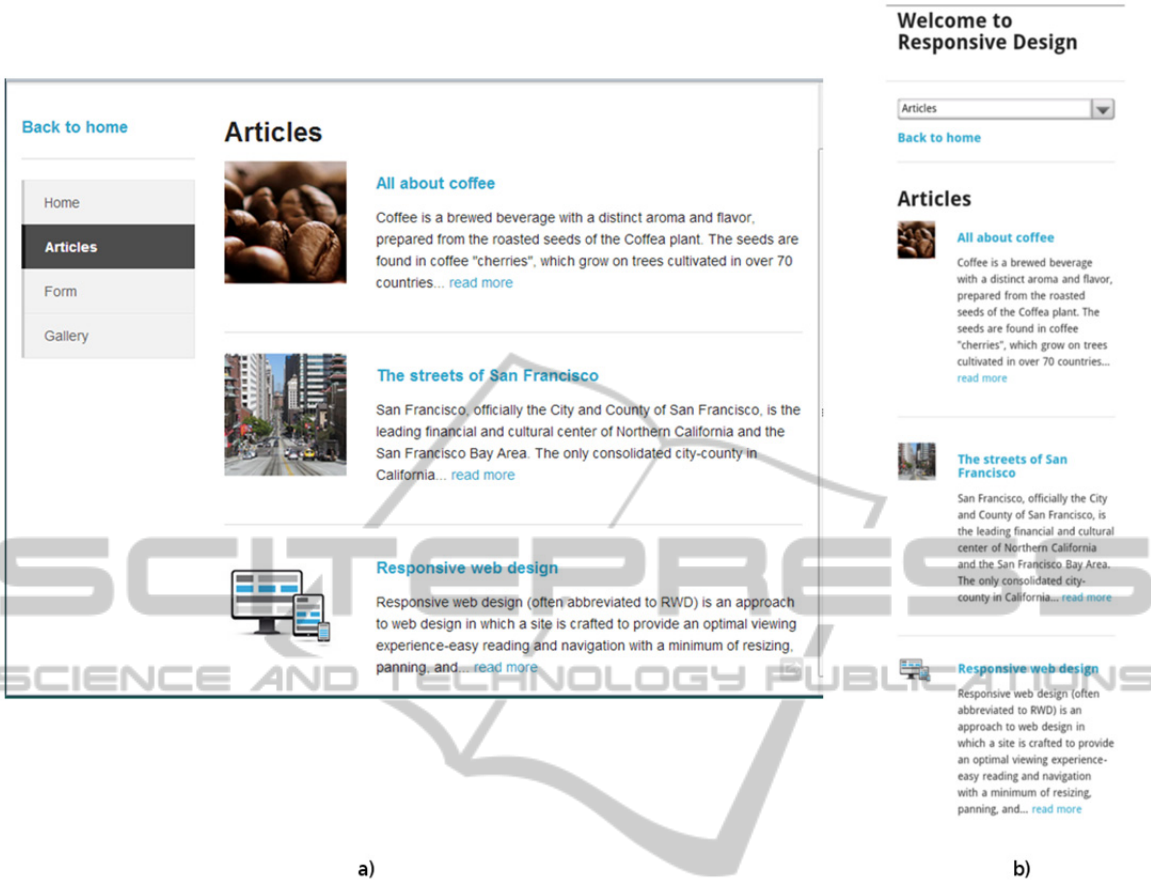

Figure 2: Sample screenshot of the web page (source: own work).

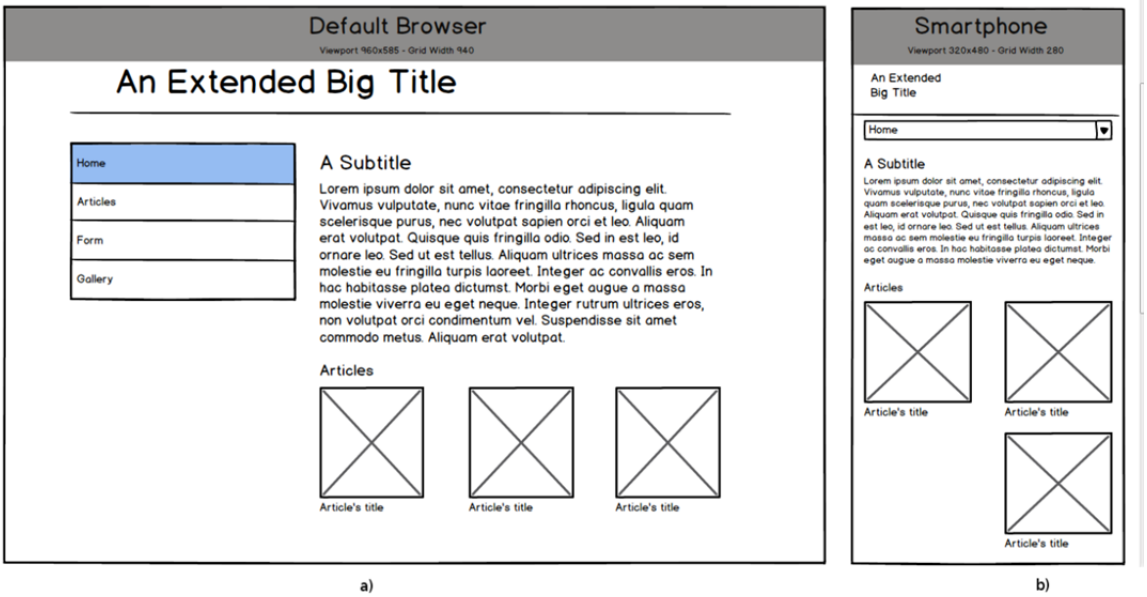

Figure 3: Sample mockup of the home page (source: own work).

The web page does not have extensive functionality. It contains several main sections:

- Articles – extended thematic articles including photos.
- Gallery – several galleries each containing a collection of photos.
- Form – typical web form composed of several questions.

The home page contains news shortcuts and links to the remaining contents of the page.

The menu is placed on the left side. Mobile and smart phone users, however, can see the menu at the top of the screen to make it more readable.

Figure 2 presents an example page screen containing the section of articles. Figure 2a) presents a screenshot taken on a computer and figure 2b) – on a mobile phone. The same page is displayed slightly different at those devices. The location and look of menu is different as well as the size of figures. Differences between web pages adjusted to computers and to mobile phones can be also seen in Figure 3. It presents mockups of the two chosen web pages. Figure 3a) and Figure 3a) present mockup dedicated to computers and tablets with resolution of minimal width 768 px.

The page is always adjusted to the screen resolution, so horizontal scroll is never displayed. The menu dedicated to mobile phones also differs – it has a form of the dropdown list and it is located at the top of the web page. Menu dedicated to higher screen resolution devices has the form of list and it is located at the left side of the web page. Also the size and location of figures is different.

The goal of the useful, high quality GUI is to adjust the web page look to the screen. Differences between web pages dedicated to computers and to mobile devices are designed to improve the user experience on different devices.

5 THE CASE STUDY

The presented case study describes the analysis of created web page. The analysis was conducted by experts experienced with GUI quality analysis.

5.1 The Analysis Process

The case study was composed of two steps. The first one is an expert analysis, the second one – the cognitive walkthrough. Both analyses were performed using the survey.

The first section analyzes the GUI quality, divided into four areas: Application interface, Navigation, Data structure and Data input.

The second section is the cognitive walkthrough based on three tasks presented in Figure 4 – in BPMN (Business Process Modelling Notation) process. Users have to: (1) find specified article, (2) find the gallery and display specified photo, (3) fill and submit data form. After tasks completion, users were asked to fill the questionnaire regarding their viewing experiences. What is more, they were also asked about number of moves and mistakes.

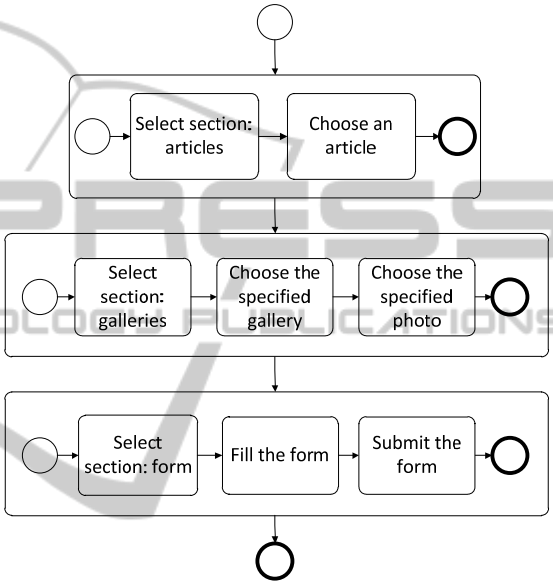

Figure 4: The testing process (source: own work).

5.2 The Expert Analysis Results

The most important issues concerning interface quality are organized by following areas: Application interface, Navigation, Data structure and Data input.

Experts performed the analysis using smart phones (40%), tablets (10%) as well as desktop computers (30%) and notebooks (20%). Using diversified screen sizes enables to check how the application adapts to different resolutions.

The detailed results are presented in Table 1. The general assessment is estimated at 4.3.

5.2.1 Application Interface

The overall assessment of the application interface is good (Table 1, section *Application interface*). The layout occurred to be readable and coherent. Arrangements of fonts, colours and elements were assessed high regardless of the resolution device.

Experts rated it as 4.8. Application interface is adjusted to presented data. No horizontal scroll is displayed, pictures and text are always visible. However, the mobile view is long and it makes user to perform multiple swiping. Mobile devices and different resolutions adjustment was assessed well – respectively 4.3 and 4.6.

The application interface was also assessed as supportive (4.3) and consistent (4.2). Most of available options are visible and accessible. Minor interface errors like small spelling mistakes did not affect user experience significantly. Another slight error is that text and labels are not standardize well – one can find inconsistencies in the sections names. All labels should be made cohesive and aligned in terms of the nomenclature and presentation. This would help to better manage the space and improve readability.

5.2.2 Navigation

This area considers several subareas, such as Ease of use, Menu hierarchy, Navigation structure and Screen elements (Table 1, section *Navigation*).

The general rate of the navigation area is high (4.4). Access to all page elements is easy and intuitive (4.9). The menu was also assessed as easy to use for all type of devices. It is important to notice the menu is separately adjusted to different screen resolutions. In all cases it was proved to be well designed (4.7). However, the localization of menu was assessed at 3.9 and its hierarchy – at 3.7.

The navigation structure seems to be easy and intuitive (4.4). It is also well adjusted to different screen resolution (4.7). All screen elements were also assessed to be supportive (4.6). However, some elements were disabled or working improperly, especially on the mobile version.

The arrangement of most of sections is intuitive and proper. Section elements are standardized and visually grouped, but stronger highlights would additionally improve the navigation.

It is easy to navigate the site and perform such tasks as articles and galleries browsing. However, there is no searching option, which would help to navigate the site and to find required data.

5.2.3 Data Structure

This subarea of the Data structure area are: Ease of use, Information hierarchy and Information structure (Table 1, section *Data structure*).

Table 1: The expert analysis results (LUT list).

Application interface		**4.44**
Layout	Is the layout readable?	4.8
	Is it adjusted to different resolutions?	4.3
	Is it adjusted to mobile devices?	4.6
	Is it consistent?	4.3
	Does it support task implementation?	4.2
Navigation		**4.38**
Ease of use	Is the access to all elements of menu easy and intuitive?	4.9
	Is the use of menu easy?	4.7
	Is the localization of menu intuitive?	3.9
Menu hierarchy	Isn't the menu hierarchy too complicated?	3.7
Navigation structure	Is the navigation structure intuitive and understandable for users?	4.4
	Is the navigation well adjusted to the screen resolution?	4.7
	Is it well planned?	4.1
Screen elements	Do they support the navigation?	4.6
Data structure		**4.49**
Ease of use	Is the access to all sections of an application easy and intuitive?	4.8
	Is the access to all functions of an application easy and intuitive?	4.4
Information hierarchy	Isn't the information hierarchy too complicated?	3.9
Information structure	Is the information structure understandable?	4.7
	Is it consistent?	4.7
	Is it well planned?	4.4
Data input		**3,99**
Data	Is the data validated by the form elements?	3.3
	Do the forms have elements acting as hints for the input data (e.g. on format or data range)?	3.1
	Can an average user fill in the form easily?	4.5
Forms	Are they designed in a readable way?	4.5
	Are they adjusted to the mobile devices?	4.1
	Do they allow user to input all of the necessary data?	4.4

The data structure was rated as easy to use. Experts had no problems to access to all data and

functionalities (4.8). The information hierarchy occurred to be simple and understandable (4.7).
The web page content was found to be consistent (4.7) and well planned (4.3).

Conventions applied to data and labels are coherent. Consistent naming convention is applied.

5.2.4 Data Input

The Data input regards Data and Form sections (Table 1, section *Data input*). The overall assessment of this area is 4.

The data validation needs for improvements (3.3). Application should not accept all data formats. What is more, form's elements do not have hints and additional user help (3.1). On the other hand, the form is intuitive and its elements do not need to be described in detail.

While filling the form it is possible to choose a keyboard instead of a mouse. Forms were assigned to be constructed in readable, intuitive way (4.5). They are also well adjusted to different screen resolution, especially of mobile devices (4.1). However, some form elements were inaccessible on mobiles phones and needed to be additionally adjusted. It was concluded, that forms allow user to input all necessary data.

Web forms work properly and react on user's activities. However, the application should offer more forms of help such as tooltips or pop-up messages. It is also necessary to add improved form validation.

5.3 The Cognitive Walkthrough

Each of prepared tasks was performed by experts working on different devices. This approach enables to check the ability to accomplish tasks at different resolutions and using different navigation methods. Those differences, however, influence on results in that way, that it spreads the number of performed moves.

Figure 5 presents the number of moves performed in, respectively, task no. 1, 2 and 3.

Task 1 could be performed using at least 2-3 moves, depending on the used device. Users responds, however, range from one to six moves. What is more, the most of responses regarding number of done mistakes were set to 0 (Figure 6). It means that task execution has not caused many problems.

Similar conclusions might be drawn from tasks no. 2 and 3. Low number of declared errors shows, that the interface created using responsive design occurred to meet the requirements.

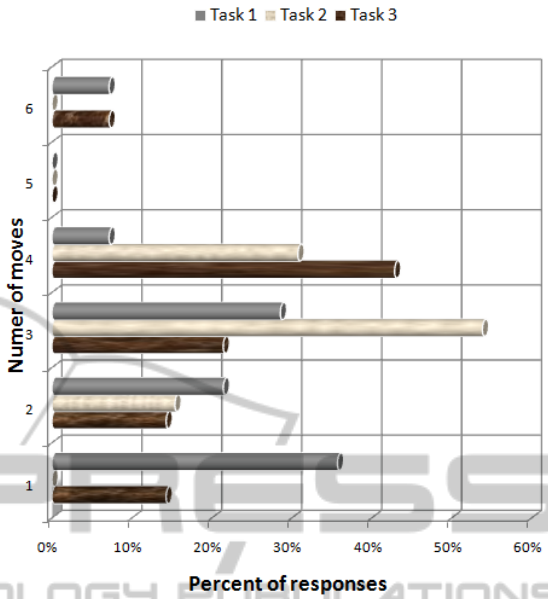

Figure 5: The number of moves needed to perform case study tasks (source: own work).

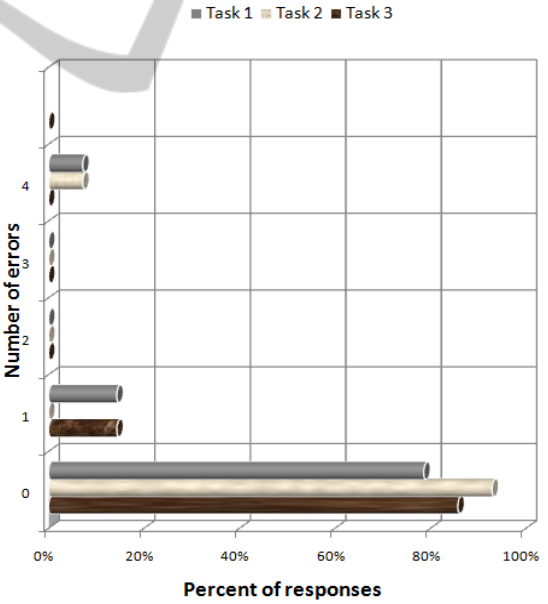

Figure 6: The number of errors done during performing case study tasks (source: own work).

The case study gave also answers to the stated questions. Users knew what to do during the analyzed step, because similar numbers of users moves and low number of errors show, that the tasks were clearly understood and users didn't face serious problems. Users generally were also aware of their

progress and tasks completion. In few cases slight navigation problems were faced by users. However, they did not have a large impact on the general assessment.

6 CONCLUSIONS

The main goal of the presented case study was to assess capabilities of Responsive Web Design (RWD) and to determine the user experience of RWD web pages. The case study was based on two methods (expert analysis and cognitive walkthrough) applied on web experienced users using different devices like computers, smart phones, tablets.

Obtained results confirm the effectiveness of RWD. Low number of errors and quickly completed tasks prove that RWD can be successfully applied in practice.

Responsive web design enables to create web pages, which can be viewed on different devices in similar way. Of course, due to devices diversification, it is impossible to obtain exactly the same web page look and user experience on all devices. However, the exact page look is no more desired result. The aim is to adapt the page to different users' scenarios, not for different screens. Website needs to adapt to users' interaction patterns changes.

Responsive web design helps to obtain this goal. Users do not need to install anything extra or to set any properties. They can use one common interface.

However, one should be aware that the only thing certain about the future is that web design is not predictable. Its development will alway be adjusted to the technology and device trends.

ACKNOWLEDGEMENTS

This research has been supported by the project "GUI usability and accessibility: exchanging knowledge and experiences (AUKEE)" established in the frame of Leonardo da Vinci (LdV) Lifelong Learning Programme in Partnerships action.

REFERENCES

comScore., 2012. Mobile Phones and Tablets Now Account for 1 in 8 U.S. Internet Page Views. comScore. Internet: http://www.comscoredatamine.com/2012/10/mobile-phones-and-tablets-now-account-for-1-in-8-u-s-internet-page-views/. (Visited 2/2/2013).

Davies, D., 2013. A simple survey of screen sizes. Internet: http://my.opera.com/ODIN/blog/2013/01/17/a-simple-survey-of-screen-sizes. (Visited 2/2/2013).

Frost, B., 2013. This is Responsive. Internet: http://bradfrost.github.com/this-is-responsive/. (Visited 2/2/2013).

Grannell, C., 2012. 15 top web design and development trends for 2012. .net magazine. Internet: http://www.netmagazine.com/features/15-top-web-design-and-development-trends-2012. (Visited 2/2/2013).

Krug, S., 2000. Don't Make Me Think! A Common Sense Approach to Web Usability. Que, New York.

Laskowski, M., 2012. Proposals for application interface testing methods. Informatyka Automatyka Pomiary w Gospodarce i Ochronie Środowiska 4b/2012: 21–24 (in Polish).

Marcotte, E., 2010. Responsive Web Design. A list apart, issue 306. Internet: http://alistapart.com/article/responsive-web-design. (Visited 2/2/2013).

Marcotte, E., 2011. Responsive Web Design. A Book Apart.

Milosz M., Milosz E., 2005. Hidden Costs of IT Skills Ignorance. Vilnius University, Information Sciences, vol. 34, pp. 30-34.

Milosz M., Plechawska-Wojcik M., Borys M., Laskowski M., 2013. Quality Improvement of ERP System GUI Using Expert Method: a Case Study, 6th International Conference on Human System Interaction, in print.

Mitchell, A., Rosenstiel, T., Christian. L., 2012. Mobile Devices and News Consumption: Some Good Signs for Journalism. The State of the News Media. Internet: http://stateofthemedia.org/2012/mobile-devices-and-news-consumption-some-good-signs-for-journalism/. (Visited 2/2/2013).

Nielsen, J., Molich, R., 1990. Heuristic evaluation of user interfaces, Proc. ACM CHI'90 Conf., 249-256.

Pan, J., 1999. Software Testing. http://www.ece.cmu.edu/~koopman/des_s99/sw_testing. (Visited 10/2/2013).

Phung, Q. M., 2007. Identifying Usability Problems in relation to User Experience with System and Tests, http://projekter.aau.dk/projekter/files/61070563/1181058253.pdf. (Visited 10/2/2013).

Resmini, A., Rosati, L., 2011. Pervasive Information Architecture: Designing Cross-Channel User Experiences. Morgan Kaufmann Publishers.

Shneiderman, B., 1998. Designing the user interface. Addison-Wesley Longman.

Wharton, C., et al., 1994. The cognitive walkthrough method: A practitioner's guide. Usability inspection methods. New York, NY: John Wiley & Sons Inc.

Wroblewski, L., 2012. Multi-Device Layout Patterns. Internet: http://www.lukew.com/ff/entry.asp?1514. (Visited 2/2/2013).