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Exploring the possibility of applying the GOMS model to e-banking software design

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Abstract. The GOMS model in human-computer interaction could be applied in improving software design in e-banking, ie in improving the function of appointed bank clients as outermost users of software. We researched users' opinions on some actions performed in the software and on suggestions for making changes to the software. An online survey questionnaire was used as a research instrument. The analysis of the survey results answered the question of whether the application of the GOMS model in the design software for e-banking can be significantly improved. There were also proposals to introduce changes that would improve the function of software intended for furthestmost users.

Keywords. E-banking, HCI, GOMS model, Web application, software

1. Introduction

Electronic banking is an indispensable component of modern business, which is characterized by the intensive use of information and communication technologies (ICT). The development of ICT has influenced the change in the concept of e-business. It is possible to overcome some problems that previously existed due to the geographical distance of business participants.

Interaction between customers and the store has also advanced, as the Internet enables the use of interactive sites to listen to customer opinions, involve them in product design and examine customer satisfaction.

The Internet store and payment via the Internet are considered to be among the most significant innovations in e-business. Considering the widespread presence of ICT in e-business, some define e-business as "any type of business over the Internet". [1] It can be said that the result of e-business is the application of new technology and the need for change, where the way of doing business is fundamentally changing. [2]

Banks have also found their place in the new, transformed business models. The bank occupies a central place in financial transactions, because it transfers money from the buyer's account to the seller's account. It also provides its clients with additional services, such as loans, etc. By using ICT, banking can improve and automate. One of the most frequently used forms of e-banking is network or Internet banking, which can be defined as an electronic payment system that enables clients of a bank or financial institution to perform financial transactions through the institutions of the website. [2]

In this regard, banks use interactive web applications tailored to customer requirements. In order to determine the requirements of users, it is necessary to apply some of the models of human-computer interaction during the design or re-application of applications. Human-computer interaction involves the joint execution of user-computer tasks; the structure of communication between computer users, the human ability to use a computer (including learning to use the interface); development of algorithms and programming of the interfaces themselves; the process of interface specification, design and implementation. [3]

The GOMS model in human-computer interaction enables the examination of user requests according to the manner of performing certain actions in the application. It represents the acronym of the words: Goals, Operators, Methods and Selection. [4]

A specific goal, ie function in the application is performed by performing a series of steps (operators) that make up the method. If a goal can be achieved by several methods, e.g. using several actions by using mouse or using a keyboard, selection rules are used to determine better methods, depending on the abilities and habits of the user.

The GOMS model enables the right decisions to be made in designing the user interface based on the experiences gathered from the users themselves using the GOMS model. [5]

2. Previous researches

The use of Web applications in e-banking, as well as the application of the GOMS model in researching the requirements of application users, are the topics of many textbooks, professional and scientific research papers.

The importance of improving e-business by switching from desktop information systems to Web applications is discussed in here [6].

Electronic banking is the topic of many international scientific conferences. The paper [7] presents the advantages that ICT gives to banks in accessing clients and improving and expanding the services they provide. Presented is the case of DBS bank from Singapore, which made an extraordinary turnover in its business towards digital transformation and positioned itself as the leading digital bank in the world.

The research of key characteristics of IT that enable e-banking is presented in [8]. The authors focused on information security (ISec), through elements of confidentiality, integrity and accessibility (CIA). The study helped to configure a model framework that contributes to create and determine the IT capabilities needed to operate an e-services model, particularly in developing countries.

In the paper [9], a research of factors influencing customer response in electronic banking was conducted and the development of solutions for their retention was presented. A binomial logistic regression technique was used to identify factors influencing customer response in e-banking. The results of the research show that the period of providing services to clients, the age of the client, gender and the number of enabled transactions in mobile banking are of key importance. These factors should be considered when finding solutions to retain and attract clients.

Customer satisfaction in e-banking with the following services: reliability, efficiency and ease of use; reactivity and communication; and security and privacy, were examined in a study [10]. It has been shown that E-banking can, if properly implemented, increase customer satisfaction and give banks a competitive advantage.

The GOMS model is used to examine the requirements of users of computer programs and is of great importance in software design that allows human-computer interaction. This is evidenced by the paper [11] which deals with the research of the possibility of improving the model itself.

The paper [12] presents research on user requirements regarding navigation in Web applications using a keyboard and mouse. The GOMS model was used and a comparison of the representation of keyboard navigation and mouse navigation was made. This comparison allows us to make the right decision about the extent to which keyboard navigation should be represented in Web applications.

3. Research methodology

Research topic: The role of e-banking Web applications in electronic banking.

Research problem: Adaptation of actions in e-banking Web applications to user requirements, regarding the possibility of performing actions using a mouse and keyboard.

The aim of the research. The research aims to determine whether and to what extent the design of e-banking Web applications can be improved by examining user requirements.

Subject of research: Opinion and evaluation of e-banking Web application by users, as well as their suggestions for improving the functionality and usability of the application. The application of the GOMS model examines the efficiency of starting and executing individual application functions and filling out forms. For operators, mouse clicks on commands and buttons and the use of function keys on the keyboard are taken.

The importance of research is reflected in finding solutions to improve e-banking Web applications. In that way, a larger number of clients would be attracted to use the application, and that brings certain advantages in business. Online banking is a service with great potential that has the potential to enhance bank performance. [13]

Research hypothesis. In research, it is very important to set up a research hypothesis, in order to achieve a scientific contribution by proving it. A research hypothesis is a specific, clear, and testable proposition or predictive statement about the possible outcome of a scientific research study based on a particular property of a population. [14] The hypothesis set in this study is that by applying the GOMS model in human-computer interaction, it is possible to arrive at a solution to improve the design of an e-banking Web application in accordance with user requirements.

Research methods. The method of generalization, survey method and statistical method were used in the research.

Research instrument. An online survey questionnaire was used to survey user requests and opinions. The questionnaire was created using the Google Forms application.

Sample of respondents. The population for this research is represented by bank clients who are users of the e-banking Web application. 103 application users of different ages and different levels of education were taken as a sample. The beneficiaries of the sample are residents of several countries: Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Montenegro and Kosovo.

Research time. The survey of e-banking Web application users via an online survey questionnaire was conducted during November and December 2020.

Research problems. The main problem that arose during the research is the distrust of banks and their clients towards the intention of the researchers, despite the fact that it was emphasized that the survey is anonymous and does not require confidential and sensitive data on respondents. The authors of the paper sent a link to the online survey questionnaire to the email addresses of several international banks and asked them to forward it to their clients and ask them to fill out the questionnaire. Only two banks responded to the email. One answer was that they could not do it for security reasons, and the other was that the bank's management had decided that it could not fulfill our request. Other banks did not send any response. Also, in the period of one month, there was not a single completed questionnaire. To solve this problem, the

authors of the paper sent a link to the survey questionnaire to their acquaintances who they assume are users of the application and asked them to fill it out and also forward it to their acquaintances. In this way, the described sample of respondents was arrived at.

3.1. Research results

As the results of the research, we consider the respondents' answers to the survey questionnaire.

The survey questionnaire used instructions from the teaching material for the course: Methods and techniques of scientific research and analysis, doctoral studies at the Faculty of Economics, University of Belgrade [15] and original scientific paper on surveying as a testing technique and its application in research [16]. At the beginning of the questionnaire, respondents are introduced to the purpose of the survey. The questions are designed to be clear and to enable exactly what the research seeks to achieve. For multiple-choice questions that examine users' opinions of the application, the answers offered are optimized, with a well-defined intensity range.

For the purposes of this research work, five questions were singled out from the survey questionnaire. All questions are in the form of multiple choice, with offered answers from which the respondent chooses one. The questions collected data on the age and level of education of the respondents, on how they initiate certain actions in the application and on their opinion regarding the use of the mouse and keyboard when working in the application.

Question 1: Age of respondents

The age range of the respondents was divided into five segments. The aim is to monitor the answers of each category individually, so that the correct conclusions can be made based on the information obtained.

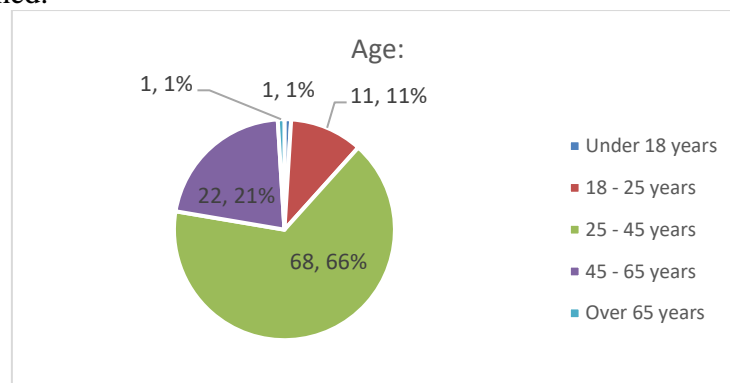


Figure 1. Graphic representation of the answer to question 1

The data shown in the chart show that a large percentage, as many as 66% of respondents are aged 25-45. This is three times more than the respondents aged 45-65 years (21%). Both of these groups represent able-bodied people, but can be classified into different generations based on computer literacy. The division of the population on the basis of ICT knowledge can be found in professional and scientific literature. Today, internet banking has become an essential service to provide. Many studies show the young, educated, and salaried as active users of e-banking services. The older adults and people residing in suburban and rural areas are yet to catch up with the trend. [13]

Question 2: Level of education of the respondents

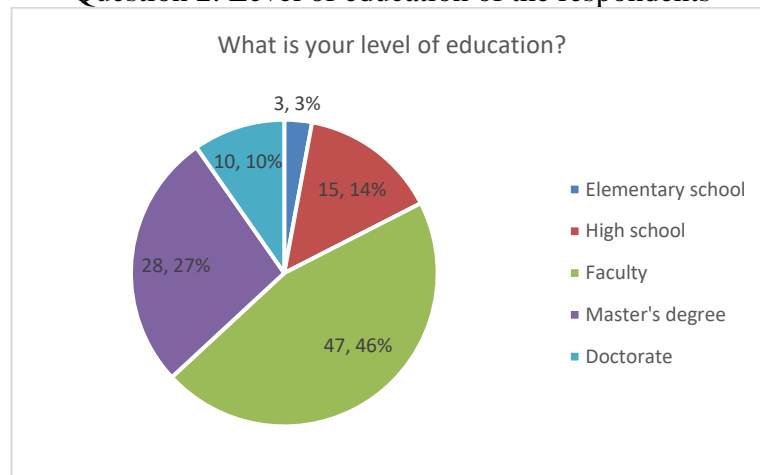


Figure 2. Graphic representation of the answer to question 2

Users of e-banking Web applications among members of all levels of education, even those who have completed primary school (3%). This shows that Web applications can also be used by people with a low level of education, but in a small percentage. This means that e-banking applications are acceptable to everyone, but work needs to be done to improve the functionality and simplify the use of the e-banking application, in order to increase the number of low-educated bank customers who will use the application. Most users have a university degree (46%), followed by a master's degree (27%), while high school students (14%) and doctors of science (10%) have approximately the same number.

Question 3: Using a mouse and keyboard when working in an application

This question examined the ratio between the use of mouse and keyboard when working in e-banking Web applications. The offered answers include a sufficient number of combinations, so that each respondent can give a true answer to the question asked.

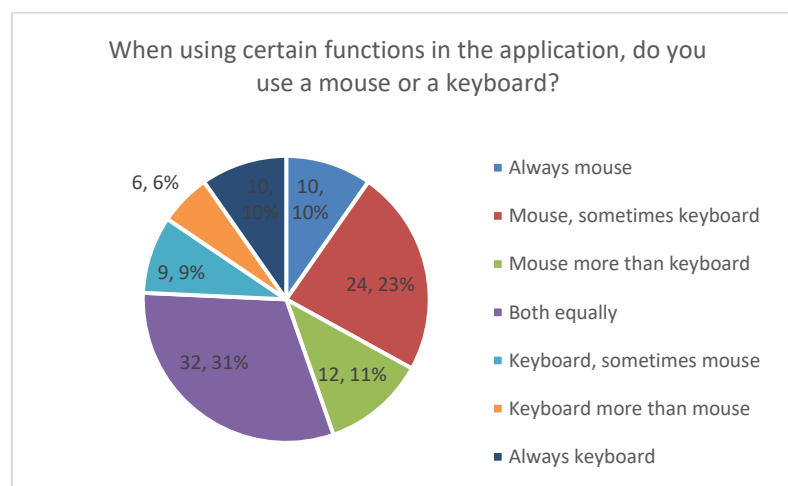


Figure 3. Graphic representation of the answer to question 3

It can be seen that most users of the application use both devices, mouse and keyboard (80%). Some use one device more than others, to a greater or less extent, while a small number always use only a mouse (10%) or only a keyboard (10%). There is also a high prevalence of

keyboard use, which can mean good computer literacy of users. This is an indication that in software design it should be possible to perform most functions using both devices.

Question 4: Use the mouse or Tab key to move through the forms in the application

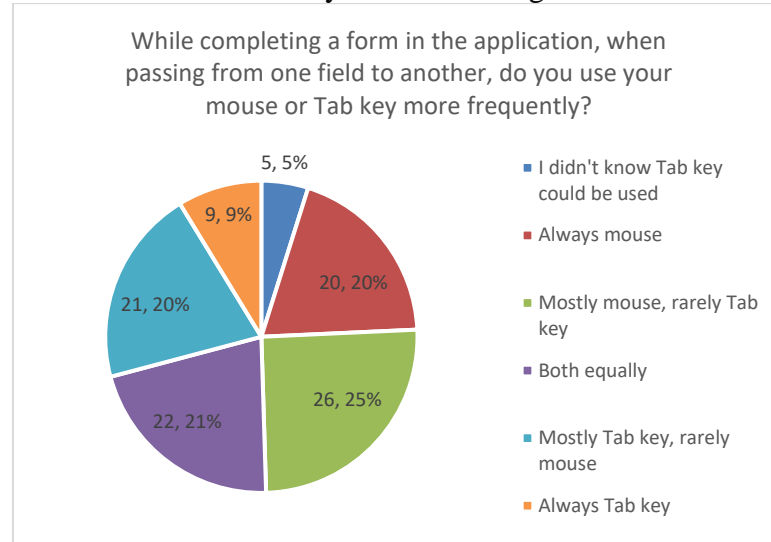


Figure 4. Graphic representation of the answer to question 4

A common action in e-banking applications is filling out forms. An application should make this job easier and faster. So we asked users if they used a mouse or keyboard more to navigate through forms. 20% of respondents use only a mouse, which is a slower process compared to using the Tab key. There are 5% of those who did not know that you can move through the form with the Tab key. Another 25% rarely use the Tab key. Thus, half of the users use a less efficient method to navigate through the forms.

Question 5: User recommendations for using a mouse or keyboard to run commands in an application

After the previous two questions, we asked the respondents to think and give their opinion on the ratio in which it should be possible to run commands in the application using the mouse and keyboard.

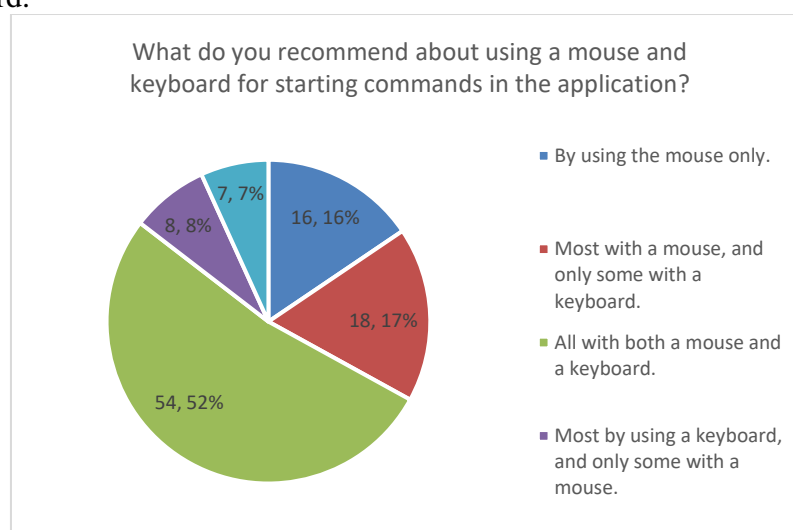


Figure 5. Graphic representation of the answer to question 5

Over half of the respondents (52%) believe that all commands in the application should be able to run using both devices, mouse and keyboard. There is a higher number of those who prefer to use a mouse over a keyboard (17%) than those who put a keyboard in front of a mouse (8%). 16% think that only a mouse should be used, and 7% only a keyboard. These opinions of respondents can be a very significant benchmark in the design of e-banking software.

3.2. Analysis of research results

The analysis of the research results provides information on the influence of age and level of education of the respondents on the ratio between the use of mouse and keyboard when working with e-banking Web application and their opinion on that ratio. The table shows the number of answers to questions 3, 4 and 5, separated by age categories and by education.

Table 1. Influence of age on the ratio of mouse and keyboard usage when working in e-banking Web application - number of answers.

	Age				
	Under 18	18-25	25-45	45-65	Over 65
Always mouse		2	5	3	
Mouse, sometimes keyboard	1	1	14	7	1
Mouse more than keyboard			8	4	
Both equally		6	20	6	
Keyboard, sometimes mouse		2	7		
Keyboard more than mouse			5	1	
Always keyboard			9	1	

When it comes to the ratio of the use of the mouse and keyboard when working in the application, it was shown that the equal use of both devices has the most answers in the age categories of 18-25 and 25-45 years. Other age categories give little advantage to using a mouse.

Table 2. Influence of age on the ratio of mouse and usage of Tab button when filling out forms in e-banking Web application - number of answers.

	Age				
	Under 18	18-25	25-45	45-65	Over 65
I didn't know Tab key could be used		1	3	1	
Always mouse	1	3	9	7	
Mostly mouse, rarely Tab key		2	17	6	1
Both equally		2	16	4	
Mostly Tab key, rarely mouse		2	16	3	
Always Tab key		1	7	1	

Respondents in the 18-25, 25-45, and 45-65 age categories answered approximately the same answers for equal use of the mouse and Tab key, for greater use of the mouse relative to the Tab key, and for greater use of the Tab key relative to the mouse. A small number of answers were given for the use of only the mouse or only the Tab key. Specifically, these categories have a higher number of mouse-friendly answers than the Tab key.

There is a negligible difference in the number of answers for the use of the mouse always in ratio to the use of the Tab always button, in the age category of 25-45 years, while in the categories of 18-25 and 45-65 years this difference is more significant. Subjects under the age of 18 and over 65 voted to use the mouse.

Table 3. Influence of age on recommendations on the use of mouse and keyboard when running commands in e-banking Web application - number of answers.

	Age				
	Under 18	18-25	25-45	45-65	Over 65
By using the mouse only.		4	11	1	
Most with a mouse, and only some with a keyboard.		2	10	6	
All with both a mouse and a keyboard.	1	5	34	13	1
Most by using a keyboard, and only some with a mouse.			7	1	
With only a keyboard.			6	1	

Regarding the use of the mouse and keyboard to run commands in the e-banking application, respondents of all ages recommended in significant numbers to enable the execution of all commands using the keyboard and the mouse.

Other respondents aged 18-25 chose answers that recommend the use of a mouse, and did not give a single vote to recommend the use of a keyboard.

The remaining number of answers given by respondents in the age categories 25-45 and 45-65 years more recommend a dominant use of the mouse over the keyboard, to a less extent the opposite, and the number of answers that recommend the use of only the mouse or only the keyboard is small.

Table 4. Influence of level of education on the ratio of mouse and keyboard use when working in e-banking Web application - number of answers.

	School				
	Elementary school	High school	Faculty	Master's degree	Doctorate
Always mouse	1	2	2	4	1
Mouse, sometimes keyboard	1	3	13	4	3
Mouse more than keyboard	1	1	3	4	3
Both equally		4	16	10	2
Keyboard, sometimes mouse		2	4	3	
Keyboard more than mouse			4	2	
Always keyboard		3	5	1	1

In all categories of respondents, based on the level of education, the most answers were given to the equal use of the mouse and keyboard. What all categories have in common is that they use more mouse than keyboards. Regarding the dominant use of the keyboard, in proportion to the number of respondents, the leading category is those with completed master's studies, followed by those with a university degree. Behind them are those who have finished high school. Among doctors of science, there are 10% of respondents who always use the

keyboard, and of those who finished primary school, no one chose the answer that gives preference to the use of the keyboard over the use of a mouse.

Table 5. Influence of the level of education on the ratio of the use of the mouse and the Tab key when filling out the form in the e-banking Web application - number of answers

	School				
	Elementary school	High school	Faculty	Master's degree	Doctorate
I didn't know Tab key could be used	1		3	1	
Always mouse	1	3	9	5	2
Mostly mouse, rarely Tab key		7	6	8	5
Both equally	1	2	12	7	
Mostly Tab key, rarely mouse			13	7	1
Always Tab key		3	4		2

All categories, except those with a university degree, prefer the use of the mouse over the use of the Tab key. College-educated respondents use the mouse and the Tab key approximately equally. Masters are the second category in terms of the number of answers that give preference to the Tab key, followed by doctors of science, followed by those who finished high school, while respondents who finished elementary school did not choose such answers at all.

Table 6. Influence of education level on recommendations on the use of mouse and keyboard when running commands in e-banking Web application - number of answers

	School				
	Elementary school	High school	Faculty	Master's degree	Doctorate
By using the mouse only.	1	1	9	3	2
Most with a mouse, and only some with a keyboard.		4	7	6	1
All with both a mouse and a keyboard.	2	6	25	16	5
Most by using a keyboard, and only some with a mouse.		1	3	3	1
With only a keyboard.		3	3		1

The answer most often chosen by respondents from all categories is to allow all commands to be run using the mouse and keyboard. Also, everyone has a larger number of answers that recommend more use of the mouse compared to the keyboard. The ratio of these answers and the answers that recommend greater use of the keyboard than the mouse is approximately the same for all categories of respondents, except for respondents with completed primary school. They did not choose the answers that give preference to the keyboard over the mouse at all.

4. Conclusion

The use of ICT in banking is considered important. Therefore, the application of the Internet in the business of banks is discussed in the professional and scientific literature, and this presupposes the existence of a quality Web application.

Based on the results of this research, conclusions can be drawn about the quality of design of e-banking Web applications, according to user requirements.

Based on the data on the age and level of education of the respondents, it is concluded that in software design special attention should be paid to users aged 25-45 and those who have a university degree. Also, the target group of users of other age categories and levels of education must not be completely neglected, because there is a significant number of users from those categories.

The results of research related to the prevalence of mouse and keyboard use, as well as user recommendations on the same, indicate that the design of the application must deal with enabling the execution of commands and execution of functions using the mouse and keyboard. For elements intended for users with a lower level of education, more attention should be paid to the use of mouse, and elements for users with a higher level of education should be designed to enable the use of mouse and keyboards in working with them. Also, the same rule should be applied when designing application elements intended for different age categories. Users aged 25-45 use the mouse and keyboard equally well and should be allowed to choose the method for performing the required function. For elements that use other age categories, a mouse-dominated design should be applied. This can save the resources needed to design keyboard-executable commands.

The software design should provide a solution that will allow users to discover all the benefits of using a mouse and keyboard when performing certain tasks. This is supported by the fact that there are users who do not know about the possibility of navigating through the form using the Tab key, even among the educated.

According to everything presented so far in this paper, it can be said that the research hypothesis has been proven: by applying the GOMS model in human-computer interaction, it is possible to reach a solution to improve the design of e-banking Web application in accordance with user requirements.

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