Usability Testing in Human-Computer Interaction Classroom

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Abstract: *Before launching a new product in the market, series of testing are preformed, in order to satisfy required demands. One of the criteria that needs to be fulfilled is usability testing, which consists of evaluation of products and services by users. Users are expressing their opinion by accomplishing previously defined tasks regarding difficulties they meet during product or service usage. In this paper, the most important concepts of usability and usability testing are explained. Also, basics of web usability, its definition and main website usability testing elements and methods are introduced. In addition, review of few popular and free usability testing tools, as well as a practical example of website usability testing process is presented. Nowadays, usability testing is very important part of the Human-computer interaction research and study.*

Keywords: *Usability testing; Human-computer interaction; Evaluation; Web usability*

1. INTRODUCTION

Every product and service on the market is created in order to meet the demands of a specific group of users. These products and services are rarely able to satisfy needs without continuous improvements. Also, customer requests often change over time, so usability testing on a regular basis is necessary to determine the extent to which a product or service is fulfilling the requirements. The received feedback should be used for product and service improvement.

Usability testing implies product and service evaluation by users. During the usability testing, users are preforming given tasks, while test practitioners are observing examinees and recording results. Main objective of this process is determining problems and difficulties which costumers encounter while using specific product or service, and collecting qualitative and quantitative data of user satisfaction with the product or service. Analysis of usability testing results is the best method for identification of costumer opinions and level of product or service suitability to customer demands.

If the product is a software, usability testing should be done before it enters the market. Thus, costs of rewriting the software and the possible bad first impressions that users could gain if software is not implemented properly would be avoided. Besides that, re-implementation of testing process should be done regularly, because changes of costumer needs and product functionalities are commonly occurring.

Usability testing is one of the main focuses in the area of Human-computer interaction (HCI) all over the world. Usability testing is being studied through HCI master course at some Universities or through HCI course as it is being studied at the Faculty of Technical Sciences Čačak, Serbia.

This paper will provide introduction to web usability concept, explanation of models and norms of testing and a brief analysis of usability testing in HCI classroom. As for a practical example, two differently implemented websites are compared and analyzed in order to determine whether some of them are more suited to the average user and to what extent.

2. USABILITY

Usability is qualitative aspect of product, which is used for measuring whether the interface is easy to use and to which degree [1, 2]. Term "usability" also refers to the process of ease of use improvement which is a part of software design. Usability consists of five components, which are related to quality of above-mentioned process [1-3]:

- Learnability – Do users easily master the basic functions during the first encounter with interface design of software product?
- Efficiency – How fast can users do the tasks when they get familiar with the interface design?
- Memorability – Do users easily return to the professional level of product use after a pause?
- Errors – Do users make a lot of errors, how serious they are, are they easy to handle?

– Satisfaction – Is design user-friendly?

There are qualitative characteristics other than usability such as utility and usefulness. Utility refers to providing the necessary functions to users, while usefulness refers to summation of usability and utility [3].

Usability of software product is of a high importance for its survival on the market. If product is complicated, unclear and inconsistent, it will not be sold. The market is big enough so every type of software will have at least two or three competitive products. Thus, buyers will not waste their time trying to understand a specific product, when they can try another one, more appealing and appropriate for their needs. About 10% of the product development budget is spent on usability testing, which leads to significant improvements in product design [1-3].

2.1. Usability testing

Usability testing is a technique for evaluation of software product, and it is done in real circumstances with real customers [1]. Tests are usually designed by domain experts, and they consist of series of tasks that users should complete while the examiner spectates and records his observations. Consequently, many significant data concerning the customers approach to the product, their way of handling it and existence of problems and errors which should be removed can be collected.

Usability is an important part of every product design process, so testing it only once during the product development is often insufficiently. Besides that, information about design and characteristics of competitive products should be gathered for comparison.

Nowadays, the main challenge for companies is not creating convenient conditions on the market or using modern technologies, but understanding its customer's needs. In order to learn weather product meets users demands or not, product testing should be done.

Many companies still do not apply methods for usability testing during the product design, regardless of all the benefits they can achieve through this process. Some of the reasons for that are following [5]:
– Usability testing can be expensive.
– Usability testing can delay product launching.
– Usability testing can reduce creativity.
– Usability is less important than user feedback.

Website usability testing is becoming more and more important, because the number of companies which are operating via the Internet is constantly increasing. Thus, it is significant that they have appealing and user-friendly web presentations.

Usability testing is classified into three main categories [1, 3, and 5]:

1. Explorative – which is applied in early stage of product development for efficiency and usability assessment of product prototype, as well as for the user understanding and way of thinking evaluation.
2. Assessment – which is used for user level of satisfaction, product efficiency and overall usability assessment.
3. Comparative – which is used for comparing two or more products in order to determine their differences, strengths and weaknesses.

Some of the possible methods of website usability testing are [2, 5]:
– Hallway Usability Testing – The main idea of this method is hiring random individuals for testing instead of trained personnel.
– Remote Usability Testing – This method implies using people from different countries as respondents. The testing can be performed either as a video conference or independently of evaluator. Nowadays, many remote usability testing software are being used for this method of testing. Remote usability testing is often present in HCI courses.
– Expert Review – In this method, expert in the field that is being tested is performing the tests.
– Paper Prototype Testing – This method includes creating rough drafts and hand drawings of interface which are used as design models or prototypes. This method is also of a great importance in HCI courses, especially at lower levels of design learning.
– Questionnaires and interviews – In these methods, face-to-face approach is used, so testers can directly communicate with examinees and ask them additional questions.
– Do-it-yourself (DIY) Usability Testing – As for this method, analyst is creating a testing scenario, as well as completing it in the role of average customer.
– Controlled Experiment – This method is similar to scientific experiments and it usually involves the comparison of two products, with careful statistical balancing in experimental conditions.
– Automated Usability Evaluation (AUE) – AUE is a holy grail among all of the usability testing methods. This is quick and inexpensive method which includes the use of automated tools for testing. This method easily reaches wider audience and provides results rapidly. A large number of website AUE tool prototypes has been developed, all of them with different levels of success.

2.2. Defining the goals

Before usability testing process starts, it is essential to make a test plan. In order to attain satisfactory test results, test subject and method must be completely comprehended. Hence, goals of usability testing should be clearly defined, which

implies objective categorization along with adequate data type selection.

There are different types of usability test objectives, and the right questions should be asked so the whole process can be fully understood and proper goals can be set. Some of these questions can arise during the product data collection, and they usually refer to main information about product, users, product successfulness, competition, product research, duration of testing etc. [5].

After the goals are set, the proper usability testing method should be chosen. Firstly, type of results to suit defined objectives should be determined. Some of the common result types are charts, rating scales, printed forms, audio or video records etc. Depending on the interest group, different results can be needed. For example, shareholders would easily understand numerical results displayed through charts and rating scales, while executive board members would rather have video presentation of test results. So, in order to choose the correct data and result types, it is crucial to properly define the goals of usability testing. In table 1, the examples of different question types and corresponding results are shown.

Another important aspect of test planning are metrics. Metrics refer to quantitative characteristics of usability, rather than qualitative ones acquired through verbal responses to questions [2, 6, 7]. By combining the quantitative and qualitative data collected during the test, the number of usability problems, their cause and possible solutions can be identified. Qualitative methods involve direct communication with respondents and they are answering the questions how, when and what has happened, while quantitative methods involve indirect communication with respondents and they give answers to the question how much.

Usability metrics are actually statistics that measure performance of user task execution. Success rate, error rate, execution time and rates estimated by examinees are just some of the values that can be measured for quantifying usability [7].

Table 1. *Test results depending of question and answer types [5]*

Type of question/answer	Question example	Result
Oral	Describe and show what was the most irritating part of this website to you.	Verbal answers are usually directly connected to a part of website which is being tested at that moment, so this type of questions are used for gathering information about main issues of the product.
Multiple choice	Do you trust this manufacturer? – Yes – No	This type of questions/answers are primarily used for categorization. Responses can be nominal (e.g. dogs or cats), dichotomous (yes or no) or ordinal (Likert scale for measuring the level of agreement/disagreement).
Rating scale	What is the probability that you will revisit this website? 1 2 3 4 5 (Strongly Disagree (1); Disagree (2); Undecided (3); Agree (4); Strongly Agree (5))	These questions are used for presenting ordinal values with different levels (low, intermediate, high).
Written	Do you think that this website has some defects and which?	Written answers are typically used for analysis which are preformed after testing.

Although defining of usability metrics is simple, gathering needed data can be time consuming and expensive. The need for this process should be justified and strongly determined so unnecessary expenses can be avoided.

Main aspects of product usability are characteristics related to product simplicity and ease of use [6]. Besides that, it is highly important that website provides accurate and accessible information and to include all functionalities that user may need. Fulfilling user demands is a must for having satisfied and loyal customers. There are few elements which must be adjusted to users on every page of website [5, 6]:

– Design,

– Content,

– Labeling,

– Functionality and

– Navigation.

During the website evaluation, all of the above-mentioned elements must be tested. There are many tools which can be used in this process for

testing some of the following elements: page loading speed, design and navigation, interaction with users, error testing, testing of target (internal) pages, user surveys, accessibility [6-8].

2.3. Methods and types of usability testing

Classification of usability testing can be done on different basis. There are three main classes of usability testing depending on method used for its implementation [9]:

– In-person,
– Under the supervision and
– Remote,
   – Supervised and
   – Unsupervised.

There are many other methods which are used in combination with before-mentioned techniques, such as [4, 5, 7, and 9]:

– Card Sorting,
– Tree-testing,
– Voice of Customer Surveys,
– Heuristic Evaluations,
– Keystroke Level Modeling,
– A/B Testing,
– Click Testing.

The choice of the appropriate method and the test type depends on the well-defined objectives of the usability testing. Selection of proper test is crucial part of whole usability testing process.

Regardless of elected test type, testing should start with pilot test. Pilot test requires additional time and effort, but it provides information about test mistakes and inaccuracies. This test is a demonstration of real test and it is performed in the same way, but without analysis of results. The main goal of pilot test is not interpreting results, but identifying irregularities and errors which could occur during the real test conducting. Some of the common problems are technical problems, human errors or a set of circumstances. In order to achieve maximum precision of test and reliability of data, pilot test should be done at least once throughout the test process.

Next classification of tests is based on method of product use [4, 5, 7, and 9]:

– Scripted – These tests focus on specific aspects of testing of usability;
– Decontextualized – In these tests, products are not being used in test phase. These tests are designed for user experience and generating ideas.
– Natural – These tests are used for customer behavior patterns and product trends analysis.
– Hybrid – These creative and untraditional testes are focused on understanding of user way of thinking.

Besides previously-mentioned test classes, there are also tests which include user characteristic analysis such as: problem discovery, benchmark, eye-tracking etc.

The main purposes of eye-tracking website usability testing are determining the eye-catching parts of website and establishing user navigation through website. This type of testing must be done in-person and under supervision. Eye-tracking is very common in the field of HCI.

3. WEB USABILITY TESTING

Website usability testing implies using specific method and tool for testing in order to analyze every part of the website. Main goal of web usability testing is achieving the satisfaction of the website users. The web usability testing process is similar to testing of other products.

It should be kept in mind that there are currently 1 870 000 000 active websites worldwide and this number is constantly increasing [10]. This means that there is a huge number of websites with similar purpose and users have no reason to spend time trying to understand a website that is complicated when they can easily switch to the next one offered.

When performing testing, there are a few tips to follow [5]:

– Encourage users to act naturally - websites are generally made with responsive design and support different approaches to their functionalities, which users may not try if they do not feel comfortable;
– Users should complete the task the way they choose - although it might seem that the user did not understand the task or went in a wrong direction, observer should wait and watch, so information of user interaction with website could be gathered and understood;
– Competitive websites should be tested as well - by testing other, similar websites, more important information can be collected.

Whether the subject of testing is an official website of a company or a personal blog, there are six criteria that must be tested [5, 6, 9]: task performance, navigation, design, readability, accessibility and speed.

3.1. Tools for web usability testing

There are many tools for web usability testing depending on test type. These tools are usually commercial and their price ranges from a few hundred to several thousand dollars. However, for students needs at faculty courses, there are trial versions of many tools which are limited either by provided functions or time.

As mentioned before, there are certain segments of websites that are crucial in usability testing such as: page loading speed, design and navigation, interaction with users, error testing, testing of target (internal) pages, user surveys and accessibility. For each of these areas, one tool for testing will be presented, comparison and other analyzes [11]. Also, there are software packages

that can be used to test website usability for all the above-mentioned segments.

For the page loading speed, one of the best tools with a wide range of possibilities and analysis integrated is *GTmetrix* [11]. *GTmetrix* is a free tool that can identify all the files which are used by website, in order to identify the part of the website that takes the most time to load. It also has the ability to compare two websites and perform a large number of comparative analyzes.

In the design and navigation area, free tool called *Spur* can be used. This tool is very simple, i.e. it is only necessary to enter the page address and the system will display the page in different contrasts, zoomed in, with an unclear image, etc. [11].

As for the interaction with users, there is a paid *CrazyEgg* tool, which is used for recording the movement of the mouse and highlighting the places that users most often visit on the website. It also records mouse clicks on every position on the website [11].

In the errors and error testing field, there is a free tool called *PowerMapper*. It has very useful features when it comes to identifying errors, as well as failures that may cause errors in the future [11].

To test target (internal) pages, there are free *Google Content Experiments* that can provide information related to the first pages that users visit on the website [11].

UserEcho is a free tool used for creating surveys on the website that everyone can complete. As a result, direct feedback from users regarding important questions about website can be collected [11].

Accessibility of websites can be checked with *BrowserShots* tool. This is a free tool used for testing the website appearance and functionalities in different browsers and on different devices [11].

4. EXAMPLE OF WEB USABILITY TESTING

4.1 Methods of analysis

This work includes research realized through testing of several elements of websites using available tools. In test plan, two websites are chosen for testing, one that gives an impression of functional and practical website, and another that looks less efficient. In this research, remote, unsupervised methodology is used and comparative test type.

Master students from study programs Electrical and computer engineering and Information technologies did all testing and present obtained results. Students chose two websites for testing: www.uspon.rs [12] and www.metalacposudje.com [13]. They are both official web presentations of companies, but the first one also includes web shop functionality.

Comparative tests are carried out by testing each website individually, and then both results obtained are compared. Testing of each element on both websites must be performed with the same tool and the same methodology. Thereafter, results are being compared, and a website that provided better performance for tested element is being selected. When all elements are tested, on both websites, a general conclusion about the usability of websites is made. Also, all of the elements that are being tested are evaluated in sense of relevance for usability.

One of the reasons why these websites were selected for analysis is that they are web presentations of local firms, so the test results could be useful both for them and for other smaller local firms in terms of highlighting the areas they should pay attention to when it comes to usability of websites. The crucial factor that influenced the selection of these two websites is the subjective opinion of students that they differ in their usability level, so it would be easier to explain the advantages and disadvantages of one in relation to the other website.

In this example, the following website usability elements were tested using tools listen in brackets: accessibility (*BrowserShots*, *Responsinator* tools), page loading speed (*GTmetrix* tool), user interaction (*Clueapp* tool) and error checking on the website (*PowerMapper* tool).

4.2 Results of usability testing

For accessibility testing, tests were performed on three different browsers: Chrome, Firefox and Opera, on three different operating systems: Linux Ubuntu, Windows 7, and Mac OS. In addition, websites were tested on two browsers that are typical for Linux and Mac OS: *Dillo* and *Safari*.

Primary conclusion for the website of the Uspon Company is bad responsive rate, which is the first disadvantage of this website. Therefore, further testing on tablets and phones of different sizes would be superfluous. As for the Metalac Company, website has a responsive design and has been adapted for viewing over the phone, tablets and computers. However, the Uspon website has given a better overall result when testing on different search engines and operating systems was done.

When it comes to page loading speed, the Uspon website is in the lead. An average loading speed of 6.5 seconds measured on 77 requests was estimated for Uspon website, while on the Metalac website average time was 11 seconds for 129 requests. It should also be taken into account that the home page of Metalac is more than 5MB larger than Uspon website. The overall conclusion for loading speed is that both websites have very low ratings, so this usability element should be considered as one of the disadvantages of these websites.

In the Figure 1 detailed loading speed time consumption for both websites is presented. In Figure 1 a) it can be seen that a significant part of the loading time for Metalac website is spent on loading the images which are obviously very large. This means that the entire website takes up plenty of space and consequently it takes too much time to load. In order to improve this segment of usability, images should be optimized by changing their size and resolution or even completely removing some of them. In figure 1 b) it can be seen that loading speed divided by elements for Uspon website is much shorter and evenly distributed. In this segment of usability, observed websites vary greatly, and it can be concluded that Uspon website shows somewhat better results.

In the interaction with users testing field, initial impressions on a sample of 10 users who visited these websites for the first time or very rarely are collected. For ten users surveyed, the most memorable items on the Uspon website are the company logo, advertisements and navigation (Figure 2). Also, users noticed red color adequately integrated with the gray. It can be concluded that website designers have found the most suitable positions for the most important parts of the website, such as the logo and navigation. Based on this sample of users and their opinions, the impression is that no changes should be made in terms of design and layout of the elements on the website. However, perhaps this impression would be different if the survey was conducted over a larger number of users using different search engines and devices.

In the Figure 3 the results of survey on the impressions of the Metalac website are shown. Within five seconds (the duration of the home page display before the survey appears), the page could not be loaded, so the users gave responses accordingly to that occurrence. Although this was not the point of the test, it provided information about the opinion on the pages with slow loading

speed and the website designers should definitely deal with this problem.

Figure 2. *User opinions about website Uspon*

Figure 3. *User opinions about website Metalac*

As an improvisation of the test, due to the lack of desired results in the previous survey, an additional test was carried out, as the authors of the work went through all the elements of the website. It was noticed that navigation is well placed, but at some pages navigation is missing and there are no Home and Back buttons. This is certainly an oversite and a deficiency of design.
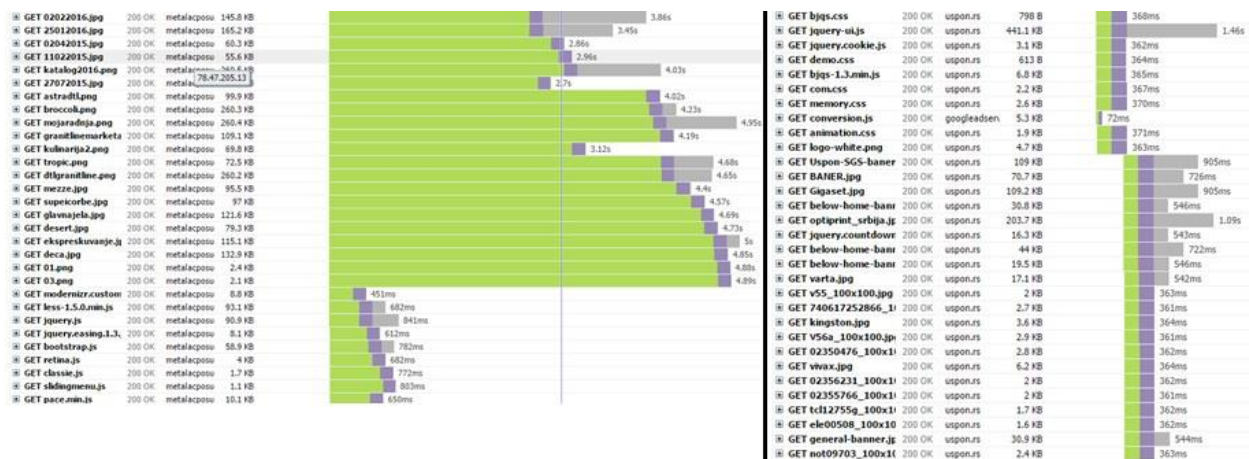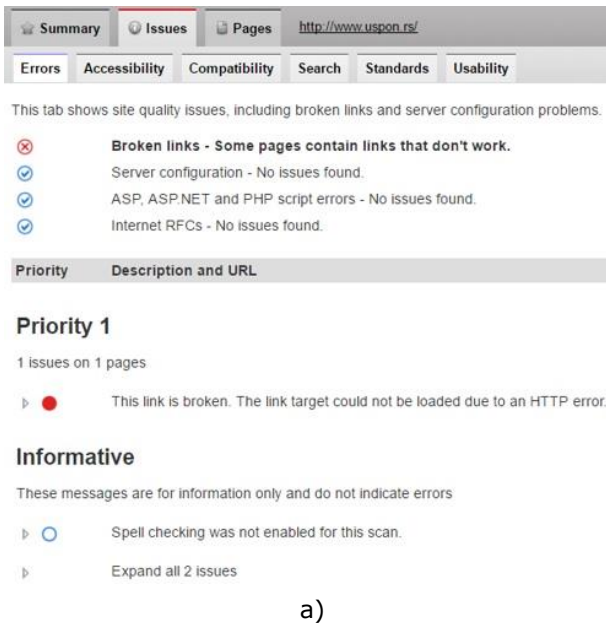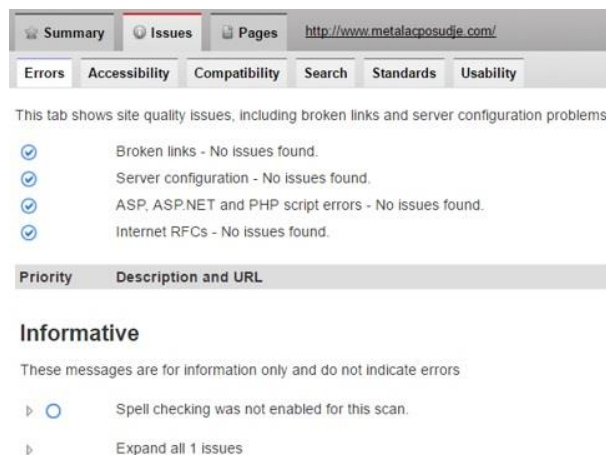

a)   b)

Figure 1. *Loading times for a) Metalac website b) Uspon website*

When testing errors, it is necessary to enter the addresses of the websites that are being tested in the *PowerMapper* tool, and the system itself will recognize bugs and errors. In the Figure 4 the results of testing for both websites are shown.


a)

b)

Figure 4. *Testing results for errors a) Uspon website b) Metalac website*

As it can be seen in the Figure 4a, the Uspon website has an error in the form of a link that does not work, i.e. does not lead anywhere. The Metalac website did not have any errors (Figure 4b)).

What can also be noticed is that both websites have certain flaws that are not in accordance with the guidelines established by Usability.gov (Figure 5), an institution that defines good practices when it comes to usability of websites. In both websites minor errors are detected and grouped by priority level. Explanation and solution within the standards and guidelines of this institution for all errors are provided.
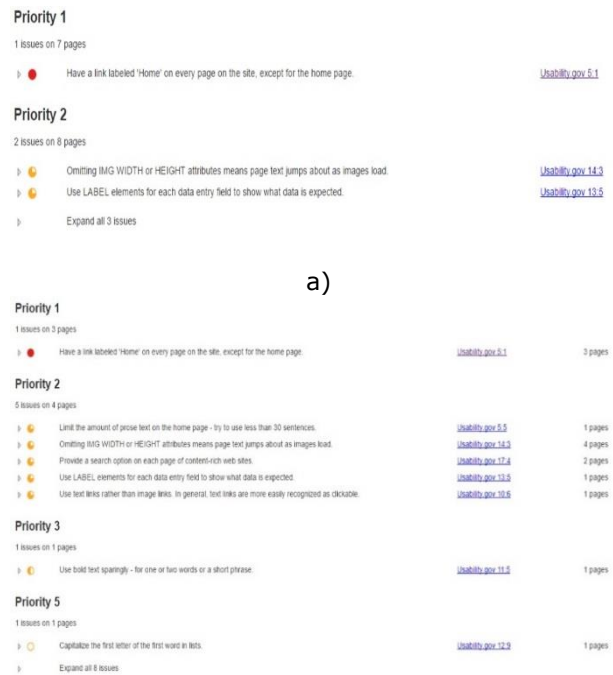
a)

b)

Figure 5. *Oversights on the sites that are not in accordance with standards a) Uspon website b) Metalac website*

At the end of the error test, it can be concluded that both websites in this segment are free of any major errors and serious failures. Practically, there are no mistakes that can affect the usability of these websites. The only thing that is noticed is that some segments are not in compliance with the guidelines and rules of good practice proposed by Usability.gov.

This research provided the information about usability problems in four segments of websites. Majority of the results confirmed the initial impressions of the students about the websites. In Table 2 an overview of the final results is shown. The exact level of the quality and usability of websites was not established, so results are not presented quantitatively, but as a pluses and some minuses, depending of determined level of usability for each segment. Comparative analysis showed that the Uspon website has a great advantage over Metalac website.

Table 2. *Results of testing*

Segment \ Website	Uspon	Metalac
Accessibility – responsive design	–	+
Accessibility testing	+	–
Loading speed	+	–
User interaction	+	–
Error testing	+	+

5. CONCLUSION

Usability is a very important feature of every product, whether it is a tangible product or a service, a software or a website. The extent to which customers' requests are met, represents the level of user satisfaction with the product, which directly affects its survival on market.

The usability test is a topic that is attracting more and more attention of many companies, and it will surely be important to everyone who wants their product to be successful and to fulfill demands of the users. Although it may require a lot of resources and time to obtain needed data for analysis, usability test can also be done with a very small budget, often with paper and pencil only. Despite that, the results will certainly be significant to the products sustainability on market, because any feedback from the user is better than no feedback at all.

This paper presents a comparative usability testing of two websites, with an attempt to show in practice that some website elements can affect its performance. It is necessary to pay attention to the as more details as possible and to try to eliminate all problems and errors. Feedback of the users is very important and their opinion should be relied on during the website design and usability improvement, since they are those who determine the success of the website, product and company.

Usability testing found an important place in HCI courses, where students from Master studies learn theoretical concepts and use some of the available software for usability testing and evaluation of user interfaces. This way they are more prepared for future job opportunities in sector of Information technologies.

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