Marek Miłosz[1], Sergio Lujan-Mora[2]

ECONOMICAL ASPECT OF WEBSITE MEMORABILITY

The economic model for estimation of hidden costs of using websites is presented in this paper. These costs are the result of productivity loss in connection with the use of poorly, non-usability designed web pages. One of the elements of usability is memorability. This aspect is considered in detail. The experiment to determine the loss of time due to poor memorability are presented.

Keywords: costs of loss, productivity; usability, memorability; economic model.

Марек Мілош, Серхіо Лухан-Мора

ЕКОНОМІЧНИЙ АСПЕКТ ЗАПАМ'ЯТОВУВАНОСТІ САЙТУ

В статті представлено результати експерименту щодо визначення втрат часу через погану запам'ятовуваність сайту. Описано економічну модель для оцінювання прихованих витрат використання веб-сайтів. Доведено, що ці витрати є результатом зниження продуктивності праці в зв'язку з використанням погано розроблених, без урахування юзабіліті, веб-сторінок. Одним з елементів юзабіліті є запам'ятовуваність. Цей аспект розглянуто більш докладно.

Ключові слова: *втрати, продуктивність, юзабіліті, запам'ятовуваність, економічна модель.*

Марек Милош, Серхио Лухан-Мора

ЭКОНОМИЧЕСКИЙ АСПЕКТ ЗАПОМИНАЕМОСТИ САЙТА

В статье представлены результаты эксперимента по определению потерь времени из-за плохой запоминаемости сайта. Описана экономическая модель оценки скрытых затрат использования веб-сайтов. Доказано, что эти затраты являются результатом снижения производительности труда в связи с использованием плохо разработанных, без учета юзабилити, веб-страниц. Одним из элементов юзабилити является запоминаемость. Этот аспект рассматривается более подробно.

Ключевые слова: *потери, производительность, юзабилити, запоминаемость, экономическая модель.*

Introduction. In today's electronic economy, employees of companies are increasingly using various web sites to carry out their tasks. So, the productivity of these services users depends on the quality of these services (Landauer, 1996). The quality of web services is affected by many factors: from the technology layer (its speed, quality equipment etc.), competences of these users and their needs, up to the quality of interfaces. This quality is characterized by the concept of usability (Nielsen, 1993; Palmer, 2002).

Web usability generally refers to the experience the user has when reading and interacting with a website. Websites usability consists of the following elements (Nielsen, 1993): learnability, efficiency, memorability, number of errors and users satisfaction. Increasingly, the principles of web usability is a requirement not only economical but also legal (Laskowski and Szymczyk, 2010).

[1] Institute of Computer Science, Lublin University of Technology, Poland.
[2] Department of Software and Computing Systems, University of Alicante, Spain.

Currently, there is no European legislation relating to web usability. The only pan-European legislation close related to web usability is the legislation on web accessibility. The member states of the European Union are required to adhere to the eEurope Action Plan (European Commission, 2002) designed to increase use of the Internet in all areas of European society. The Action Plan recommends the adoption of the Web Accessibility Initiative (WAI) guidelines in order to offer public information accessible to people with disabilities.

The memorability is the quality or state of being easy to remember or worth remembering. In the context of websites, memorability can be defined as the quality of a website that a user can leave and, when he or she returns to it, remember how to do things in it (Nielsen, 1993). Memorability is extremely important for website users because they may not be using web application all the time and they were not trained.

Literature analysis and problem definition. From the economic point of view a website usability is assessed using various cost-benefit models (Rajanen and Jokela, 2004). These models consider the general problem in all phases of life on the website: from design to operation (daily use) (Rajanen and Jokela, 2004; Rajanen and Tivari, 2007). Most of these models were created to justify the need for investments by the supplier of services (Rajanen and Tivari, 2007; Wong, 20003). Meanwhile, on many sites a user has limited impact on its structure and technical layers.

A variety of metrics is created to empirically evaluate and compare the usability of websites (Hub and Zatloukal, 2009; Palmer 2002; Romano et al., 2009). They are aimed at comparing sites to each other.

Many methodologies were created to assess the economic efficiency of websites as software applications. For example, Hub (2009) considers the econometric model for evaluation of usability of public administration information systems, mainly accessed by the Internet. Well-known existing methods for evaluation of investment efficiency have been used in (Hub, 2009), for example: Net Present Value (NPV), Internal Rate of Return (IRR), Payback Method and Return of Investment (ROI). All these methods use costs of investment as a variable and are designed to assess effectiveness of the website from its owner point of view. But the Internet sites often generate large costs for end users.

The main aims of this research are to build the model of estimation of the costs of badly designed websites for their users and to create a method of its parameters measurement.

Economic model of memorability losses. Costs of employee's productivity loss related to the memorability problem can be calculated as a employer cost for thet lost work time. So, it is possible to calculate it as (Milosz and Milosz, 2005):

$$KRU = \frac{52 * TSK * TSU}{NTR * TSP^2} KRP, \quad (1)$$

where:

KRU - average yearly cost loss of productivity per one employee, EUR/year;

TSK - average employee week work time with web systems, hour per week;

TSU - average employee week time loss, hour per week;

NTR - number of workweeks per year;

TSP - average employee week work time, hour per week;

KRP - yearly cost of employee work/year;

52 - number of weeks a year.

The average of employee week time loss due to the memorability problem can be calculate as:

$$TSU = \sum_{g=1}^{NWG} \sum_{i=1}^{NPW_g} TLS_i^g, \quad (2)$$

where:

g - the number of the webpage group;

NWG - the total number of webpage groups;

i - number of a webpage access in a week;

NPW_g - the total number of accesses per week in the g group of a webpage;

TLS_i^g - time loss (due to the memorability problem) per access number *i* to the webpage in the group number *g*.

Time losses (TLS_i^g) can be calculate as:

$$TLS_i^g = TPT_i^g - TPT_{i\to\infty}^g, \quad (3)$$

where:

TPT_i^g - task performing time in access number *i* to webpage in the group number *g*;

$TPT_{i\to\infty}^g$ - the minimum (without losses due to bad memorability) of task performing time on the webpage in the group number *g*.

Most elements of this model are determined by economic and organizational parameters of the company. To calculate *TSU* the practical experiment is necessary to find both components of time loss, i.e. TPT_i^g and $TPT_{i\to\infty}^g$.

The experiment and its results. The main aim of our experiment was to try to estimate the amount of time lost by an employee while working with a corporate website in connection with its memorability.

In order to measure the amount of time lost when working with a website, a set of experiments was carried out with two different groups of students. A/B testing (splitting the subject users into two non-overlapping groups) was used in order to compare the results of a control sample to other sample and then discover significant differences. Therefore, students were split into 2 groups (Figure):

- Group A. The main goal of this group was to measure the *short time memorability*. The same experiment was repeated 4 times, with a time gap of 30 minutes between each attempt.

- Group B. The main goal of this group was to measure the *long time memorability*. In this case, the same experiment was repeated with a time gap of 1 week between each attempt.

In each repetition of the experiment, students had to accomplish the following tasks:

1. Open the europa.eu web page (Figure 2).

2. Switch into Polish language version of the website (Figure 3).

3. Find the answers to the following questions:

a. Find the number of the European Union member states on January, 1, 1981, after the Greece admission. Students had to write the number of member states into the result file.

b. Find the multimedia presentation (Microsoft PowerPoint file) about "3 main key players" in the European Union. Students had to write the name of the first player and the URL address to the multimedia presentation into the result file.

c. Find the general information about The European Health Insurance Card. Students had to write the URL address of the main page into the result file.

d. Find the list of the European Union member states and the current number of European Union member states. Students had to write the number and the URL address into the result file.

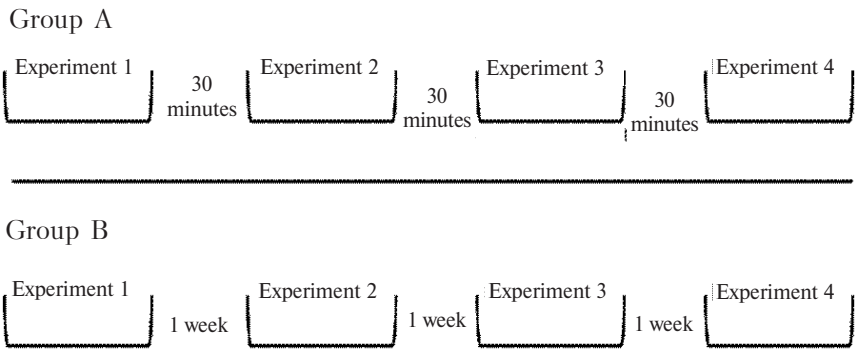

Figure 1. **Time planning of the experiment**

Students were not allowed to use other websites apart from the europa.eu website to find the requested information. Especially, the use of Google was completely forbidden.

In the result file, the students had to write the following information for each task:

- The number of the task (1, 2, 3, or 4).
- The starting time of the task, measured in hours, minutes, and seconds.
- The answer to the task.
- The ending time of the task, measured in hours, minutes, and seconds.

Each student had to produce a result file with a certain format. In Figure 4, an example of the result file is shown. All the result files were gathered to check their validity and to calculate some statistics, such as the maximum, the minimum, and the average time needed to accomplish each task and each experiment.

In Figure 5, the results of the short time memorability experiment are summarized. In this experiment, the same tasks were repeated 4 times, with a time gap of 30 minutes between each attempt. Between the first and the second attempt, the largest drop in the time needed to accomplish the experiment is detected, since the time needed to finish is reduced by near 60% (from the average time of 12 minutes in the first attempt to 5 minutes in the second attempt).

Between the second and the third attempt, the time needed decreases another 40%. Finally, between the third and the fourth attempt the time stabilizes and the difference in the time needed is less than 8%. Basically, the conclusion is that the time needed stabilizes quickly after the third attempt.

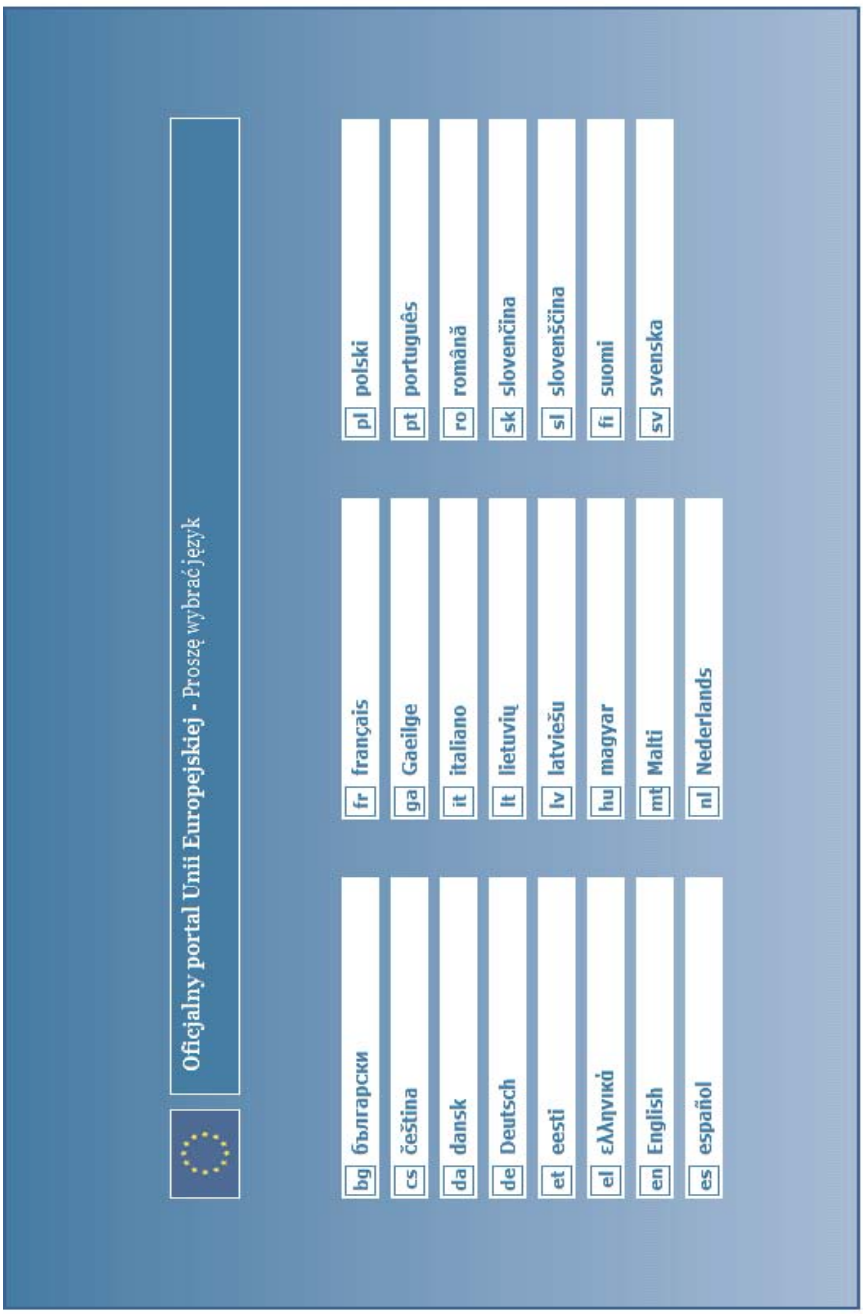

Figure 2. **europa.eu welcoming web page**

Figure 3. **europa.eu main web page in Polish**

1@15:35:25@33@http://europa.eu/...@15:37:25
2@15:37:30@Jerzy Buzek@http://europa.eu/...@15:40:10
3@15:40:15@http://ec.europa.eu/social/...@15:43:40
4@15:43:55@27@http://europa.eu/about-eu/...@15:48:20

Figure 4. **An example of the result file**

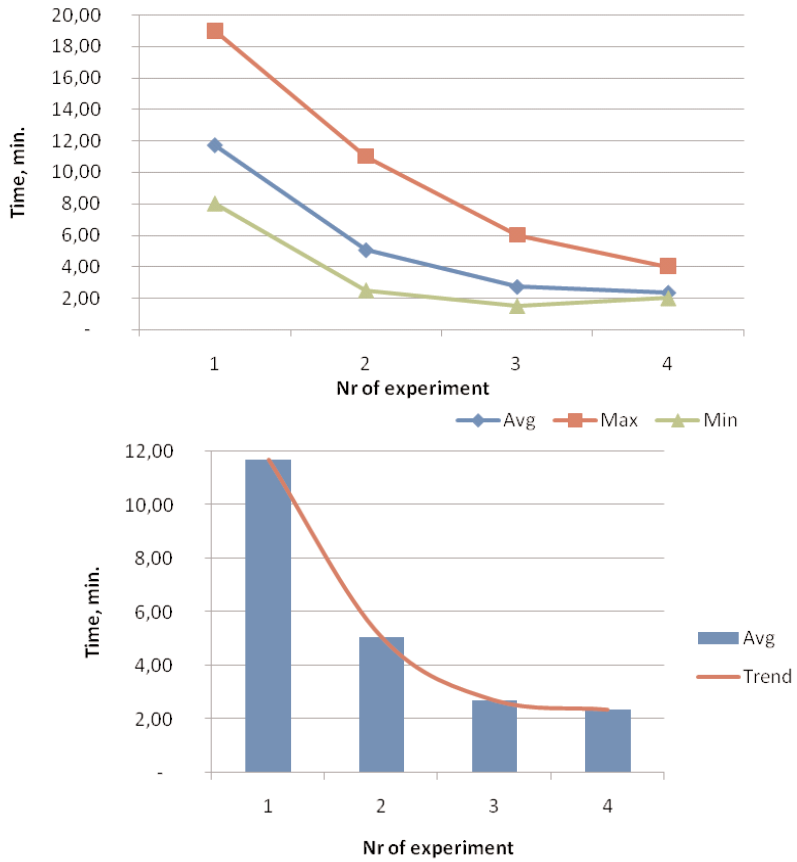

Figure 5. **The results of the short-time memorabilty experiment**

In Figure 6, the results of the long-time memorability experiment are summarized. In this experiment, the same tasks were repeated 4 times, with a time gap of one week between each attempt. Between the first and the second attempt, the time needed to perform the experiment dropped by about 30%, whereas in the short time memorability experiment the time needed reduced by near 60%. This result is very reasonable and shows the effect of memory on the repetition of a task.

Between the second and the third attempt, the time needed decreases by less than 6%. Finally, between the third and the fourth attempt the time needed dropped by about 4%.

If the results of the short-time and long-time memorability experiments are compared side by side, a remarkable value can be detected. Whereas in the short-

time memorability experiment the average time tends to nearly 2 minutes, in the long-time memorability experiment only tends to nearly 8 minutes. This result opens a new research possibility: to measure the importance of long-term working memory.

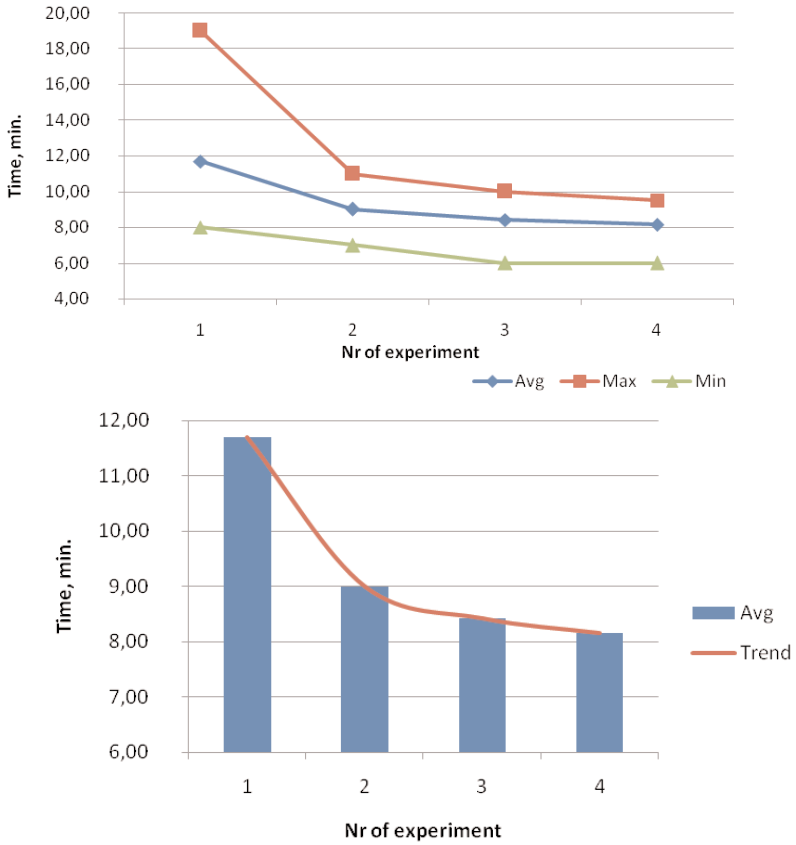

Figure 6. **Results of the long time memorabilty experiment**

The short-time experiment allowed to determinate the value of the minimum (without losses due to bad memorability) of task performing time on the webpage (i.e. $TPT^{g}_{i\to\infty}$). It is the stabilized value of time of tasks performing - Figure 5 (app. 2 minutes).

Conclusions and study perspectives. It is possible to use economical model to calculate costs of employee's productivity loss related to the memorability phenomenon.

Some studies (Craik, 1987) showed that recall (the retrieval of information from memory without a cue) and recognition (the retrieval of information from memory in response to a sensory cue) are two basic components of memorability (Hintzman, 1992), changing by increasing age. Recognition is easier than recall, and therefore, recall requires more processing resources than recognition and such resources are depleted as people grow older. Therefore, we plan to measure the impact of age in

memorability and we plan to check if older people perform relatively less well in the tasks where memorability plays an important role.

Besides, another important factor is the familiarity, the quality or state of being familiar, i.e., the perception of somebody that compares a new thing with previous knowledge (Hintzman, 1994). This is another important factor that influences the usability of a website.

Another research possibility is to measure the importance of long-term working memory. Nowadays, workers' memory is crucial in the information age. However, workers suffer several distractions during their working time: telephone calls, emails, meetings etc. We are thinking about repeating the experiments presented in this paper but including the distraction factor.

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