USABILITY EVALUATION OF MOBILE AND DESKTOP WEBSITES: A STUDY OF COMPARING USABILITY EVALUATION METHODOLOGIES

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ABSTRACT

USABILITY EVALUATION OF MOBILE AND DESKTOP WEBSITES: A STUDY OF COMPARING USABILITY EVALUATION METHODOLOGIES

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The aim of this research was to investigate usability issues of websites of three entrepreneurial and innovative universities, Middle East Technical University, Koç University, Sabancı University, on mobile and desktop in Turkey. In order to figure out the limitations and differences of conducting same usability evaluation methods for mobile and desktop websites and to explore effective and efficient usability evaluation methods for mobile websites, usability evaluation methods were compared by using qualitative and quantitative data gathered from user-based and expert-based experiment. Four usability evaluation methods, eye-tracking experiment, WAMMI (Website Analysis and MeasureMent Inventory) questionnaire, concurrent think aloud technique, heuristics evaluation, were applied throughout the research. Results of the research showed that users' satisfaction of desktop websites was higher than mobile websites. Lack of responsive design on websites, inconsistent navigation design between the main page and subpages and user interface design problems such as small size texts and unorganized structure were main mobile-specific usability problems. Results of the research also revealed that there were critical methodological differences of usability evaluation methods between mobile and desktop experiments. For instance, concurrent think aloud technique was not appropriate for mobile experiments. Besides that, mobile eye-tracker device could not record participants' eye movements and gaze plots due to mobile experiences of participants and settings of mobile eye-tracker.

Keywords: Mobile Usability, Usability Evaluation Methods, Eye Tracking, Website Usability, Human Computer Interaction

ÖZ

MOBİL VE MASAÜSTÜ WEBSİTELERİNİN KULLANILABİLİRLİK DEĞERLENDİRMESİ: KULLANILABİLİRLİK DEĞERLENDİRME METODOLOJİLERİNİN KARŞILAŞTIRILMASI

Özen Çinar, Nesibe

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Bu çalışmanın amacı girişimci ve yenilikçi üniversitelerden Orta Doğu Teknik Ünivresitesi, Koç Üniversitesi ve Sabancı Üniversitesi'nin websitelerinin mobil ve masaüstü platformlarda kullanılabilirliğini araştırmaktır. Aynı kullanılabilirlik metodlarının mobil ve masaüstü websitelerini değerlendirirken ne gibi kısıtlama ve farklılıklara sebep olduğunu ve mobile websitelerini değerlendirmek için kullanılacak etkin ve etkili kullanılabilirlik değerlendirme yöntemini bulmak için kullanıcı bazlı ve uzman bazlı deneylerden nitel ve nicel veri toplanmıştır. Çalışma içerisinde göz izleme tekniği, WAMMI (Web Sayfası Kullanılabilirlik Ölçüm Anketi), eş zamanlı sesli düşünme tekniği ve sezgisel değerlendirme kullanılabilirlik değerlendirme yöntemleri kullanılmıştır. Sonuçlara göre üniversitelerin masaüstü websitesilerinin mobil versiyonlarına göre daha yüksek katılımcı memnuniyetine sahip olduğu görülmüştür. Tasarımların mobile duyarlı olmaması, ana sayfa ve alt sayfalar arasında tutarsız gezinimin olması, ufak yazı boyutları ve düzensiz sayfa yapılarının sebep olduğu kullanıcı arayüzü problemleri mobil tasarıma yönelik temel problemler olarak gösterilebilir. Çalışma sonuçlarına bakıldığında, ayrıca, mobil ve masaüstü deneylerde kullanılabilirlik değerlendirmeleri kapsamında kritik metodolojik farklılıklar görülmüştür. Örneğin, eş zamanlı sesli düşünme tekniğinin mobil websitesinin değerlendirilmesi için uygun bir teknik olmadığı bulunmuştur. Bunun yanı sıra, kullanıcıların mobil cihaz kullanım tecrübeleri ve mobil cihazın düzeneği göz önünde

bulundurulduğunda, bu çalışmada kullanılan mobil göz izleme cihazının, katılımcıların göz hareketlerini beklenen seviyede kaydetmediği görülmüştür.

Anahtar Kelimeler: Mobil Kullanılabilirlik, Kullanılabilirlik Değerlendirme Metodları, Göz-İzleme, Websitesi Kullanılabilirliği, İnsan Bilgisayar Etkileşimi

dedicated to my beloved husband,

who makes all things possible

&

to my dear family,

who love and support throughout my life

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LIST OF ABBREVIATIONS

HCI	Human Computer Interaction
METU	Middle East Technical University
SU	Sabancı University
KU	Koç University
WAMMI	Website Analysis and MeasureMent Inventory

CHAPTER 1

INTRODUCTION

In the first chapter, the general context of the field is stated for clearer presentation of the study. Moreover, the origin of the problem, details of the study and research questions arising from the problem are mentioned.

1.1 INTRODUCTION

Technology has been evolving over the years in every field. Every function that a computer does can be done by mobile devices such as accessing the Internet, receiving and delivering e-mails, playing games etc. Mobile devices allow people to reach information instantly anywhere and because of the affordable price, more people can buy them and be part of the technology community. Thanks to developing technology, ordinary phones have been replaced with smart phones which have similar functions to computers. ComScore stated prediction about number of mobile and desktop users according to the Morgan Stanley Research in 2010, mobile use will exceed desktop use within five years and the number of global mobile users will continue to increase after this crossing [33]. According to eMarketer, the number of smart phone users has increased from 1 billion to 1.75 billion between 2010 and 2014 [59]. Moreover, the number of smart phone users expected to reach approximately 2.3 billion which is one-third of all the people in the world. Considering these statistics and forecasts, it makes mobile devices especially smart phones more remarkable and an important field of Human Computer Interaction (HCI).

Prior to the usage of mobile devices, life cycle process of a software or website was critical only for the desktop computers. Using mobile devices more than desktop affected all those development, design and HCI processes. Nowadays, designing for mobile use before for desktop is popular because of the huge growth of the mobile world. In fact, designing mobile first provides increasing effectiveness and usefulness, which allows users to satisfy themselves with web pages or applications and engage easily in technology [65]. The whole design process has changed and as a result of this, usability for mobile devices has been one of the most significant issues. Mobile usability differs from desktop due to specific features such as screen size, performance, location and when designing mobile applications or websites make usability become a significant issue, mobile-friendly websites should be designed considering constraints and capabilities of mobile devices.

To create user-friendly products and allow better user experiences, there are several usability evaluation methods which have been under focus for a long time, used and improved by the

usability experts. There are different types of usability evaluation methods but in general three approaches, which are used usability inspection, group walk through and user testing, are used to identify usability problems [6]. Usability inspection methods consist of different principles used by experts, software developers or end users who have domain knowledge, which is why usability inspection methods differ from each other in the context of requirements [36]. Group walk through is based on the tasks representing the real world as much as possible. Experts, designers or developers go through the process of completing tasks by using interface to see what problems the users may encounter. Unlike usability inspection methods and group walk through, user testing includes real users and real tasks. Considering differences of usability evaluation methods, methods could be separated into two categories: usability testing which includes users and usability inspection methods based on expert evaluation [18]. Brinck, Gergle & Wood [6] stated that applying multiple evaluation methods might be useful to validate the specific usability problems. All these approaches are used for desktop and mobile websites but fundamentally these two platforms have to be evaluated based on their specifications. For example because of the screen size, designs of websites change so it is considered that usability evaluation methodologies might differ or specialize according to the needs.

Academic websites are serving important information for the teachers, university staff, alumni and guests, and especially students as they try to find everything they need in those sites. To make university websites more usable, effective and satisfactory for users, they should be tested and improved for the benefit of the users. In this study, 3 specific university websites are evaluated by using more than one usability evaluation method to see usability problems. Converging different methods, it will help to determine the key differences of usability evaluation methods for mobile and desktop platforms.

1.2 STATEMENT OF THE PROBLEM

With the increasing rate of mobile users, websites have started to be available on mobile platforms. Designers create mobile websites and put the desktop content in to the design rapidly to respond to the needs of mobile users. This rapid design might cause designers to ignore usability principles and users' satisfaction. University websites have to meet users' requirements and contain the fundamental content.

In Turkey, in the leadership of TUBITAK, Ranking of The Entrepreneurial and Innovative University Index 2014 has announced on July 2014. In that index, the most entrepreneurial and innovative 50 universities are listed. There is a set of indicators such as the number of R&D projects, having a Technology Transfer Office, the number of scientific papers published etc. Sub-indicators of Culture of Entrepreneurship and Innovation are related with transferring information to the market to generate benefits for universities. Based on this purpose, it was assumed that entrepreneurial and innovative universities have their own website which is accessed by both desktop and mobile devices in order to share information with all the marketplace. Being entrepreneurial and innovative is required not only to follow the technology but also to be part of the technology community. In addition to this, websites should be designed by considering usability and users' requirements. There is a need to evaluate the websites of the entrepreneurial and innovative universities by using usability evaluation methods and see the situation of the websites from usability perspective.

However, evaluating websites on both mobile and desktop platforms by using the same us-

ability evaluation method might be ineffective. In this point of the study, it is required to find out the methodological differences of the usability evaluation methods for mobile and desktop platforms and use different usability evaluation methods to get proper results from the study.

1.3 PURPOSE OF THE STUDY

The purposes of the study are;

- to investigate the usability issues of entrepreneurial and innovative universities' websites on mobile and desktop,
- to compare usability evaluation methods according to the usability problems found by using each method,
- to find out the limitations of applying the same usability evaluation method for mobile and desktop devices,
- to explore the most efficient usability evaluation method for mobile devices.

1.4 SIGNIFICANCE OF THE STUDY

University websites have been evaluated by using different usability evaluation methods; laboratory experiment, heuristic evaluation, survey etc. to find out usability issues. There are studies which include users as participants of the laboratory experiments and surveys ([68], [41]), while some studies include only experts who evaluate websites by considering usability principles and guidelines (Hasan, 2013). Converging multiple usability evaluation methods is not common in the studies evaluating the same website on both desktop and mobile. For this reason, this study will be useful for the website designers and usability experts when they determine the appropriate usability evaluation method for both desktop and mobile websites.

In this study, usability problems of the universities' websites will be explored, which will help those universities enhance interfaces of websites in terms of effectiveness, efficiency and satisfaction. To provide better experience for the users how both mobile and desktop versions of a university website might be more effective and user friendly will be discussed. Moreover, by using different usability evaluation methods, more and detailed usability problems on mobile platforms will be found, which is useful not only for the university websites but also for all accessible websites by the mobile devices.

Findings will be useful to the people who are interested in HCI field for understanding the methodological differences of usability evaluation methods as they might conduct, research considering them. Converging usability evaluation methods for both mobile and desktop devices will increase the quality of the research because methods including users will be used while usability inspection methods are applied at the same time.

1.5 RESEARCH QUESTIONS

In this study, following questions will be answered:

- How usable are mobile and desktop websites of the entrepreneurial and innovative universities?
- What are the methodological differences of mobile and desktop websites in usability evaluation?

1.6 ASSUMPTIONS

The study were run with the following assumptions:

- Laboratory experiments were held properly and the data were collected appropriately.
- Results of usability testing and usability inspection methods were analyzed and compared correctly.
- Reliable and valid measurement were performed properly.
- Questionnaires and interviews were answered by the participants truly.

1.7 DEFINITION OF THE TERMS

Usability: The extent to which the product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.

Human-Computer Interaction (HCI):A discipline concerned with the study, design, construction and implementation of human-centric interactive computer systems.

Fixation: Looks of users in eye tracking experiments. Each look measures with its focus, movement and frequency.

Heat Map: Representation of the different areas of the screen where the user has spent the most time looking. Green, Yellow, Orange and Red colored areas presented around the screen representing a user's focus on certain areas over time. Green represents the least time focused on an area and Red represents the most time focused on an area of the screen.

Gaze Plot: Representation of user's eye movement across the screen, fixation by fixation.

Website Analysis and Measurement Inventory (WAMMI): Questionnaire - designed to evaluate the quality of use of web sites.

Tobii Studio: Eye tracking analysis and visualization software which provides a comprehensive platform for stimuli presentation, recording, observation, visualization and analysis of eye tracking and other data streams.

CHAPTER 2

LITERATURE REVIEW

In the second chapter, an overview of previous studies about usability and usability evaluation methods considering both mobile and desktop interfaces is summarized to support this study. Moreover, to understand the scope of the study, general knowledge is explained with the similar studies without ignoring the different point of views in the context of HCI field.

2.1 USABILITY

Usability has been a significant subject over the years and gaining recognition day by day. The reasons for this increasing popularity of usability are electronic devices which continue to evolve thanks to the rapidly changing technology, different type of users and applications which meet different needs [27]. Interest in usability has increased and it has become a broad term including products, services, websites etc. with which people interact. A well-known definition of usability stated by International Organization for Standardization is that usability is the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [19].

In the definition, usability is based on three dimensions; effectiveness which is about completing the task and achieving goals, efficiency which may be confused with effectiveness, but unlike effectiveness, efficiency is related with the effort and time to achieve the goals. The last dimension is satisfaction which measures the emotional reactions and gets feedback from the users. There are some different dimensions which cover usability in a different way in the literature. Nielsen [35] provides five dimensions: learnability, efficiency, memorability, errors, and satisfaction while Shackel [51] provides four dimensions which are effectiveness, learnability, flexibility and attitude. Even if the dimensions seem different from each other, fundamentally they cover two broad dimensions: easy to use and easy to learn.

In Human Computer Interaction (HCI), the systems such as software, websites and applications need to be easy to use and learn for both novice and expert users. Although they have different purposes and goals considering the systems, each system has an interface that all users experience. Actually, over the years, usability has been taken into consideration but because of the competition in the market, the focus has shifted from the technology centered design to the user centered design. Designing user-friendly systems has become a requirement to present information in an effective manner.

2.2 WEBSITE USABILITY

Main contribution of the Internet is providing a better access to information and the websites have gained an important position thanks to it. People are getting information, communicating, shopping, banking and doing so many thing by using websites. Figure 2.1 shows that, according to the Internet Live Stats, the number of websites in January 2015 is over the one billion, which is 5 times more than in 2010.

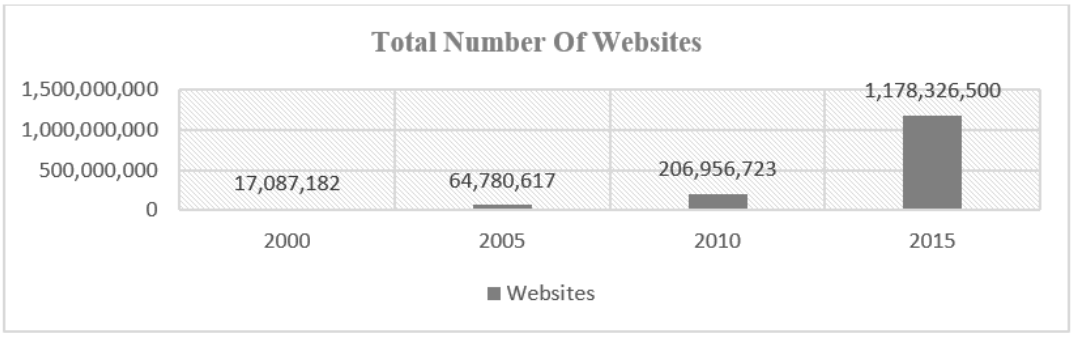

Figure 2.1: Total Number of Websites (Internet Live Stats - January 2015)

Websites have been part of our daily life and this has brought the need for research relationship between the websites and interaction. Presenting information effectively and interacting with people through the website are accepted as the main goals for website owners. Having a good experience with websites motivates people to visit that site again and being satisfied about their actions [14].

Usability is a necessary quality not only to make websites more useful and user friendly but also it has been found that usability has a significant role in the satisfaction of the website users. In other words, usability provides an increase in the satisfaction and further intention to use the website due to this satisfaction. When examining the effects of usability, it is found that usability helps consumers deal successfully with the fear of using online commerce websites [5]. More usable websites influence users' behaviors and perceptions positively. Designing a website which meets the requirements of the users, eases the users' work and gives essential knowledge to the users make them have higher a degree of loyalty.

In this study, to answer the research questions, university websites will be put under the scope. University websites have a wide range of academic information and latest announcements. Users of the university websites are generally prospective students, current students, alumni, faculty members, researchers and public and different types of users have different needs. Some look for general information about the faculties, but the others might be interested in the ongoing researches. To satisfy all the users and meet their needs, usability is as important as the content they need.

Usability of university websites have different quality attributes which are found to be considered for evaluating the websites. Nielsen [38] stated that there are five quality attributes which are learnability, efficiency, memorability, errors and satisfaction. However, to make those quality attributes more specific for the academic websites, according to the Rahman &

Ahmed [45], factors that influence the usability of the academic websites have been found:

- navigation, searching and interface attractiveness
- interactivity and functionality
- accuracy, currency and authority of information
- accessibility, understandability, learnability and operability
- efficiency and reliability.

They found that the most significant factor is up-to-date and useful information for the students and they stated that website designers should consider usability as one of the primary design features in designing academic websites. To enable users to benefit from the university website, it is important to make the interface component understandable and allow the users to reach the information quickly. Clear link names, proximity of the similar content and balanced design both horizontally and vertically influences achieving goals in the website effectively and efficiently [68].

2.3 MOBILE USABILITY

Increasing development of the mobile devices brings usability to the mind for mobile devices, applications and websites. Differences between desktop and mobile devices are taken into consideration by the designers, experts and people who develop mobile technologies. Because of constraints of the mobile devices, basic actions on desktop become hard to achieve. Constraints of the mobile devices which affect usability might be listed as follows [65]:

- **Screen Size:** While small screen size provides a better focus on content or function, it might make it hard to navigate in the application or website easily.
- **Performance:** Limited connection affects performance of the mobile devices while getting data. Moreover, because of data download speed and hardware on mobile, performance might be low.
- **Time and Place:** Mobile devices are used anytime in different contexts. Mobile device users might be distracted by the people or environment all the time. Inputting data, reading or sending information are hard compared to the desktop.

Websites and applications on mobile are designed by considering the display size for showing content in the context of usability. Raptis et al. [46] examined the influence of the mobile phone's display sizes to understand the effectiveness and efficiency. By using different sizes of same mobile phones, it was tried to understand whether there is a relationship between screen size and effectiveness and efficiency. It was found that finding information and achieving tasks with mobile phones which have a screen size larger than 4.3 inches is more efficient. Also, the study shows that large screen sizes lead to more effective usage. Larger screen sizes shows more information and it enables users to see and scan all the information quickly.

Designing websites for mobile devices requires elaborating the design paying sufficient attention to the constraints of mobile devices. Users use mobile devices in a dynamic places which have distractors such as low light, crowded place. Context of the mobile device usage affects efficiency and effectiveness which include the time for completing the task, and a higher possibility of making mistakes. Tsiaousis & Giaglis [60] stated that different variables such as light, sound, proximity and motion affect efficiency and effectiveness of mobile websites although user satisfaction is not related with the context of usage. User behaviors are also changing with the development of mobile technology. People want to get all the content with a little effort and when mobile website has better readability with a user friendly design, people prefer mobile version of the website [31]. In some cases, mobile websites might not have all the information desktop version of the website has. When users need to reach the information mobile devices do not have, mobile websites provide a shortcut to provide user access to the full site ([38], [29]).

Usability engineering helps to design usable websites for desktop and an effective approach that might be used for the mobile website design. Usability of mobile websites is evaluated by using different evaluation methods to get nearly all usability problems ([69], [25], [62]). It is required to consider the constraints of the mobile devices during evaluation.

2.4 USABILITY EVALUATION TECHNIQUES

Usability evaluation is used to get information about a system, product or anything that has interaction with the people and enhance usability. Users are the center of usability evaluation because all evaluation process is held to make them satisfied, allow them to learn, and use the system effectively and efficiently. To get information about user interface, there is a wide range of usability evaluation methods generally based on two categories: usability testing and usability inspection methods [18]. Usability testing is commonly known as user based testing which focuses on the understanding of real users' behaviors and thoughts and includes methods such as think aloud, user testing, questionnaire and survey. Unlike usability testing methods, usability inspection methods such as heuristics, cognitive walkthrough and pluralistic walkthrough are based on the experts' and designers' opinions within the scope of guidelines and usability principles.

Considering interfaces of websites, usability evaluation methods are used for both desktop and mobile platforms. The most used usability testing methods are user tests, laboratory testing, field testing [67] and think aloud [35] because of getting more reliable and valid usability problems. Moreover, among the usability inspection methods, heuristic evaluation and cognitive walkthrough are preferred to get opinion about usability of interfaces.

Advantages and disadvantages of the usability evaluation methods and the goal of the study determine the method used for the evaluation. While one method is enough to define usability problems ([61], [15]), it is common to combine more than one usability evaluation method to gather comprehensive results ([25], [21], [12], [29]).

2.5 USER BASED EVALUATION METHODS

User based evaluation is a valuable evaluation method to obtain information about real users' behaviors, thoughts and usage of the interface. When real users evaluate the system, to obtain reliable and valid results, interaction between user and interface is required. User based evaluation methods (usability testing) are carried out through similar steps ([30], [49]):

- **Develop the Test Plan :** Major goals of the study are determined to make a goal-directed study and not to leave any goal out of the scope. Depending on the goals, tasks which reflect interaction between user and website are developed. In this step, following steps are created shortly.
- **Set Up A Testing Environment :**Environment of the usability test is determined and set in this step. Testing environment might be a lab or an available space appropriate for arranging seats for both participant and observer, testing materials and conducting a usability test.
- **Find and Select Participants :** Participants are the crucial factors to get reliable and valid results from the test. While selecting participants, it is taken into consideration that they represent the real users of your website. Target user profile provides effective information about usability problems of websites. Moreover, in this step, the number of participants is decided, which depends on the degree of confidence, number of resources, availability of participants and duration of the sessions.
- **Prepare Test Materials :** Materials for usability testing vary in the context of subject. Data collection instruments, pre-test or post-test questionnaires, task scenarios and the set-up of a system are examples of the test materials. It is important to make a pilot study which helps to understand the deficiencies of test plan and materials.
- **Conduct the Test Session :** During the testing session, researcher moderates the test considering the guidelines including information about how to moderate. For an effective and right testing process, it is significant to inform participant about the process and make them feel comfortable during the test. It is required not to intervene in test because the participant might be directed incorrectly and it might affect results of the study.
- **Debrief the Participant and Observers :** After the test session, asking questions about actions of the participant might be provided by going through the notes taken by the researcher or video recording. Post-test questionnaire might be useful for getting qualitative results.
- **Analyze the Data and Observations :** All the data and observation results are gathered together. After summarizing the results, they are analyzed considering the severity of usability problems, task completion times and other data.
- **Report Findings and Recommendation :** Analyzed results are discussed and findings and recommendations are stated to propose ways to enhance usability of the website.

These are the general steps of usability testing process and it is appropriate to apply them to all usability testing methods which have different purposes.

2.5.1 Laboratory Experiment

Laboratories in this method include a setting which might have a video camera, eye tracker, and places for the participant and researcher. Scenarios are used to evaluate the websites by using laboratory experiment. This method is commonly accepted because it is easy to conduct. The researcher simulates the context and environment easily, actions and behaviors of the participants might be recorded video and audio and distractions which affect results of the study are minimized [11]. Laboratory experiments help the researcher observe the user, record all the process and identify usability problems easily. Although it is a conventional method for evaluating websites on desktop, it is also used for evaluation of mobile devices ([25], [23], [10], [34]). For mobile websites, dynamic context is required to be taken into consideration and field usability test becomes more of an issue. Laboratory and field experiments might reveal different usability problems. Based on Kaikkonen, et al. [23] study, laboratory test seems to give sufficient information to improve the user interface and interaction of the system. It was found that laboratory test where the participant sits and uses the website is more ideal than other techniques because participants are willing to talk about their actions and thoughts easily [25]. Conducting studies in laboratory makes participants complete their actions in a short time and use the system easily but some critical usability problems might be missed out [34]. Considering mobile usability, the most used usability evaluation method is end user tests which include laboratory experiment [40].

2.5.2 Think Aloud

Think aloud method might be seen as the most important and valuable usability testing method [35]. It is a direct way to acquire a deep inspection regarding problem solving methods of humans. Participants of usability testing are instructed to talk about their actions and thought while they are solving the problem. Getting thoughts from the participants verbally belongs to the field of cognitive psychology and this method particularly helps to see how the users use the system, so it is essential to get their thoughts on the cognitive behavior while performing tasks [21]. This method fills the gap of the observation because the experts could get the reason of the users' actions from them. Making users think aloud during the study might affect the result because concentrating and talking at the same time might not be easy for the users [18]. This might cause a slowdown in the participants' performance. Although most participants tend to talk about the process, it is helpful telling this method or demonstrating it before the study to support them speak with more use ([49], [41]).

Think aloud method is separated into two methods: concurrent and retrospective thinking aloud. In the concurrent thinking aloud, participants verbalize their thought while they are performing tasks. On the other hand, in the retrospective thinking aloud, participants talk about their actions after all tasks are completed. Study is recorded visually or auditorily and the researcher takes notes about the observation during the study. Then, participants talk about their actions as far back as that they can remember. These two methods are compared in the context of number and types of the usability problems, task performance and participants' experiences. It is found that concurrent think aloud method provides more usability problems than the retrospective think aloud but participants are not comfortable during the concurrent process [61]. In the same vein, when the participants are not eager to think aloud, researcher asks questions like "what are you thinking now" or "what do you think about the interface" [35]. However, these questions affect participants' attention and influence the validity and

reliability of the results [21]. Think aloud methods enrich the data but, observing and listening thoughts of the participants might not be enough to reach a conclusion, so it is necessary to use this method together with eye tracking or laboratory experiment observation [12].

2.6 EXPERT BASED EVALUATION METHODS

Expert based usability evaluation methods are also called analytical methods or inspection methods. In these methods, evaluators inspect or examine usability-related aspects of a user interface [36]. In inspection methods, judgments of the experts are shaped the evaluation. Heuristic evaluation, cognitive walkthrough, pluralistic walkthrough, standard inspections and formal usability inspections are the well-known analytical methods. The most used methods are heuristic evaluation and cognitive walkthrough while pluralistic walkthrough continues in a state of being as an evaluation technique even if it is not used in large researches [17].

Expert based evaluation is easy to perform and compared with the user based evaluation, it is more cost efficient and done in less time. This type of evaluation method is preferred early in development [24] and handled with a small group of usability experts [39] to find critical and minor usability problems and improve the interface design before user testing. To increase the power of the methods, it is often combined two expert based evaluation methods and beside the usability experts, including stakeholders in the evaluations provides different point of views which are necessary to find out more problems [17].

2.6.1 Heuristics

Heuristic evaluation is a method which has been found by [39] and is conducted by usability experts during the development process through the specific set of heuristics. Like the other expert based evaluation methods, heuristic evaluation is easy to perform in a short time and appropriate to apply with very few resources [36]. Table 2.1 shows comparison of usability principles of Nielsen and Schneiderman. Besides Nielsen's Heuristics, Shneiderman and Plaisant [53] proposed eight principals which are based on experiences and used in so many interfaces. Moreover, it is found that a small group of evaluators, more than three, is enough to conduct usability evaluation and makes it possible to find 55-90% of usability problems while Danino [8] proposed that 5 experts in this field as evaluators might find 81-90% of usability problems where the software is developed. According to Nielsen & Mack [36], to get better results from heuristic evaluation for the websites, some steps are required to consider:

- **Prior training:** Before evaluation, researcher has to brief about the process and then make right judgments, and they have to spend time with the interface.
- **Evaluations:** Set of principles, heuristics, have to be considered during the evaluation and it is important to write interpretations about the interface in the consideration of heuristics.
- **Rate severity:** Significance level of the problems found has to be rated, which is based on three parameters: frequency with which problems occur, impact of the problem, and persistence of the problem.

- **Review:** All the reported results are analyzed to provide better solutions.

Table 2.1: Nielsen's Heuristics and Shneiderman's Principals about Usability

Nielsen's Heuristics	**Shneiderman's Eight Golden Rules of Interface Design**
Visibility of system status	Strive for consistency
Match between system and the real world	Enable frequent users to use shortcuts
User control and freedom	Offer informative feedback
Consistency and standards	Design dialog to yield closure
Error prevention	Offer simple error handling
Recognition rather than recall	Permit easy reversal of actions
Flexibility and efficiency of use	Support internal locus of control
Aesthetics and minimalist design	Reduce short-term memory load
Help users recognize, diagnose, and recover from errors	
Help and documentation	

In the heuristic evaluation, evaluators firstly scan the websites to get a general idea about the website. By using pre-defined heuristics, evaluators assess the website separately on interface and interaction structure by defining the problems and their severities. Each evaluator's assessment is finalized with the problems found related to the specific heuristic. All the evaluators come together to discuss incomprehensible and different decisions to reach a consensus. The outcomes of this process are considered by the designers to enhance the usability of the website. Evaluators play a significant role since their judgments are required to reflect the problem users' face. However, heuristic evaluators could not put themselves into users' place as only using heuristics and identified problems might not cover actual problems [15]. Therefore, creating real life scenarios and going through heuristics with scenarios make evaluator find more usability problems by acting like users [42]. Moreover, beside the Nielsen's heuristics; other heuristics based on content, attractiveness and aesthetic design and navigation are used to evaluate the websites and it is stated that interpretations are not objective when aesthetic factors and attractiveness are considered [57].

On the other hand, considering the number of problems, heuristic evaluation as an inspection method finds more problems than user based testing methods ([22], [54]), even if it is conducted with non-interaction web interfaces [1]. For mobile interface usability evaluation, 9 different heuristics sets, heuristics of Nielsen and Molick [39] are still the most commonly used set and have an increasing usage. Beside the scenarios, questionnaires and checklists are used with heuristics [9] in the researches. Mobile interfaces differ in terms of many factors such as size, features, usage context and mobile-specific heuristics are proposed to meet the evaluation need and recommend well known methods ([26], [66]).

2.6.2 Cognitive Walkthrough

Cognitive walkthrough is an expert-based usability evaluation method. In cognitive walkthrough process, initially, evaluators who might be designers or usability experts determine

the most used operations. Then, operations are converted to tasks and those tasks are performed by evaluators to find potential usability problems. Lewis et al [28], stated that simulating predefined tasks, approximately an hour per task, provides 50% of usability problems. Cognitive walkthrough method helps discover usability problems but it is helpful only in the context of predefined tasks. It does not include general opinions about interfaces [43]. Therefore, defining tasks is a critical step for this method. Moreover, it was stated that it is convenient to apply this usability evaluation method during the development or design stage by using the high fidelity prototypes. During evaluation, four questions are asked by evaluators to themselves [64]:

- Will the user try to achieve the right effect?
- Will the user notice that the correct action is available?
- Will the user associate the correct action with the effect to be achieved?
- If the correct action is performed, will the user see that progress is being made toward solution of the task?

It is possible to get collective assessments from usability experts who have different organizational backgrounds and this method is beneficial when user testing may not be available [16]. Like heuristic evaluation, qualification of usability experts are significant as to get reliable results.

2.7 COMPARISON OF USABILITY EVALUATION METHODS

Usability evaluation methods have been developed and changed according to the needs but user interfaces are evaluated by using two types of techniques which are empirical usability testing in laboratory or field and inspection methods [24]. Moreover, think aloud method is combined with empirical methods to get more information about users' perspectives. Empirical methods are user based and inspection methods are mostly expert or evaluator based. For desktop and mobile interfaces, these methods are compared with each other to find the appropriate method for different cases and needs, while they are being used for one significant purpose which is to enhance usability of the interface. It is recommended to begin with the expert evaluation on the development of the interface to see the general usability problems and after that include the users into the evaluation and alternative methods which are surveys, questionnaires, focus groups, interviews and user observations that might be useful to get quick results [47].

Most used methods which are user testing from empirical usability testing and heuristic evaluation from inspection methods are compared in studies to find out which one is more appropriate. Tan, Liu & Bishu [58] stated that user testing and heuristics compensate for each other's deficiencies. In their study, commercial websites were evaluated according to their attributes such as navigation, information content and usability and usability problems found were separated into three severity level. It is seen that, using one of these methods might not provide the opportunity to find all usability problems because user testing and heuristics covered different problems and levels of severity. By using heuristics, more usability problems are identified because experts as evaluators and explore the interfaces independently from the

scenarios like user testing. The same study was conducted by Batra & Bishu [4], and it was found that using heuristics and user testing in the evaluation provides more efficient and useful results for enhancement. Moreover, using scenarios for not only user testing but also heuristics gives more detailed results. Karat, Camphell & Fiegel [24] compared empirical testing and walkthroughs which are inspections methods and revealed that empirical testing detects more usability problems and to take advantage from inspection methods, it was preferred to be used in early development.

Usability evaluation methods were compared to discover the most appropriate method among the same type of methods. Think aloud is one of the most used evaluation method and this method might be conducted in two ways: participants explain their thoughts during the study called as concurrent think aloud or after the study which is retrospective think aloud. Van Den Haak, De Jong & Schellens [61] compared these two types of think aloud methods in the context of number and types of the usability problems, task performance and participant experiences on web interfaces. It was revealed that concurrent think aloud method makes participants perform badly and affects the task completion rates adversely. Participants had difficulties in both completing tasks and thinking aloud. However, Jaspers [21] stated that, concurrent method is more appropriate because after the experiment, participants forgot the reasons of their actions even if they watched them in the video in retrospective. Concurrent think aloud method might not be used effectively during the studies because participants could be silent mostly. Therefore, eye tracking method finds answers related to where the participants focused or gaze direction in real time and how much time they spent on specific areas on interface [68]. According to the Elling, Lentz & de Jong [12], the study revealed that participants cannot easily talk about their thoughts when the tasks are a little bit complex and eye tracking method is required to be used to understand participants' actions and usability problems comprehensively.

In user testing method for mobile interfaces, laboratory and field testing are used to diagnose usability problems and these two methods are compared to see whether which one is more appropriate. In Duh, Tan & Chen's [10] study, a mobile device was tested in the context of usability in laboratory and field. By conducting field test, they tried to understand whether different situations cover usability problems. At the end of the analysis, more important usability problems were found in the field than in the laboratory. It was observed that field testing exposes some crucial problems hard to find in laboratory testing. Although getting usability problems from real life was more meaningful than from laboratory, it was seen that users did not feel comfortable and for the users, it took more time to complete their tasks. In the same vein, Nielsen et al [34] conducted a study and they found that field testing is more successful in finding realistic usability problems than laboratory testing. However, Kjeldskov & Stage [25] tried to explore the new techniques for mobile devices and six different situations in which five field testing and one laboratory testing were applied for evaluation. When participants sat in the laboratory and completed the tasks, more usability problems were found and thinking aloud method was seen more effective in the laboratory. In field testing, some usability problems which could not be found in laboratory were detected but participants divide their attention into completing tasks, moving and thinking aloud.

Combining user testing and heuristics enables the researcher to find different usability problems in the evaluations. In user testing, laboratory experiment and concurrent think aloud method reveal useful results for the experimenter. To provide more benefits from think aloud method, eye tracking method will be useful.

2.8 USABILITY OF UNIVERSITY WEBSITES

University websites have a wide variety of users who might be prospective students, current students, alumni, faculty members, researchers and public. Different user profiles have different needs so university websites should respond to all those needs. Hasan [15] tried to find usability problems of three university websites by using heuristic evaluation method. That method includes predefined tasks and heuristic guidelines which have several categories: navigation, architecture/organization, ease of use and communication, design and content. It was found that design has the highest percentage of all usability problems and in this category, inconsistent design includes the most usability problems. Moreover, it was found that by using heuristic evaluation method, a large number of usability problems might be detected. However, Hasan proposed that in order to find out more usability problems, it should include real users in the evaluations because usability experts could not behave in the same way as a real user. University websites are evaluated by using questionnaires completed by large numbers of students. Jabar, Usman and Sidi [20] used questionnaire based usability evaluation method which has several sub-categories: content, organization & readability, navigation & links, user interface design, performance & effectiveness. They discovered that evaluated university websites evaluated have weaknesses regarding font size, too many advertisements and unattractive design. Roy, Pattnaik and Mall [48] used WAMMI questionnaire to evaluate university websites using performance based evaluation method. Task completion times and satisfaction extracted from WAMMI were analyzed and it was found that there is no relationship between task completion time and satisfaction. For academic websites, Rahman & Ahmed [45], found that there are five categories of quality factors for assessing usability of university websites:

- navigation, searching and interface attractiveness
- interactivity and functionality
- accuracy, currency and authority of information
- accessibility, understandability, learnability and operability
- efficiency and reliability.

Different from previous studies, Ozcelik, Kursun and Cagiltay [68] used eye tracker to obtain users' eye movements through the predefined tasks. Eye tracker extracted different results related with total fixation duration, fixation count etc. and it was found that clear link names, proximity of the similar content and balanced design both horizontally and vertically influence achieving goals in the website effectively and efficiently so information should be presented considering those factors. Target group of the universities generally consists of young generation who access the Internet and information via mobile devices so it is important to have mobile version of university websites [32]. For university websites, quality factors need to be considered for both mobile and desktop versions.

CHAPTER 3

METHODOLOGY

In this chapter, the methodology of the study is explained in detail. It was separated into two studies considering the need to answer the research questions properly. Each study has its own research design, materials, and data collection procedures and data analysis methods. In both studies, qualitative and quantitative methods are used together to get data.

To check whether a system is usable, various usability evaluation methods are used which differ from each other within the scope of requirements and phase of the system. To get detailed and comparable results, our study is broken into two studies which are user-based and expert-based. Study 1 (user-based) is handled in the laboratory with users and study 2 (expert-based) was carried out by the usability experts. Websites are evaluated by both users and experts in the context of different usability evaluation methods. It is important to combine usability evaluation methods in one study because getting usability problems from only one type of methods does not reflect all the critical or significant problems so inspection methods (expert-based) need to be supported with the usability testing (user-based) methods [18].

To understand deficiencies of the design of study 1, a pilot study was needed. The pilot study was conducted in Middle East Technical University (METU) HCI Lab by using both desktop and mobile eye tracker. Three users (2 men, 1 woman) were chosen for the pilot study. In our design, each user used desktop version of a university and when s/he finished the tasks, the mobile version test started. This was repeated for all three universities. After completing tasks for each platform, participants filled out the WAMMI questionnaire about which detailed information will be mentioned under oncoming titles. During the pilot study, one user filled out the form six times which is twice for one university and there are three universities as seen in Figure 3.1. Two participants started completing tasks with the desktop versions of universities and the last participant started mobile versions of the universities first. When participants completed the pilot study, three main deficiencies were gathered:

- **Task Duration:** Average task completion time was recorded as 1.5 hour and it was observed that efficiency of the experiment decreased. Participants were tired of completing tasks and they emphasized their tiredness during think aloud. To increase efficiency of the experiment, the process of the study needs to be improved.

- **Same Tasks:** Doing same tasks for the mobile and desktop versions of the same university affected participants' approach. They tried to quit the task before the final step because they were familiar with the final step from completing same task on another platform which might be desktop or mobile.

- **Laboratory Setup:** Switching from mobile to desktop or vice versa for each university causes an inappropriate environment for user testing. Each time for switching platforms, eye tracker has to be re-calibrated and this made participants uncomfortable. The design of study 1 has changed due to these reasons and some enhancements were added to study 1.

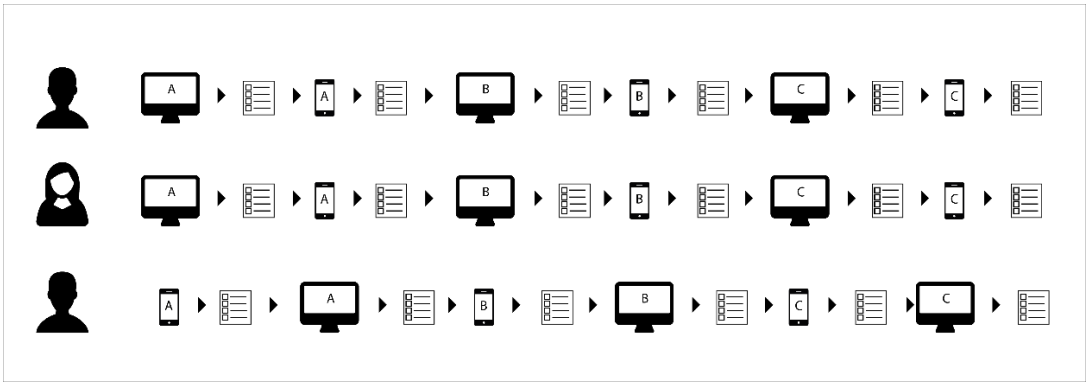

Figure 3.1: Process of the Pilot Study

3.1 STUDY 1 (USER-BASED)

3.1.1 Design of the Study

Study 1 included user-based experiments which were laboratory experiment, post-test questionnaire and think aloud method. In this study, laboratory experiment was chosen to get lifelike results from the participants. As it was mentioned in Chapter II, getting results from the participants when they are sitting is sufficient and trying to make the environment reflect real-life will not affect reaching usability problems. In order to get satisfaction of the users, WAMMI (Website Analysis and MeasureMent Inventory) questionnaire was used. During the study, think aloud method, the most important and valuable method [36], was used to get what they thought about their experiences.

After the pilot study, the process of study 1 was redesigned considering the deficiencies of the pilot study. Study 1 was based on two experiments which were mobile and desktop and they were conducted separately in Figure 3.2. There were 20 participants which were divided into two groups. One group used only mobile versions of three universities while the other group used the desktop versions of those universities. In this way, experiment completion times were more appropriate and healthier. Furthermore, getting unreliable results from doing same tasks for the mobile and desktop versions of the same university was prevented. However, in study 1, comparing results of two different groups might not be meaningful because participants might show different reactions by considering their habits. This problem was solved by using a questionnaire before study 1 to choose participants who have same background and habit of using technology.

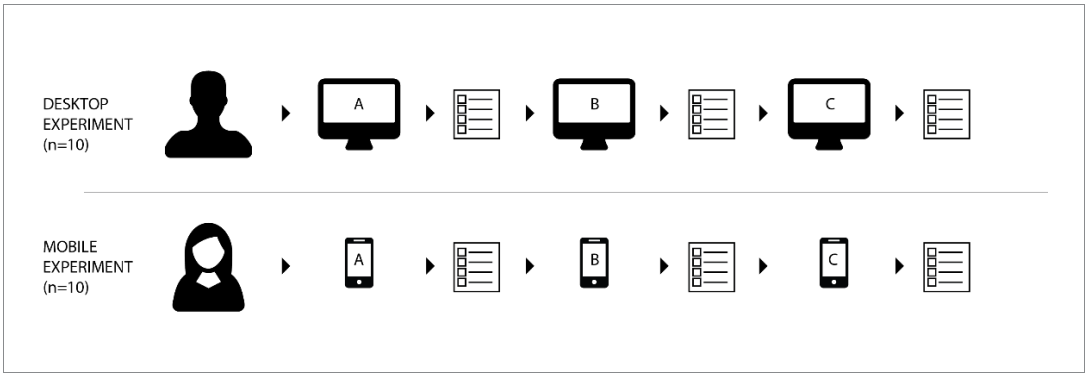

Figure 3.2: Process of Study 1 after Pilot Study

Before study 1, each participant was informed about the purpose of the study and the eye tracker. For mobile eye tracker, changing position affects results more than desktop eye tracker so participants were asked to use mobile eye tracker without changing their position. For both mobile and desktop experiments, participants were informed that they should not look at the researcher not to lose calibration setting. It was said that they can finish their usability test whenever they want if they feel uncomfortable. That websites were tested not participants was made clear to them. When they were all informed and ready for testing, Tobii Studio software which is interacting with eye tracker was started.

During the process, participants were asked to think aloud to get their thoughts verbally. Think aloud protocol was explained in detail to prevent them for asking questions and waiting answers from the researcher. Participants were silent for a while when they focused on completing tasks and at such times the researcher reminded them not to forget thinking aloud. For mobile experiments, each task was read by the researcher and when participants stated if the task finished or not, researcher read the next task. Before each task, participants returned to the main page manually for mobile experiment because software of eye tracker does not support it like desktop eye tracker. For desktop experiments, desktop eye tracker allowed the researcher to prepare tasks in the software. Participants read each task and move to the website to complete the task by using a keyboard shortcut of the software. Therefore, researcher did not intervene with participants during the process of switching websites or tasks.

After each evaluation of one university, participants filled out WAMMI questionnaire as a post-test questionnaire. To make participants interact with the websites and get detailed information about their behaviors, tasks were chosen carefully.

3.1.2 Website Selection Criteria

Academic websites are used by different group of people who are prospective students, current students, alumni, faculty members, researchers and public. During the two studies, university websites are evaluated on both desktop and mobile platforms. University websites are chosen from the Ranking of The Entrepreneurial and Innovative University Index 2014 that has been prepared in the leadership of TUBITAK. According to that, the most entrepreneurial and innovative 50 universities were listed and have been announced on July 2014. There is a set of indicators such as number of R&D projects, having a Technology Transfer Office, the

number of scientific papers. Sub-indicators of Culture of Entrepreneurship and Innovation are related with transferring information to the market to generate benefits for universities. Based on this purpose, it was assumed that entrepreneurial and innovative universities have a website accessed by both desktop and mobile devices in order to enable all the group of people to reach information in an easy way. Being entrepreneurial and innovative is required not only to follow technology but also to be part of technology. Considering this, top five universities' websites from the list were examined and it was found that only 3 of them, those of Middle East Technical University (METU), Sabancı University (SU) and Koç University (KU), have both desktop and mobile websites. Table 3.1 shows top five entrepreneurial and innovative universities. In this study, those top three university websites were used.

Table 3.1: Top Five of the Entrepreneurial and Innovative Universities and Selection Criteria

	Desktop Website	**Mobile Website**	**Used in This Study**
Middle East Technical University	Yes	Yes	✓
Sabancı University	Yes	Yes	✓
Boğaziçi University	Yes	No	✗
Bilkent University	Yes	No	✗
Koç University	Yes	Yes	✓

3.1.3 Tasks

For both experiments, same tasks were performed by two group of participants. Finding same information in different universities might not be possible because each university brings different information into the forefront and has different terminologies. Therefore, before specifying tasks, three university websites were examined to find common information. Moreover, tasks needed to be designed for users supposed to have graduated from university and are looking for graduate programs and will pretend to perform like in real-life. Task-based scenarios were prepared and it was regarded that in order to simulate the real-world context, tasks included most common operations for graduate users. The scenario was based on steps for graduate students who are looking for graduate programs and after being accepted to the university, they will search some information.

When tasks were prepared, they were sent to two usability experts to analyze and check whether tasks were appropriate for a usability test. Usability experts reviewed tasks and to make tasks more applicable, they gave detailed feedback. The number of tasks was reduced and the scenario was improved to make steps of tasks more comprehensible in response to the feedback.

After finalizing tasks, task-based scenario included 6 tasks but the first task was different from others. Only for the first task, participants were asked to scan the main page of the university without clicking / tapping anywhere so as to have a general opinion about the website. Finalized tasks might be completed more than one way so the number of steps and completion times were calculated for each way. Finalized tasks covering real-life operations and are common for three universities, the number of steps and expected completion times are given below for each university:

Task 1: Without clicking / tapping anywhere, scan the main page of the university and get an impression. When you have a general idea about the website, please tell the area that draws your attention most and express your thoughts about the website. For Task 1, there is not a set number of steps or expected completion time because this task aims at enabling participants to get first impression about the website. Time to get impression changes from one another.

Task 2: You have decided to apply for industrial engineering for a graduate programs and are searching whether universities have this program. By checking the websites of METU / SU / KU, find whether these universities offer industrial engineering program for graduate students. (Table 3.2).

Table 3.2: Ideal Number of Steps and Completion Times of Three Universities for Task 2

	Desktop			**Mobile**		
	Completion Ways	**Number of Steps**	**Completion Time**	**Completion Ways**	**Number of Steps**	**Completion Time**
METU	1	2	0:07	1	2	0:12
	2	3	0:09	2	4	0:15
SU	1	3	0:08	1	6	0:25
KU	1	5	0:15	1	5	0:30
	2	5	0:17	2	7	0:33

Task 3: You were accepted to industrial engineering for graduate programs. Find when the classes begin in 2014-2015 Spring Semester (Table 3.3).

Table 3.3: Ideal Number of Steps and Completion Times of Three Universities for Task 3

	Desktop			**Mobile**		
	Completion Ways	**Number of Steps**	**Completion Time**	**Completion Ways**	**Number of Steps**	**Completion Time**
METU	1	3	0:17	1	3	0:26
	2	4	0:18	2	6	0:30
	3	3	0:13	3	5	0:28
	4	4	0:15	4	8	0:33
SU	1	2	0:17	1	3	0:30
KU	1	7	0:15	1	9	0:35
	2	6	0:12			

Task 4: You want to get information about scholarship opportunities of the university. By using search field, find any information about scholarship opportunities (Table 3.4).

Table 3.4: Ideal Number of Steps and Completion Times of Three Universities for Task 4

	Desktop			**Mobile**		
	Completion Ways	**Number of Steps**	**Completion Time**	**Completion Ways**	**Number of Steps**	**Completion Time**
METU	1	4	0:15	1	4	0:19
SU	1	4	0:14	1	-	-
KU	1	6	0:22	1	5	0:23

Task 5: You noticed that you will not be able to attend one of your graduate program classes

because of your job and you wanted to inform your teacher about this situation. Find the e-mail address of any teacher in industrial engineering (Table 3.5).

Table 3.5: Ideal Number of Steps and Completion Times of Three Universities for Task 5

	Desktop			Mobile		
	Completion Ways	**Number of Steps**	**Completion Time**	**Completion Ways**	**Number of Steps**	**Completion Time**
METU	1	6	0:18	1	6	0:26
	2	7	0:19	2	8	0:30
SU	1	7	0:17	1	9	0:41
KU	1	5	0:15	1	6	0:25

Task 6: You noticed that you have free time after your graduate program classes and you thought that you can go to swimming pool if there is any. Find whether the university has a swimming pool (Table 3.6).

Table 3.6: Ideal Number of Steps and Completion Times of Three Universities for Task 6

	Desktop			Mobile		
	Completion Ways	**Number of Steps**	**Completion Time**	**Completion Ways**	**Number of Steps**	**Completion Time**
METU	1	3	0:10	1	4	0:13
SU	1	4	0:16	1	7	0:29
KU	1	3	0:11	1	4	0:18
	2	2	0:11			

For some tasks, there is more than one ideal path and those paths are specified on the tables in the context of number of steps and completion times. They were used to evaluate the participants' results by comparing them with the ideal paths. When there was more than one ideal path, average of the number of steps and completion times were taken to compare the results of the participants.

3.1.4 Participants

Selecting participants is a significant process for the study since getting reliable and meaningful results could only be possible thanks to representative participants. Nielsen [37] stated 15 participants are enough to find all the usability problems and if there are more than 15 participants, same results will be gathered unnecessarily. Having difficulty about budget and time in usability testing, doing three usability tests with 5 users for each is more efficient and useful. With 5 users, 85% of the usability problems might be discovered for the first study. However, this assumption is a critical issue for usability testing field. Spool &Schroeder [55] conducted a study with 49 users by using four e-commerce websites and it has revealed that more than 5 users is needed to find usability problems. 35% of 349 usability problems were found after the first 5 users. In the same vein, Faulkner [13] tested 60 users and found that the set of 5 participants was important to find more usability problems because in that study, one set of 5 participants found 55% of the problems while the other set of 5 participants found 99% of them. There might be a risk of using only 5 participants for a study. Considering these

issues, more than 5 users help getting more usability problems and also finding methodological differences of the usability evaluation methods, so it is important to increase the diversity of the participants.

The sample of the study consisted of 20 participants, 10 of whom were in the mobile experiment group and the other 10 constituted the desktop experiment group. Participants of the mobile groups experimented only mobile versions of the three universities' websites while others experimented only desktop versions of same websites. To compare the results of two groups with each other and also the expert-based study, it was necessary to have two groups where participants have same background and habit of using technology. Moreover, in order to gather reliable results, participants should represent the real users. Participants should have experience about using smartphone, which is IPhone 6in this case, and mobile websites. A questionnaire consisting of questions about usage of technology, the Internet, and mobile devices was prepared to choose right participants for the study (Appendix B). 30 people who have IPhone and graduated from a university were chosen for participating in the questionnaire. The prominent criteria are:

- All the participants should have IPhone 6,
- All participants should be university graduates,
- All participants should not be graduates or current students of Master or PhD programs in METU, SU or KU.
- All participants should have experience about using desktop Internet more than 1 hour a day
- All participants should have experience about using mobile Internet more than 1 hour a day
- All participants should have a browser experience on mobile devices
- All participants should have experience about using smart phone more than 6 months

User-based study was conducted with 20 people chosen according to the criteria in the questionnaire. Among the participants, 70% were male and the rest of them were female. For each experiment, there were 7 males and 3 females. The average of the participants' age is 27.25 (Table 3.7).

Table 3.7: Descriptive Statistics of Eye Tacking Study Participants

	N	**Minimum**	**Maximum**	**Mean**	**Standart Deviation**
Age	20	23	32	27.25	2.27

According to the questionnaire, participants use Internet via laptop or desktop computers more than mobile device. For the study, participants who use Internet more than 1 hour are specifically chosen because mobile experience is significant when getting data from mobile experiment and comparing results (Figure 3.3).

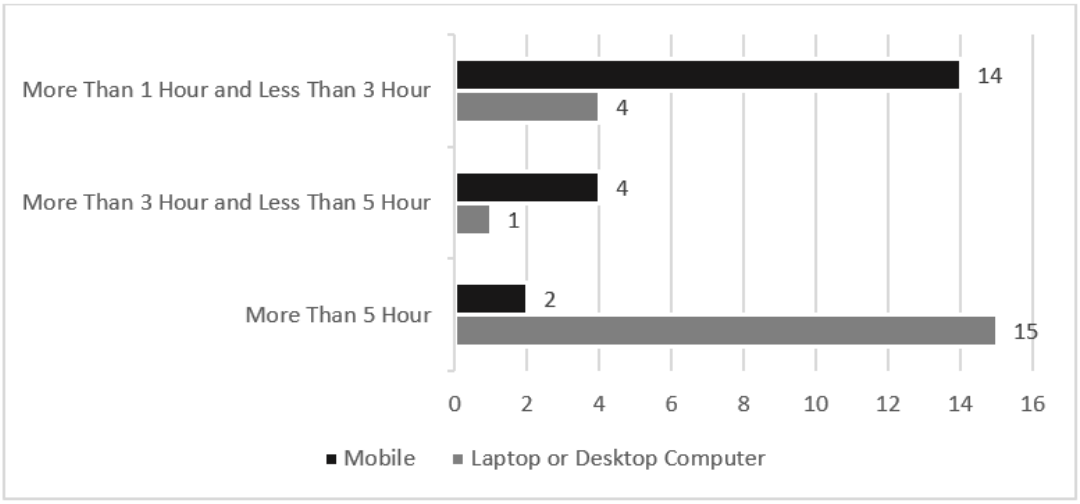

Figure 3.3: Participants' Daily Usage of Mobile Device and Laptop or Desktop Computers

When participants were asked about their purpose of Internet usage, majority of the participants stated that they are using Internet to reach information and communicate and for functions such as sending and receiving e-mails. Operations that can be done by using mobile devices are grouped under titles which are Reaching Information, Communication, Banking, Reading News, Social Media, Game / Entertainment, Shopping, Educational. Participants were asked how frequently they used the operations to have information about the purpose of mobile device usage and the three most commonly used operations were revealed as Reaching Information, Communication and Social Media.

Specific to the mobile usage information, it was important to get mobile device using time and 55% of participants have been using their mobile device more than 1 year. Usage time plays a vital role because for mobile experiment all participants should be a mobile user and used their browser even once.

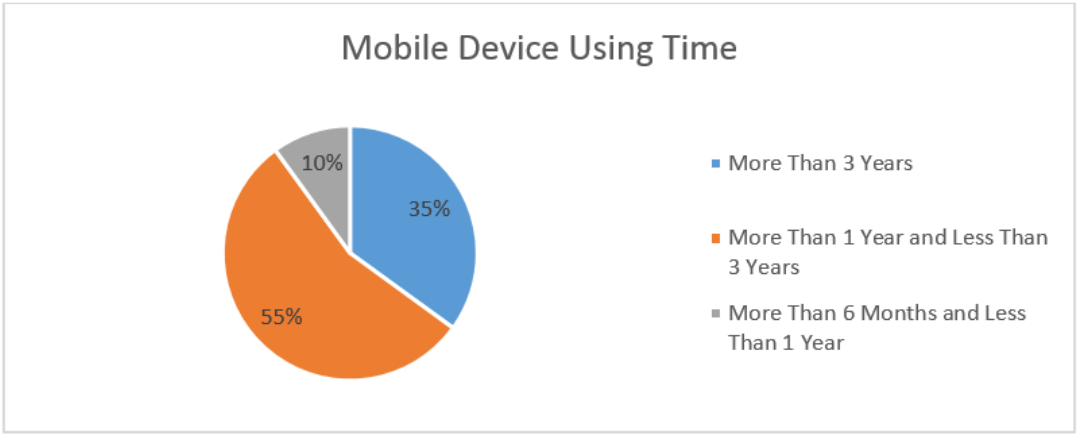

Figure 3.4: Mobile Device Using Time of Participants

Most of the participants graduated from Hacettepe University and results might be affected.

Therefore, to get reliable and valid results, those participants were distributed into the groups equally.

3.1.5 Materials

During the study, WAMMI (Website Analysis and MeasureMent Inventory) questionnaire was used for both desktop and mobile experiment. WAMMI was developed by Human Factors Research Group in 1999 and it contains 20 questions about users' experiences under five dimensions regarding attractiveness, controllability, efficiency, helpfulness and learnability. This questionnaire is specified for website usability and provided to participants to indicate their experiences in terms of five dimensions. Responses were gathered from five point likert scale which is scaled from 1=strongly disagree to 5=strongly agree.

Original language of WAMMI questionnaire is English but during the study, Turkish translated version of the questionnaire was used. Ates and Karacan [2] translated the questionnaire into English and then linguists for both Turkish and English reviewed it. Final version of the Turkish language of the questionnaire was prepared after reflecting on feedback given by linguists. Cronbach's alpha reliability coefficient was found to be 0.72.

3.1.6 Apparatus

User-based study was conducted in the laboratory which covers one of the usability evaluation methods: laboratory experiment. In the laboratory, eye tracking experiment was held, which is based on getting participants' eye movements, focused area or gaze direction in real time. All those movements are recorded by the eye tracker device which is compatible for the experiments. Eye tracking study gives information about the participants' behaviors whey they achieve the tasks on the desktop and mobile.

Figure 3.5: Tobii TX300

Figure 3.6: Tobii X2-60

In this study, desktop and mobile eye trackers were used. For evaluating desktop versions of university websites, Tobii TX300 eye tracker which is produced with latest technology by Tobii Company was used (Figure 3.5). Tobii TX300 gives highly accurate data from the experiments, and an additional front camera integrated on the eye tracker records the participants, which allows interpreting behaviors of the participants according to their gestures and

facial expressions. During the experiments, participants were asked to think aloud and verbal statements were recorded by eye tracker. Tobii TX300 belongs to TÜBİTAK BİLGEM Software Technologies Research Institute. Therefore, the study was conducted in the laboratory of the Institute.

For evaluating the mobile version of university websites, Tobii X2-60 mobile eye tracker and mobile device stand for X2 was used (Figure 3.6). This device and stand were produced for evaluation of mobile devices. Mobile eye tracker is attached at the bottom of the stand and records the eye movements of the participants while the camera attached at the top of the stand records touching. This device belongs to the METU Human Computer Interaction (HCI) lab but during the study it was set up in the laboratory of the Institute. During the mobile experiment, wireless network connection is used to avoid network disconnections of the cellular carriers. Moreover, there is a requirement for a mobile phone and Iphone 6 is used during the experiment.

3.1.7 Data Collection Procedure

This study makes use of both qualitative and quantitative methods to get data. For qualitative methods in the user-based experiments, thinking aloud process was used in the laboratory experiment and gathered thoughts about experiences of participants during the study. For quantitative methods, eye tracking and questionnaire were used. Participants were tested via eye tracking and the researcher was able to get eye gaze plots, time to first fixation, time spent with each area of the website. Besides eye tracking, WAMMI questionnaire was used to get satisfaction of participants about each website they interacted with.

While developing the user-based study plan, tasks were designated for alumni who are looking for a graduate program and trying to reach some information in order to simulate the real-world context. When designating the procedure of the study, it was decided to conduct laboratory experiment. Although for more realistic results, field experiments are conducted, laboratory experiment is successful in terms of controlling experimental conditions and encouraging participants to pay more attention to the tasks. Hence, to reduce distraction which might be hard to control in field experiment, laboratory experiment was conducted.

In this study, three university websites, those of METU, KU and SU, were evaluated for both desktop and mobile platforms. 20 participants were divided into two groups randomly considering the equal distribution of females and males in each group. For each experiment, the main process for participants started with one university website and completing tasks. After completing each task, participants pressed F10 button to move to the next tasks and at the last task they finished evaluation of one university. After completing tasks for one university, WAMMI questionnaire was given to the participant. This process was repeated for the other two university websites with same tasks. Same university order for all participants might cause order effect which produce unreliable results. To prevent order effect and reduce error margin, both experiments were held by using counterbalancing design. In this design, order of the university has changed for each participant to counteract effecting results, which is shown in Figure 3.7 and this design was used during both desktop and mobile experiment.

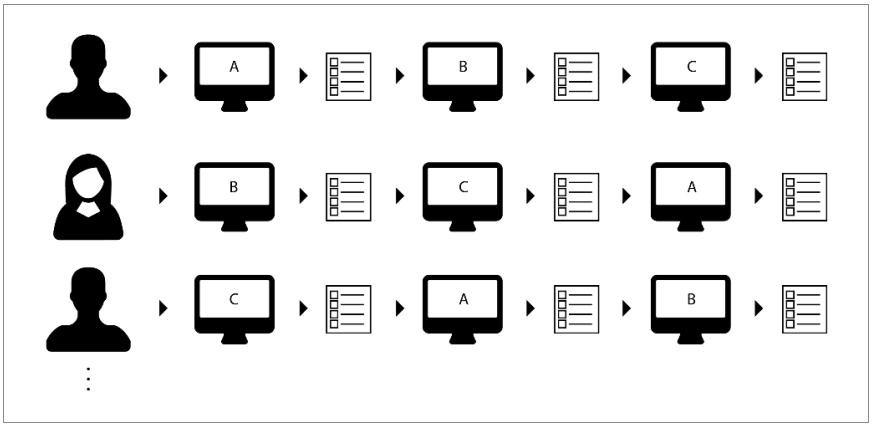

Figure 3.7: Implementation of Counterbalancing Method during Study 1 on Desktop Experiments

With respect to scope of the work, mobile experiment study was conducted with same data collection procedure in desktop experiment. However, giving tasks to the participants differed from each other for both experiments because desktop eye tracker allowed to create tasks between the website pages so just completing tasks over the website pages and pressing F10 button was sufficient to move to the next task which is shown on the desktop screen. While using mobile eye tracker, it was not possible to create tasks because participants used IPhone 6 and there was no action to link mobile device with the eye tracker software (Tobii Studio) like desktop. Therefore, for mobile experiment, the researcher read each task loudly when participants indicated that they completed previous tasks.

3.1.8 Data Analysis

As regards to analyzing data for Study 1 which is user-based, gathered data is analyzed separately, yet at the end of the analysis all data was interpreted by comparing with each other. Data analysis was explained considering the data collection methods.

For both mobile and desktop experiments, eye tracking data was collected in the laboratory experiment. Tobii eye tracking devices provide eye tracking research results over Tobii Studio Software which allows an extensive platform for recording, observation, analysis and visualization in heat maps and gaze plots. For desktop eye tracking, the duration after participants read the task and press the F10 and completing task over the website and press F10 was calculated to acquire all the task completion times for each participant. Web pages of all universities were evaluated separately in order to get heat maps, gaze plots and eye tracking and click metrics which are first fixation, fixation duration, and fixation count.

Furthermore, task paths for each participant were extracted in order to compare them with ideal paths. By using Tobii Studio, functional units such as content menu, shortcut menu, slider, and search etc. for each webpage were determined and on statistics part of the software, quantitative results that time to first fixation, fixation duration and fixation count were analyzed. For mobile experiment, the duration after researcher read the task and participant said the task was completed was calculated for each task. Different from desktop eye tracking, there was no click metric but tapping duration was calculated manually to determine whether there is any interaction cost. Tobii Studio software was used for mobile experiment to get

similar results with desktop experiment; thus reasonable comparing was done. The software does not separate each website to make analysis easy; hence separation of each task on the software was done manually (Figure 3.8). Task completion times were interpreted by using SPSS 20.0 and Kruskal-Wallis test, a non-parametric equivalent of ANOVA was used to designate whether there is a difference between universities.

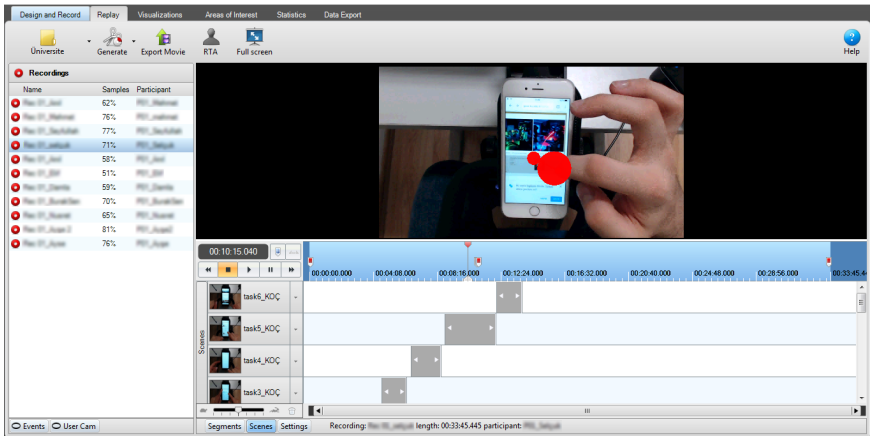

Figure 3.8: Detailed Analysis in Tobii Studio Software

During the eye tracking experiments, think aloud method was used to get thoughts of participants while they were solving the problem. This method was semi structured and provided qualitative data. Thoughts were gathered before analyzing and, they were sorted on the basis of task, university and heuristics subjects.

WAMMI questionnaire data was measured by using SPSS 20.0 in the context of 5 scale which are attractiveness, controllability, efficiency, helpfulness and learnability. Information regarding how good participants rated each website for both mobile and desktop was obtained. By analyzing each WAMMI statement, agreement level of participants was gathered. Moreover, the model of this data collection method includes dependent variable (usability) and independent variable (university websites) (Figure 3.9)

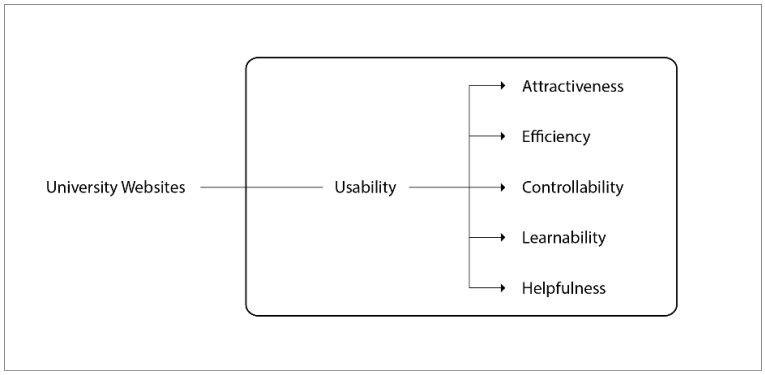

Figure 3.9: Model of Data Collection Method on WAMMI Questionnaire

3.2 STUDY 2 (EXPERT-BASED)

3.2.1 Design of the Study

Study 2 included expert-based experiments based on heuristic evaluation and cognitive walkthrough. Steps required to be considered for heuristic evaluation were done during study 2. Three usability experts were chosen for expert reviews, which is appropriate according to Nielsen and Mack [36] who has stated that 3-5 experts are enough for an evaluation. Usability experts have knowledge about usability processes, procedures and tools. Moreover, they were part of a project and they prepared a guideline about usability of websites, standards about visual design and user interface, accessibility and usability testing. In this study, experts used Nielsen's heuristics to evaluate university websites for both mobile and desktop platforms.

Study 2 consisted of three steps which were prior training, heuristic evaluation with cognitive walkthrough and review:

- **Prior Training:** Researcher gave information to the experts about the purpose of the study, the process of the evaluation, materials and university websites. It was stated that one expert would evaluate three university websites on both mobile and desktop platforms by using heuristics.
- **Heuristic Evaluation with Cognitive Walkthrough:** In this step, each usability expert worked separately by using heuristics and they inspected websites to identify potential usability problems. Heuristics helped experts when they used tasks which were used in study 1 as cognitive walkthrough. After finding problems, they rated the severity of the problems according to the severity levels which are Severe, Medium, and Mild.
- **Review:** After working separately, usability experts came together to examine each other's findings and negotiate prioritization of the problems. In this debriefing step, problems and severity levels were discussed and to make a consensus incomprehensible and different problems were reassessed.

3.2.2 Materials

During study 2, heuristics suggested by Nielsen and Mack [36] were used by experts. Heuristics are grouped as shown below:

- Visibility of system status
- Match between system and the real world
- User control and freedom
- Consistency and standards
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use

- Aesthetics and minimalist design
- Help users recognize, diagnose, and recover from errors
- Help and documentation

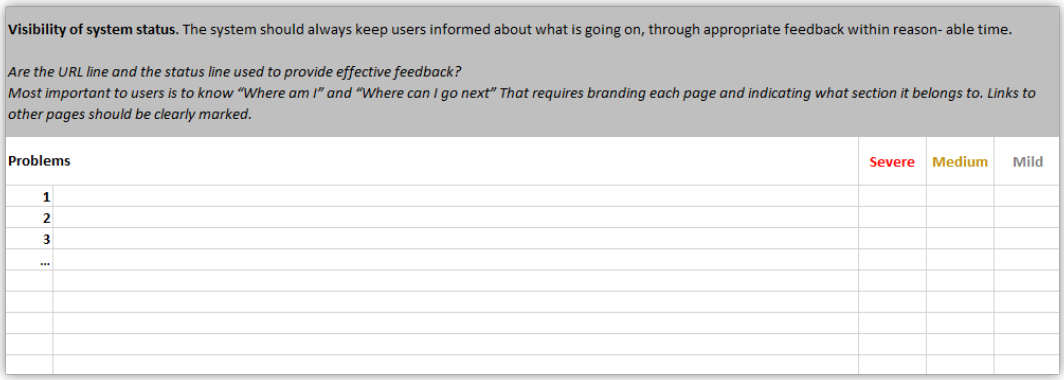

Figure 3.10: Data Collection Material during Study 2

These set of principles were added to one sheet of MS Excel for one university website so experts had three sheets both desktop and mobile platforms. Clarified heuristics were presented with brief explanation and in addition to this Nielsen's original heuristics were applied with web adaptation comments [3] (Figure 3.10). The sheet experts used has severity levels of problems. Moreover, usability experts had task scenarios used in study 1 to have prior knowledge about interfaces.

For the study, heuristics were used for mobile devices without making any changes because considering the web pages principles are common for both mobile and desktop platforms. Also, experts were informed that they were expected to find usability problems by considering mobile device limitations such as size, being responsive etc.

3.2.3 Data Collection Procedure

Usability experts worked independently to find usability problems through the university websites. During the evaluation, heuristics suggested by Nielsen and Mack [36] were used and usability experts were acquainted with heuristics. Usability experts worked on the websites freely and they also had the task scenarios used in study 1 to have prior knowledge about interfaces participants interacted with. Experts scan web pages twice to focus on interface features. Usability experts rated the severity of the problems according to the severity levels which are Severe, Medium, and Mild. (Figure 3.11)

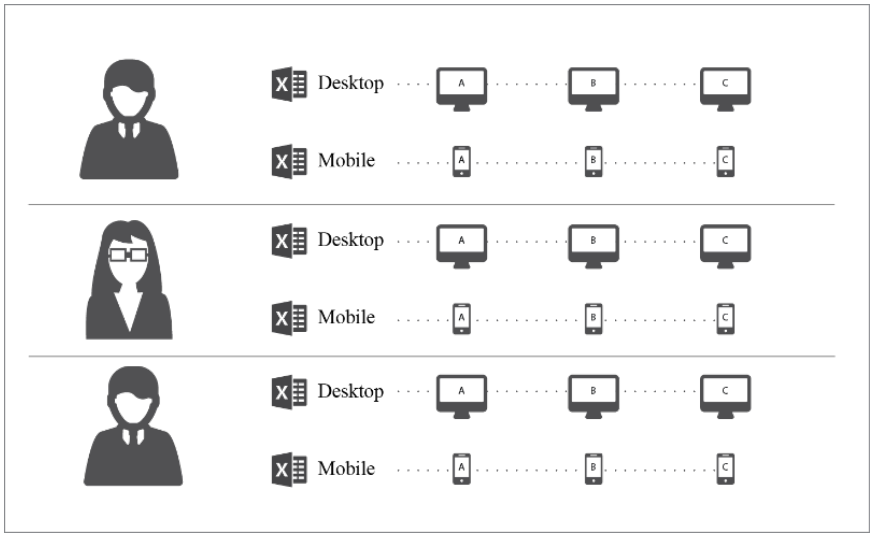

Figure 3.11: Data Collection Procedure of Study 2

After working separately, to reach a consensus about problems and their severity level, usability experts came together. At the end of the heuristic evaluation with cognitive walkthrough, there were conclusive usability problems and their severity level was compounded by three usability experts for both mobile and desktop websites.

3.2.4 Data Analysis

Usability problems that were found by usability experts were analyzed for each university based on mobile and desktop experiments. Severity levels of each usability problems were calculated. Usability problems matched with heuristics to interpret usability principles.

CHAPTER 4

RESULTS

In this chapter all the collected data from study 1 which is user-based and the expert based study 2 are presented together with the analyses of both studies. The experiments were examined on the basis of the tasks undertaken.

4.1 STUDY 1 (USER - BASED) EXPERIMENT RESULTS

4.1.1 DESKTOP EXPERIMENT

4.1.1.1 Task 1 - Scanning the Main Page

The first task was that participants should without clicking / tapping anywhere, scan the main page of each of the three universities namely; Middle East Technical University (METU), Sabancı University (SU) and Koç University (KU) to gain an impression of the content. When they had a general idea about the design of websites' main page, they were asked to explain which area had mostly attracted their attention and commented on the website. For Task 1, the number of steps or expected completion time were not meaningful because the aim was to obtain the participants' first impression from the website and this would vary from one person to another.

4.1.1.1.1 Eye Tracking Results

The participants viewed the first page of the three universities and their total fixation duration showed the most looked at area. The three universities did not have a common webpage layout therefore, some content areas were not provided on the main page. Figure 4.1 shows SU's area of interests as an example, other area of interests are given in Appendix D.

According to the area of interests created with Tobii Studio Software which was mentioned in detail in Chapter 3, the slider which contained an announcement was attention-grabbing area (1.19 / 3.00) lasting for the first 3 seconds on the METU main page. Similarly with the METU site, on the main page of KU (1.33 / 3.00) and SU (1.70 / 3.00), the slider was the most attention grabbing area. The participants showed more tendency to focus on the slider and the size of the slider affects the total fixation duration.

Figure 4.1: Area of Interests of SU

Table 4.1: Total Fixation Duration for the First 3 Sec. (N=10)

	Total Fixation Duration (Sec) (N=10)		
	METU	**KU**	**SU**
Announcement	NA	0.63	0.35
Header	0.31	0.28	0.15
Main Menu	0.42	0.44	0.16
News	NA	NA	0.27
Slider Announcement	**1.19**	**1.33**	**1.7**
Slider Options	0.45	NA	NA
Search	0	0	0
Shortcut Links	0.31	0.32	0.1
User Types	0	NA	0.27
Video	0.32	NA	NA

The slider was important in giving a quick message to the users. The attention of participants might be easily distracted by other web content on the main page so placing messages, events, and quick announcements on the slider will attract a participants' attention in a short time. The task completion times for this task changed from person to person. The heat maps of the participants during their first impression examination of the main page are shown in Figure 4.2.

Figure 4.2: Heat Maps of METU, SU and KU Websites Respectively

Most looked at area having the most intensity is shown in red and less looked area having less intensity is shown in green. The sliders for all three universities were the contents that were most focused on. However, on the main page of KU, the intensity of their attention shifted from slider to the announcement parts. Since the sliders have a picture or visual content, this might be the reason of getting attention. KU contained many announcements presented with pictures and the intensity was split up over other areas. Some of the participants stated that KU had too many announcements and the main page appeared complicated. On the other hand, some of the participants really liked the placement of the content, stating that the design resembled the Window 8 which is based on a flat design and the main page was organized in a tidy way.

During the Task 1, the participants stated that they first attended to the slider. In contrast to the other two universities, METU has a background images which changes periodically and some of the participants commented that the "website is more colorful, which makes it a little bit complicated". It might considered that background image might affect the visual perception because apart from background image, the main design was as colorful as other universities.

The main page being the gateway to the website of university might affect the perception of users. Before designing a webpage, requirements of the target groups have to be considered and main page should include the most used operation links.

4.1.1.2 Task 2 - Finding Industrial Engineering Graduate Program

In this task, the participants were given a scenario that they had decided to apply to an industrial engineering graduate program and they were required to search the website of each of the three universities to determine where they had this program.

4.1.1.2.1 Completion Time

The number of participants who successfully completed Task 2 are shown in Table 4.2 with their task completion times for three universities with minimum, maximum and median values. Table 4.2 reveals that KU (00:01:04) has the longest task completion time with METU having the shortest time (00:00:22).

Table 4.2: Task Completion Times of Three Universities for Task 2

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:00:22	0:00:11	0:00:08	0:00:10	0:00:47	0:00:21
SU	10	0:00:30	0:00:22	0:00:08	0:00:11	0:01:26	0:00:22
KU	10	0:01:04	0:00:23	0:00:16	0:00:25	0:01:36	0:01:02

The difference between the task completion time of each participant and ideal task completion time for METU is presented in Figure 4.3. For those whose task completion times were much higher than the ideal time had experienced a problem in scanning the long list of graduate programs.

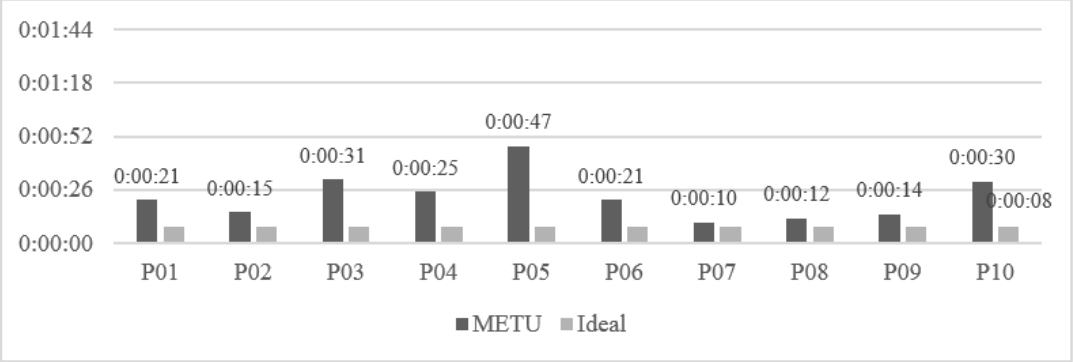

Figure 4.3: Task Completion Times of Each Participant for the METU Website for Task 2

The difference between the task completion time of each participant and ideal task completion time for SU is presented in Figure 4.4. Most of participants' task completion times were close together however, a few of participants completed the task in more than the ideal task completion time. The reasons for this difference were given as the placement of navigation menu and terminology used by the university.

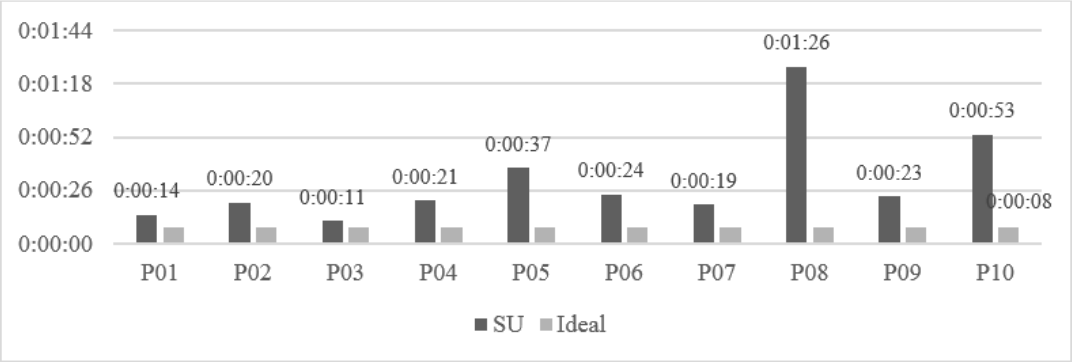

Figure 4.4: Task Completion Times of Each Participant for the SU Website for Task 2

The difference between the task completion time of each participant and ideal task completion time for KU is presented in Figure. Most of the participants completed task in more than the ideal task completion time. The navigation menu design and the lack of sufficient direction were the reasons for the participants being unable to complete task in a shorter time.

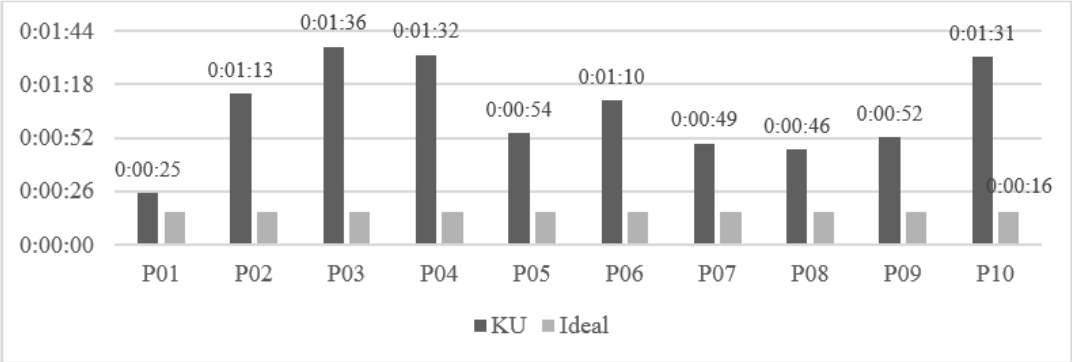

Figure 4.5: Task Completion Times of Each Participant for the KU Website for Task 2

The difference between the task completion times of each participant and ideal task completion time for METU, SU and KU, respectively, is presented in Figure. According to these results it appears that finding the same information on KU took much more time comparing to METU and SU.

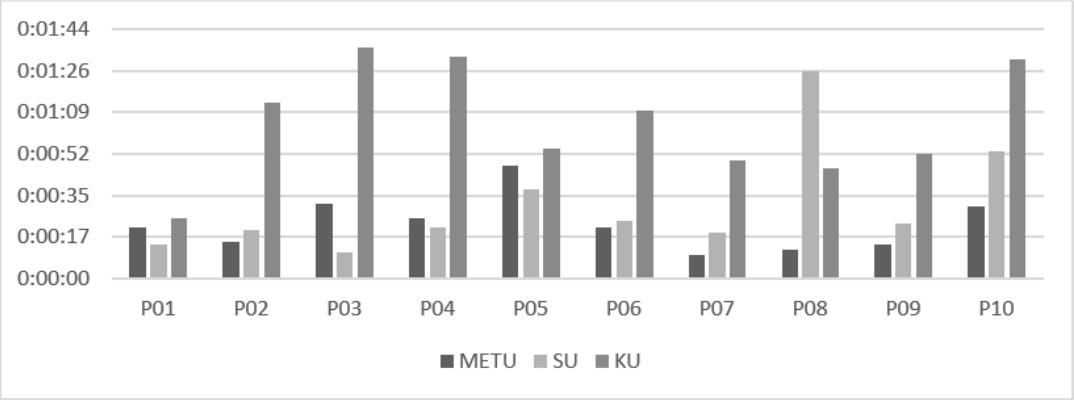

Figure 4.6: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 2

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.3 shows the Kruskal-Wallis Test analysis. The significant value (p=0.001) of the Kruskal-Wallis Test is less than coefficient alpha (a=0.05) thus, the null hypothesis (h0) is rejected. Therefore, there was a statistically significant difference in task completion times between the universities. The mean rank of task completion time is 10.20 for METU, 19.72 for SU and 14.11 for KU (Table 4.4). It was revealed that Task 2 was completed by the participants in a shorter time during their evaluation of METU website.

Table 4.3: Test Statistics of the Desktop Experiment for Task 2 (Kruskal-Wallis Test)

	Task 2 - Completion Time
Chi-square	13.84
df	2
Asymp. Sig.	0.001

Table 4.4: Mean Ranks of the Desktop Websites of Universities for Task 2 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	10.2
Sabancı University	10	12.45
Koç University	10	23.85

According to the average number of steps that participants performed (Table 4.5), these are closer to ideal number of steps, which shows that the participants understood the web design of the universities. Although KU has almost same mean of ideal number of steps as METU,

according to Table 4.5, KU has the highest mean rank. This might show that the participants spent more time on same webpages. METU has the lowest mean rank and the reason might be that navigation bar and shortcut links on the main page of METU were placed saliently so finding right link might not be difficult for participants.

Table 4.5: Number of Steps of the Three Universities for Task 2

	Number of Steps of the Three Universities				
	N	**Mean of Participant's Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	10	2.8	2.5	2	4
SU	10	5.2	5	5	6
KU	10	3.3	3	3	6

4.1.1.2.2 Eye Tracking Results

The main page of the university websites included shortcut links about the most used operations. For METU, information about Academics was placed under the main menu and at the bottom right of the main page. In this task to find whether university had industrial engineering program for graduate programs, 50% of the participants chose the main menu and the remainder used shortcut links. Figure 4.7 shows that the focus of the participants were intensified on the terms related to Academics on both the main menu and shortcut links. The participants did not have a problem in completing the task on the METU website; they located the graduate program list which was sorted alphabetically.

Figure 4.7: Heat Map of the First Step of Task 2 for METU

Main menu of the SU website was in the center of the page, while there was a user types which have specialized operations for Students, Staff, Researchers and Alumni on the top of the page this main menu was not clearly visible when color of the slider was close to that of the menu. In this situation, user types became more visible. Furthermore, placing the menu at the center of page seemed to be out of ordinary with one of the participants stating "I used

to see the main menu at the top of page so this placement of menu was not what I was used to". They found the menu and tried to go to the Faculties / Faculty of Engineering and Natural Sciences Graduate Programs (Mühendislik ve Doğa Bilimleri Fakültesi). Abbreviations such as FENS (MDBF) caused participants to slow down since they had to work out what those abbreviations stood for.

For KU, the task completion times were higher than both the ideal completion times and the other universities' task completion times. The main page of KU had a menu on the left side but it occupied a smaller space compared with that of the announcements. Figure 4.8 shows participants' gaze plot of the first fixations according to the areas of interest (Appendix E) before clicking any link. It is revealed that the size of the main menu did not affect the fixation of the participants whose first fixations were more focused on the main menu. However, the gaze plots show that participants had to read all the menu items because the menu items were not sorted alphabetically.

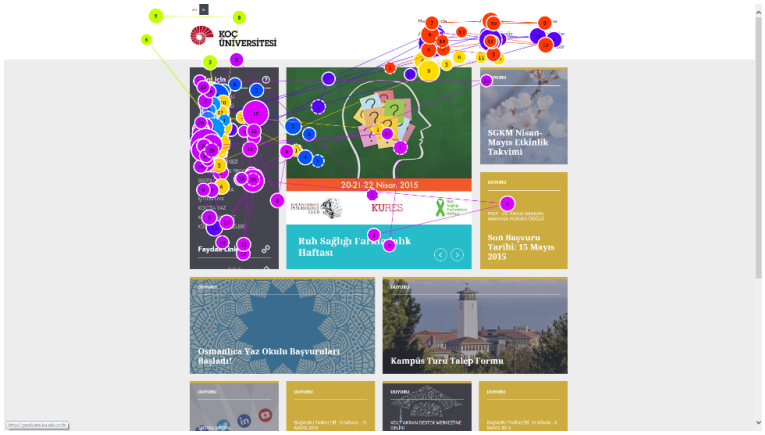

Figure 4.8: Gaze Plots of KU Main Page for Task 2

Gaze plots also gave information that the shortcut links on the right top of the menu were examined by participants. As shown in Table 4.6 for the fixation counts before the participants clicked a link, the sum of the fixation count for the main menu area is 81 while the shortcut links count is 27). When the gaze plot and fixation counts were examined it was found that shortcut links caught the participants' attention but they scanned them quickly and returned main menu.

Table 4.6: Fixation Counts until Clicking a Link for Task 2

	Fixation Counts		
	Main Menu (AOI)	**Shortcut Links (AOI)**	**Not Area of Interests (NAOI)**
Total Participants (N=10)	81	27	17

One of the reasons that KU has the highest completion time was the memory load on the page of graduate programs. When participants selected Graduate Programs on the main menu and they selected graduate programs on top of menu of Graduate Programs website, they were directed to the page which contains detailed information about graduate programs. However,

that page opened with information about Graduate Schools of Business. Figure 4.9 shows the gaze plot of that page and it can be seen that the participants did not read the Graduate Schools of Business heading and clicked the link to Master Programs to find industrial engineering. The website misdirected participants thus they spent too much time in understanding the content.

Figure 4.9: Gaze Plot of the Webpage of Graduate Programs on KU (N=6)

The results of this task shows that putting all the required information on websites does not enhance the usability of the webpages. Users should not have to think in detail when using the website, each component has to be understood clearly and actions of the users should give them the results they expect.

4.1.1.3 Task 3 - Finding the Spring Classes Start Date

In this task, the participants were given the scenario that they had been accepted on the Industrial Engineering program and they wanted to know when the classes would begin in the 2014-2015 Spring Semester.

4.1.1.3.1 Completion Time

The number of participants who successfully completed the Task 3 are shown in Table 4.6 with their task completion times for the web sites of the three universities with minimum, maximum and median values. According to the Table 4.6, SU (00:01:59) has the longest task completion time with METU having the shortest (00:00:52).

Table 4.7: Task Completion Times of Three Universities for Task 3

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:00:52	0:00:23	0:00:15	0:00:29	0:01:39	0:00:47
SU	8	0:01:59	0:00:46	0:00:17	0:00:46	0:03:19	0:02:06
KU	8	0:01:51	0:00:47	0:00:25	0:01:00	0:03:26	0:01:41

The difference between the task completion time of each participant and the ideal task completion time for METU is presented in Figure 4.10. The Academic Calendar was presented as a normal list with the Google Calendar on METU. For those whose task completion times were much higher than the ideal time had problems using Google Calendar. The reason for this was that participants had to click on each date to see the descriptions and click again to close it. Moreover, the month view of the Google Calendar opened as a default and to switch between months, participants had to use the back and forward arrows. The participants had to take extra time to switch between months and try to find correct description.

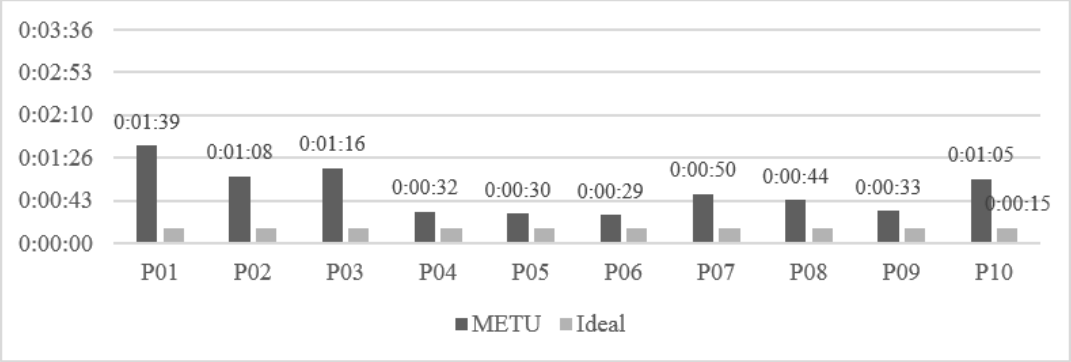

Figure 4.10: Task Completion Times of Each Participant for the METU Website for Task 3

The difference between the task completion time of each participant and the ideal task completion time for SU is presented in Figure 4.11. The reason for the higher task completion times was the placement of the Academic Calendar link. It was placed on footer of the main page and unless participants scrolled down, there was impossible to find that link. Until the participants were able to find the Academic Calendar link, they had spent too much time on main menu because they expected the Academic Calendar link to be on main menu.

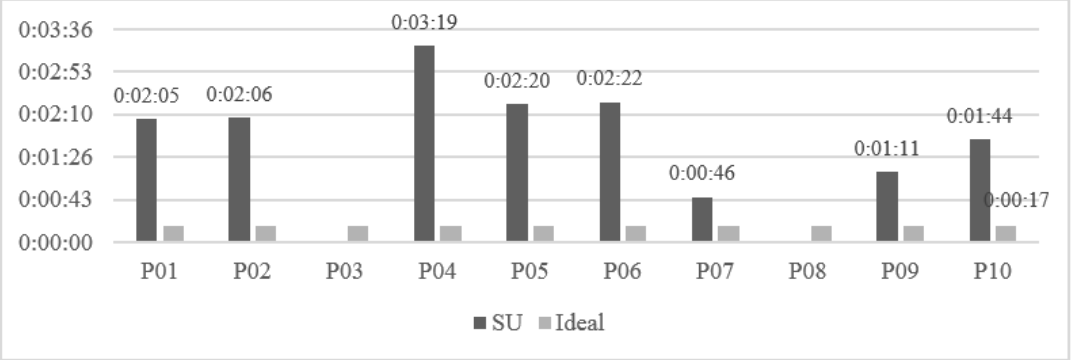

Figure 4.11: Task Completion Times of Each Participant for the SU Website for Task 3

The difference between the task completion time of each participant and the ideal task completion time for KU is given in Figure 4.12. The reason for the higher task completion times was placement of the Academic Calendar link and appearance of the calendar. When participants clicked Academic link on the main page, the website directed them to the page which includes information such as academic programs, calendar and courses. However, Academic Calendar link was not visible on the screen, participants had to scroll down to see it. Moreover, participants spent too much time using the Academic Calendar which was opened Google Calendar

as a default.

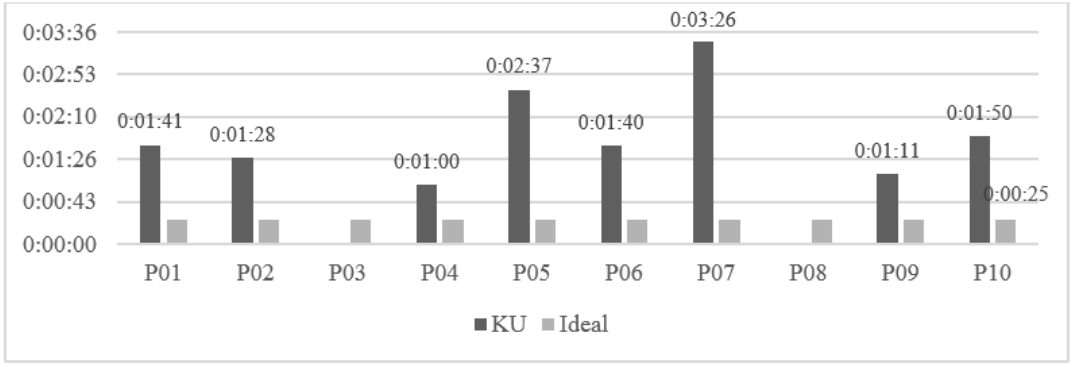

Figure 4.12: Task Completion Times of Each Participant for the KU Website for Task 3

The difference between the task completion times of each participant and the ideal task completion time for METU, SU and KU, respectively, is shown in Figure. Where it can be seen that participants took longer to complete task on the SU and KU websites than on METU.

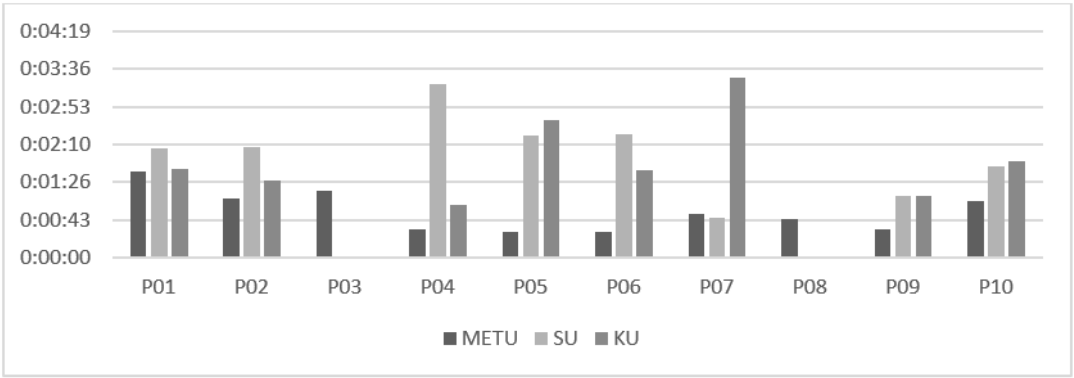

Figure 4.13: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 3

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.8 shows the Kruskal-Wallis Test analysis. The significant value (p=0.002) of the Kruskal-Wallis Test is less than the coefficient alpha (a=0.05) thus, the null hypothesis (h0) is rejected. Therefore, there was a statistically significant difference in the task completion times between the universities. The mean rank of task completion time is 6.40 for METU, 18.31 for SU and 16.94 for KU (Table 4.9). It was revealed that Task 3 was completed by the participants in a shorter time during their evaluation on METU website. SU and KU have close mean rank score but in terms of task

success, more participants completed task on the SU website.

Table 4.8: Test Statistics of the Desktop Experiment for Task 3 (Kruskal-Wallis Test)

	Task 3 - Completion Time
Chi-square	12.233
df	2
Asymp. Sig.	0.002

Table 4.9: Mean Ranks of the Desktop Websites of Universities for Task 3 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	6.40
Sabancı University	8	18.31
Koç University	8	16.94

The average number of steps that participants performed, which was shown on Table 4.9, are close to the ideal number of steps. However, for KU, more steps made participants feel lost and give up to continue. Considering mean rank of SU, participants spent too much time comparing to ideal completion time but SU has the lowest ideal number of steps. In this task, participants looked to find Academic Calendar link and SU put that link at the bottom of main page, which makes participants spend too much time for scanning the main page.

Table 4.10: Number of Steps of Three Universities for Task 3

	Number Of Steps Taken to Achieve The Tasks for The Three Universities				
	N	**Mean of Participants' Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	10	3.7	3.5	3	6
SU	8	4.8	2	3	6
KU	8	7.1	7	6	11

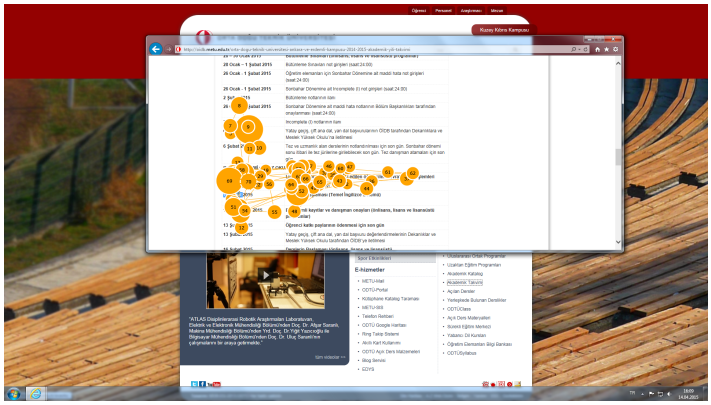

Figure 4.14: Heat Map of Seeking Academic Calendar Links for Task 3

4.1.1.3.2 Eye Tracking Results

For the SU website, the link to the Academic Calendar was not visible unless participants scrolled down. Figure 4.14 shows the heat map of the first page on which the participants searched for the link to the academic calendar. Considering to the intensity of red, participants thought that academic calendar's link might be on the menu. In fact, on the main page there was an event calendar which some of the participants clicked on in their attempt to find the academic calendar.

The main page of SU was identified according to the area of interests (Appendix F) and fixation duration was calculated from when the task was started and when the participants left the main page. Table 4.11 shows that the participants spent the longest time at center of the main page this was due to their supposition that the Academic Calendar link had to be under the main menu.

Table 4.11: Fixation Duration of SU's Main Page for Task 3

	Fixation Duration (Sec - Sum)				
	Bottom of the Main Page	**Center of the Main Page**	**Slider Announcement**	**Top of the Main Page**	**Total Time**
P1	0	4.67	0.13	1.41	6.21
P2	1.09	7.02	1.5	0.54	10.15
P4	0.88	5.98	2.85	0	9.71
P5	0	2.02	0.91	0	2.93
P6	2.4	14.57	2.92	1.55	21.44
P7	9.87	19.43	4.34	0.06	33.7
P9	7.61	24.57	2.21	5.05	39.44
P10	1.2	12.26	2.56	0	16.02
Total	**23.05**	**90.52**	**17.42**	**8.61**	**139.6**

On the academic calendar page of the SU website, there were all semesters from 2011 to date, for each year there were 4 links; full year calendar, fall semester, spring semester and summer school. Participants had difficulties selecting the right link because there were twenty links in the list. The participants commented that it was not necessary to present the academic calendars of past years and they caused confusion about reading. The Academic Calendar was shown as a table and participants had to scroll down to view dates and their explanations. However, when scrolling the top row which showed the groups of students such as undergraduate and graduate. To see which date which belonged to which group the participants had to scroll up and down. To make this table more user efficient, the participants suggested that top row might remain visible while scrolling up and down.

The METU and KU websites utilize Google Calendar as the academic calendar. For METU, there was an option that shows the academic calendar as a normal list. Looking for the dates on the Google Calendar or normal list have close task completion times but most of the participants chose to view the normal list on the METU website. The explanations of the dates were not visible on Google Calendar so users had to click each explanation to assess the content. The Google Calendar had three view options which are week, month and agenda but participants tended not to change the default view. It was observed that when dates were placed in

the left column and related explanations were located in the right column on the normal version, that design forced participants to read the dates descending order and when they reached approximate dates they started to read the explanations. The gaze plot of one participants in Figure 4.15 is an example of that reading pattern.

Figure 4.15: Gaze Plot of One Participant on Academic Calendar Webpage of METU

The KU Academic calendar was displayed as a Google Calendar in agenda view. The participants stated that on agenda view it was not clear which explanation belonged to which date because rows did not make a clear distinction between dates. Identifying dates and their descriptions was difficult for participants and in order to locate the start date of classes required a longer duration. Table 4.12 shows the fixation counts of the Academic Calendar with the Area of Interest being the area that included Academic Calendar. It was found that participants spent too much time on finding the correct date.

Table 4.12: Fixation Count on Academic Calendar Page of KU

	Fixation Counts (Sum)		
	Area of Interests (AOI)	**Not Area of Interests (NAOI)**	**Total Time**
P1	561	27	588
P2	81	0	81
P3	211	9	220
P4	88	13	101
P5	200	25	225
P6	204	4	208
P7	160	4	164
P8	175	10	185
Total	**1651**	**92**	**1772**

Some of the lack of successfully achieving the task might be related to the participants' search habit because they looked for academic calendar under the department of Industrial Engineering. They stated that academic calendar should be under the departments' websites because

they did not want to view all the dates related to the whole university. During the experiments, that usage habit affected participants' behavior in that when they failed to find the calendar within the department webpages, they did not consider that calendar could be at different location so they gave up.

Reading patterns need to be considered while designing webpages which contain dense text. As with the other tasks, participants should be able to scan the website and find the information they require where they expected. This does not mean that all the operations should be on the webpage rather that there should be a pattern which reflects the context of real-life searching and viewing of webpages.

4.1.1.4 Task 4 - Searching Information about Scholarship

In this task, the scenario given is that participants wished to obtain information about the scholarship opportunities of the university using the search field. In this task, the required information was not specifically given since the purpose of this task was to observe participants' behaviors concerning searching and examining the usability of the attributes of searching such as placement and results in the context of task.

4.1.1.4.1 Completion Time

All the participants completed task successfully and their task completion times for the three universities with minimum, maximum and median values are shown in Table 4.13. According to the Table 4.13, KU (00:00:10) has the longest task completion time. The completion times were calculated between after participants finished reading the task and before they started to type in a search box. Finding information was not examined in detail because the appropriacy of the information that the participants found changed from person to person.

Table 4.13: Task Completion Times of Three Universities for Task 4

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:00:02	0:00:00	0:00:02	0:00:02	0:00:03	0:00:02
SU	10	0:00:02	0:00:01	0:00:02	0:00:02	0:00:07	0:00:02
KU	10	0:00:10	0:00:07	0:00:03	0:00:04	0:00:26	0:00:05

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean difference in duration of finding the search box between the university websites.

h1: There is no significant mean difference in duration of finding the search box between the university websites.

The independent samples t-test was conducted and Table 4.14 shows the Kruskal-Wallis Test analysis. The significant value (p=0.000) of the Kruskal-Wallis Test is less than the coefficient alpha (a=0.05). The null hypothesis (h0) is rejected. Therefore, there was a statistically sig-

nificant difference in duration of finding search box between the universities. The mean rank of the task completion time is 9.40 for METU, 12.35 for SU and 24.75 for KU (Table 4.15). According to Table 4.13, the mean of task completion times of the tasks on the METU and SU websites were same but on Table 4.15, there was a difference between those universities. KU has the highest mean rank, which shows that participants had difficulties about finding the search field. On the KU main page, initially search was not presented as a box, it was hidden under the link named Search (Arama) on the top right of the page. Therefore, due to the fact that KU does not have common search box design, finding the search field took the participants a long time.

Table 4.14: Test Statistics of the Desktop Experiment for Task 4 (Kruskal-Wallis Test)

	Task 4 - Completion Time
Chi-square	20.296
df	2
Asymp. Sig.	0.000

Table 4.15: Mean Ranks of the Desktop Websites of Universities for Task 4 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	9.40
Sabancı University	10	12.35
Koç University	10	24.75

4.1.1.4.2 Eye Tracking Results

Considering features of search field, 70% of the participants wrote the keyword in the search box and then they pressed Enter on the keyboard while remainder clicked the magnify icon near the search box. METU had placed their search button on the top right of the main page. Therefore, it was not hard for the participants to see and reach search box. One problem that that participants faced when completing the task concerned the search results. The participants wrote Scholarship (Burs) and expected to obtain search results which contained information about scholarship. They clicked first result but that result directed participants to the page that contained announcements about scholarships. During the experiment, because of there were no announcements, the participants encountered a blank page headed Scholarship Announcements. This blank page led to participants feeling that the page had not yet loaded so they waited for a while. Figure 4.16 shows the gaze plot of participants on the scholarship announcement, which from the scattering of the gazes means that participants did not know what to do next and scanned pages while waiting. After that, they returned to the search results page and clicked the second results which contained detailed information about scholarship.

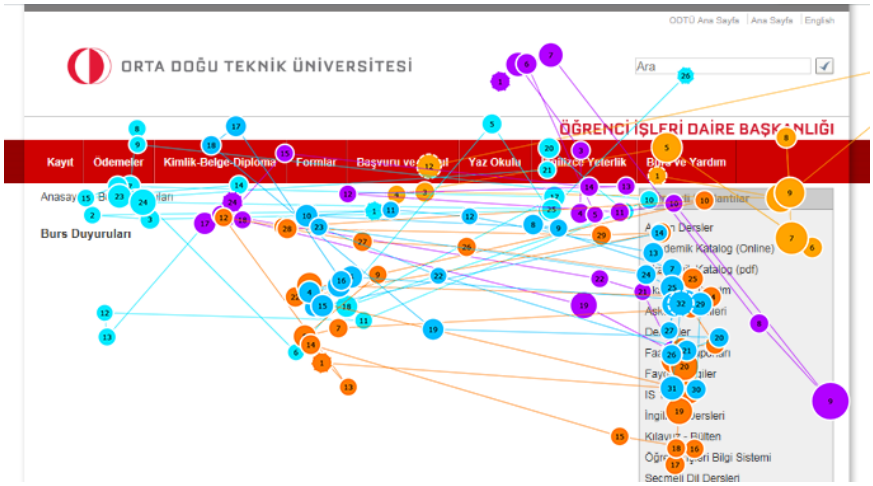

Figure 4.16: Gaze Plot of Participants on Scholarship Announcement Webpage of METU (N=5)

For the SU website, similar to METU, the participants found the search box at the top right of the main page. SU uses Google as a search engine and after the keyword was entered and searching began the webpage directed participants to another page. Concerning the search field, some of the participants realized that search box on the main page had a placeholder but when language of the website was Turkish, "Search" was written in the box instead of "Arama".

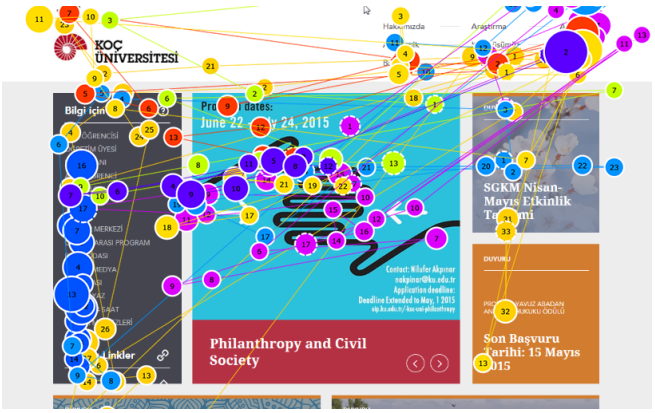

Figure 4.17: Gaze Plot of Participants When Looking for Search Field on Main Page of KU (N=6)

The KU website had different search placement, which made difficulties for the participants engaging in a search. The search box was hidden under the link called Search (Arama) on the top right of the page. Figure 4.17 shows the gaze plot of participants until they found the search. They indicated that they were looking for a magnify icon or a box but they did not think that search field could open by clicking a "Search" word. After they clicked the Search word, search area and search options appeared. KU offers two search options which are "Search in only ku.edu.tr" and "Search in all KU websites". Most of the participants did not notice these options and that changing options also changes the number of results. The

default search option was “Search in only ku.edu.tr”, which shows less search results than the other option. Some of the participants commented “In order to get more search results, the default search option should be ‘Search in all KU websites’”.

Table 4.16: Time to First Fixation and Total Fixation Duration of Area of Interests on Main Page of KU

	Time To First Fixation (Sec-Mean)	**Total Fixation Duration (Sec-Mean)**
Announcement	1.2	0.62
Header	0.89	0.35
Main Menu	0.78	1.24
Shortcut Links	**0.33**	**1.53**
Slider Announcement	2.38	0.54

The main page of the university was identified according to the areas of interest (Appendix D) in order to undertake the eye tracking analysis. Table 4.16 shows the time to first fixation and the total fixation duration of the main page of KU. Less time to the first fixation shows the first attention grabbing area. To find the search field, participants first looked at the top right of the main page. The total fixation duration produced result of that although they did not find the search field on the first look, they returned to that area and persevered in their attempts to find search field at the top right of the main page.

The number of search results and the time taken to find results were shown for all universities. The METU search results were displayed with a heading for the results and a brief explanation, the SU and KU search results gave a heading, a brief explanation and an image related to the results.

Search is an important function for all websites. During the experiments, it was seen that the search field was expected to be located at the top right of the main page. Moreover, the first result of search results is the most preferred result and it needs to contain the required information.

4.1.1.5 Task 5 - Finding E-Mail Address of a Teacher

In this task, the scenario was that participants had noticed that they would not be able to attend one of their graduate program classes because of work commitments and since they wanted to inform their teacher about this situation they needed to find the e-mail address of any teacher in industrial engineering.

4.1.1.5.1 Completion Time

According to the task completions, task 5 was not successfully completed three times. Task completion times for the three universities with minimum, maximum and median values are shown in Table 4.17. According to the Table 4.17, KU (00:01:41) has the longest task completion time when METU has the lowest task completion times (00:00:36).

Table 4.17: Task Completion Times of Three Universities for Task 5

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	9	0:00:36	0:00:15	0:00:18	0:00:22	0:01:05	0:00:31
SU	10	0:00:40	0:00:17	0:00:19	0:00:22	0:01:10	0:00:33
KU	8	0:01:41	0:00:41	0:00:24	0:00:41	0:02:53	0:01:36

The difference between the task completion time of each participant and ideal task completion time for METU is presented in Figure 4.18. The webpage of Industrial Engineering did not have a Turkish language option. Therefore, participants' performance decreased because this changing.

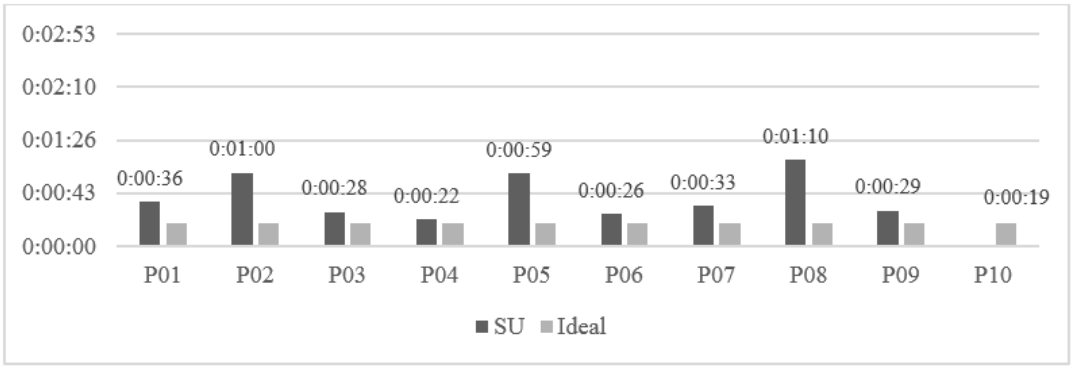

Figure 4.18: Task Completion Times of Each Participant for the METU Website for Task 5

The difference between the task completion time of each participant and the ideal task completion time for SU is presented in Figure 4.19. Those whose task completion times were higher mistakenly selected the Faculty of Engineering and Natural Sciences link instead of the FENS Graduate Programs and then they tried to find the Industrial Engineering Program using the navigation menu. Since this menu on the webpage of Faculty of Engineering and Natural Sciences had general terms this made participants spend too much time for selecting correct menu.

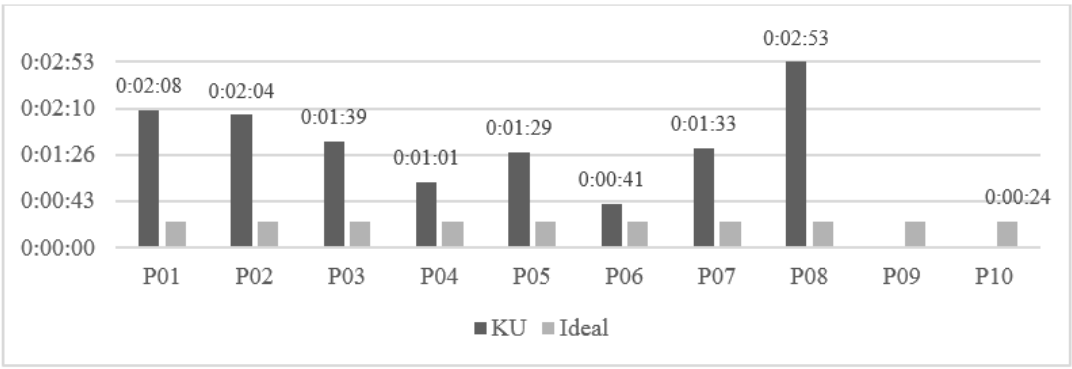

Figure 4.19: Task Completion Times of Each Participant for the SU Website for Task 5

The difference between the task completion time of each participant and the ideal task com-

pletion time for KU is presented in the Figure 4.20. There are many reasons for these higher task completion times these included directing participants to an unexpected page on the site, the unusual design of the webpage that includes more than one navigation menu and offering less user control which led to participants having problems in completing this task.

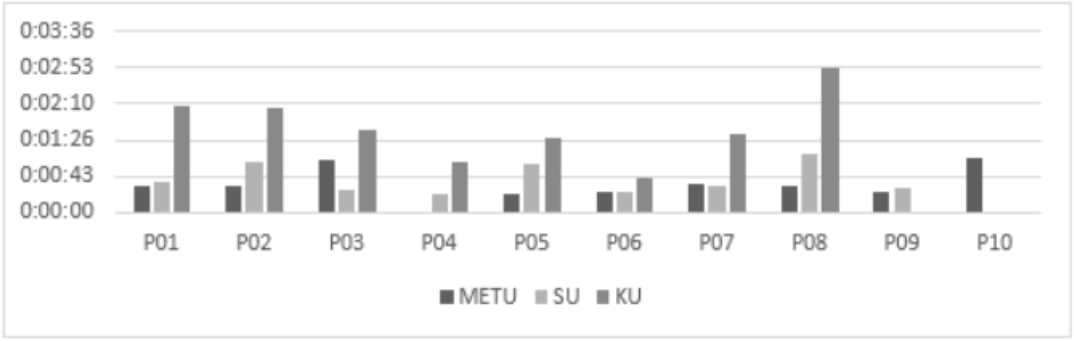

Figure 4.20: Task Completion Times of Each Participant for the KU Website for Task 5

The difference between the task completion times of each participants and ideal task completion time for METU, SU and KU, respectively, is presented in Figure 4.21. According to that the data, it is seemed that most of the participants completed the task on the KU website in a longer time than on the METU and SU sites. This reveals that the design of KU should be examined in terms of usability principles.

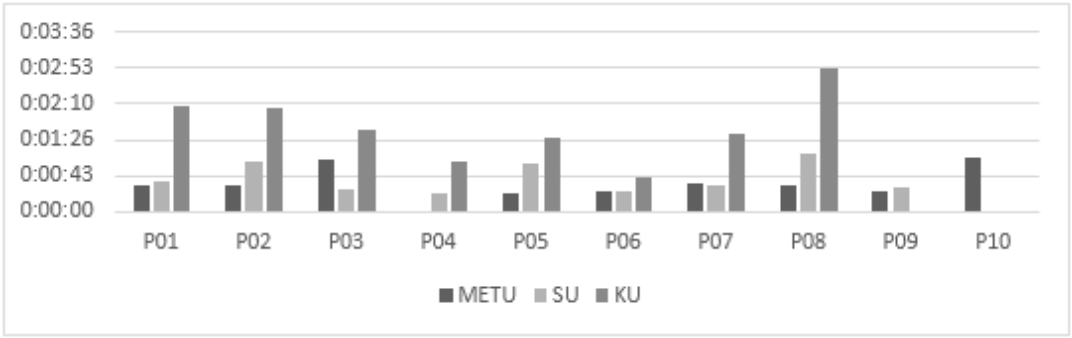

Figure 4.21: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 5

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.18 shows the Kruskal-Wallis Test analysis. The significant value (p=0.002) of the Kruskal-Wallis Test is less than the coefficient alpha (a=0.05). The null hypothesis (h0) is rejected. Therefore, there was a statistically

significant difference in task completion times between the universities. The mean rank of task completion time is 9.39 for METU, 10.50 for SU and 21.50 for KU (Table 4.19).

Table 4.18: Test Statistics of the Desktop Experiment for Task 5 (Kruskal-Wallis Test)

	Task 5 - Completion Time
Chi-square	12.750
df	2
Asymp. Sig.	0.002

Table 4.19: Mean Ranks of the Desktop Websites of Universities for Task 5 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	9	9.39
Sabancı University	9	10.50
Koç University	8	21.50

According to the average number of steps that the participants performed (Table 4.20), for METU and SU, the average number of steps are close to the ideal number of steps but for KU, considering number of steps together with task completion times, the participants spent too much time moving between the webpages. KU main page has too many announcements, which distracted the participants and slowed them down. Moreover, the KU webpages include links which have similar labels. There was a correlation between the degree of participant confusion and increased task completion time.

Table 4.20: Number of Steps of Three Universities for Task 5

	Number of Steps of Three Universities				
	N	**Mean of Participant's Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	9	6.7	6.5	6	9
SU	10	7.2	7	7	9
KU	8	10	5	7	14

4.1.1.5.2 Eye Tracking Results

METU had the lowest task completion time and except for one participant who found the right page but did not obtain the right menu, all participants found one e-mail address of a teacher. Most of the participants used the Faculties, Institutes and Schools link under the Academic menu or the shortcut links right bottom of the page. The gaze plots of the participants who used the list of Faculties, Institutes & Schools are shown in Figure 4.22.

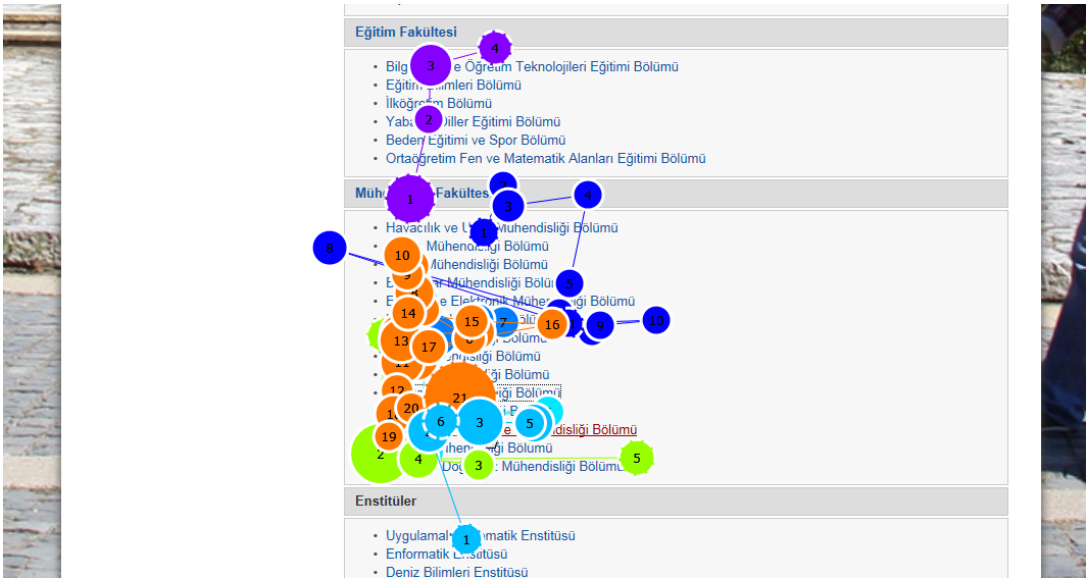

Figure 4.22: Gaze Plot of Participants When Seeking Industrial Engineering on METU Website (N=5)

The reading pattern of those participants were scattered because the departments under the faculty of engineering were not sorted alphabetically. One participants commented “I do not like the way it is sorted, it confuses me. Sorting alphabetically is not difficult to do but it is useful for users”. Considering numbers on the gaze plots which were not ordered, it can be seen that the participants could not easily find the link of Industrial Engineering.

The task completion times for the SU website was close to that of METU. Participants tried to find the e-mail address of a teacher within the department so they went to webpage of Industrial Engineering in which the Menu labelled People help them find the information. SU shows teachers together with their photograph and their research areas. In addition, under the information about the teacher there was a mail icon. At first the participants did not recognize the icon and clicked on the photograph they stated that detailed information might be displayed when they opened the individual teacher’s webpage. Eventually the participants noticed that e-mail address appeared when they moved the mouse over the mail icon. The webpage of People looked tidy and usable but only desktop websites have sufficient space to show the important information. The participants in the current study stated that e-mail address might be placed next to the mail icon to make it more visible.

KU has the highest task completion time because the same situation occurred as in Task 2. Participants tried to go to the Industrial Engineering webpage using the Graduate Programs link on the main page which made them lose their way and they had to start again. The ideal path to find the teacher information was to select Academic on the top right of the main page, then select Faculty of Engineering and click link of Faculty in the center menu. The webpage of the Engineering webpage had a top and center menu; the top menu directed participants to the external pages, the center menu contained information about the faculty. According to the Table 4.21, it was found than participants looked first to the top of the page and this made them use top menu which directed them to the main page. The participants focused on the top menu until they saw the center menu which led them to the e-mail address of teachers.

Table 4.21: Time to First Fixation of College of Sciences and Graduate School of Sciences and Engineering on KU

	Time to First Fixation (Sec - Mean)			
	Bottom	**Center**	**Slider**	**Top**
P1	11.62	10.24	0.37	0.56
P2	14.59	11.84	0.66	0.48
P3	8.01	0	0.61	0
P4	13.59	8.88	0.74	2.17
P5	29.35	26.53	0.34	0.83
P6	0	2.91	1.76	1.67
P7	11.18	8.77	3.71	0.8
P8	2.34	2.21	0.41	0.22
Total	**12.96**	**10.2**	**1.07**	**0.84**

4.1.1.6 Task 6 - Finding Whether There is a Swimming Pool

In this task, a scenario was given that the participants noticed that they had free time after their graduate program classes and they thought that they could go to the swimming pool if there was one. Their task was to find whether the university had a swimming pool.

4.1.1.6.1 Completion Time

The participants' task completion times for the three universities with minimum, maximum and median values are shown in Table 4.22. According to the Table 4.22, KU (00:01:00) has the longest task completion time with METU having the lowest task completion times.

Table 4.22: Task Completion Times of Three Universities for Task 6

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:00:27	0:00:28	0:00:09	0:00:09	0:01:44	0:00:20
SU	10	0:00:40	0:00:24	0:00:16	0:00:18	0:01:28	0:00:32
KU	10	0:01:00	0:00:42	0:00:12	0:00:22	0:02:26	0:00:42

The difference between the task completion time of each participant and the ideal task completion time for METU is presented in Figure 4.23. Most of the participants tried to find swimming pool using the main menu but some used the shortcut link which directed participants to the Office of Sports page. Even if they clicked to the shortcut link, seeking information through the webpage took some extra time.

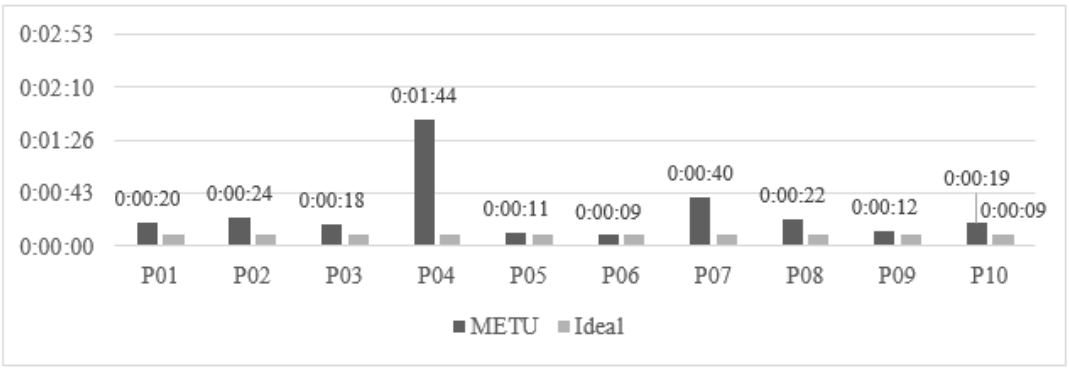

Figure 4.23: Task Completion Times of Each Participant for the METU Website for Task 6

The difference between the task completion time of each participant and the ideal task completion time for SU is presented in Figure 4.24. SU does not have a swimming pool and most participants discovered this after examining the webpage which included only a small amount of information about Sport Activities. Participants who had a higher task completion time wanted to be sure and opened the webpage of Sport Activities. Examining that webpage meant that the participants spent more time on completing the task.

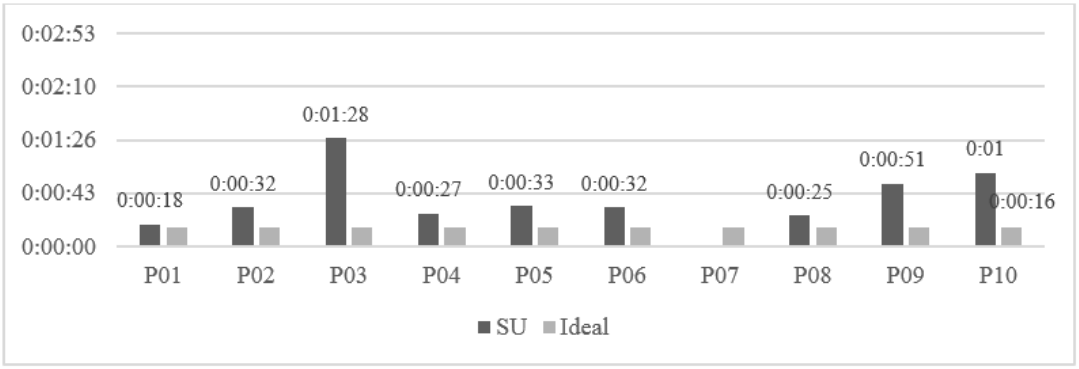

Figure 4.24: Task Completion Times of Each Participant for the SU Website for Task 6

The difference between the task completion time of each participant and the ideal task completion time for KU is presented in Figure 4.25. Seeking the information about sports on main menu together with large size images resulted in the participants slowing down and taking longer to complete the task.

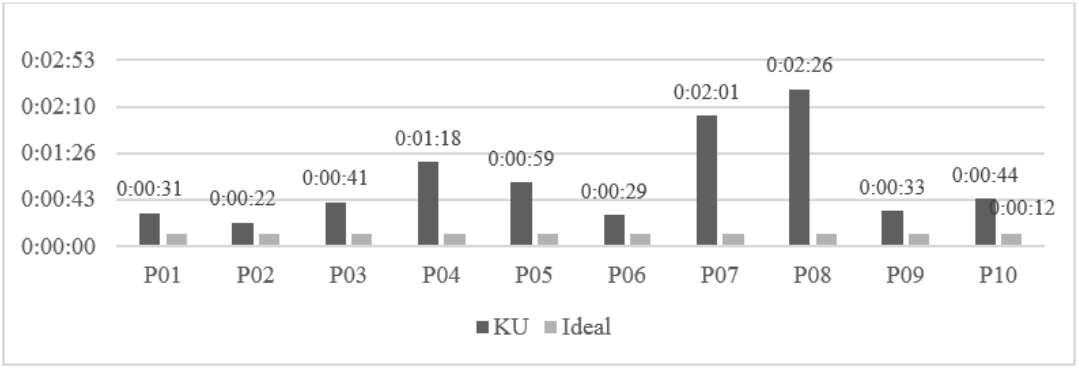

Figure 4.25: Task Completion Times of Each Participant for the KU Website for Task 6

The difference between the task completion times of each participant and the ideal task completion time for METU, SU and KU, respectively, is presented in Figure 4.26. From this data it seems that most of participants completed task on the METU website in a shorter time than on the KU and SU websites.

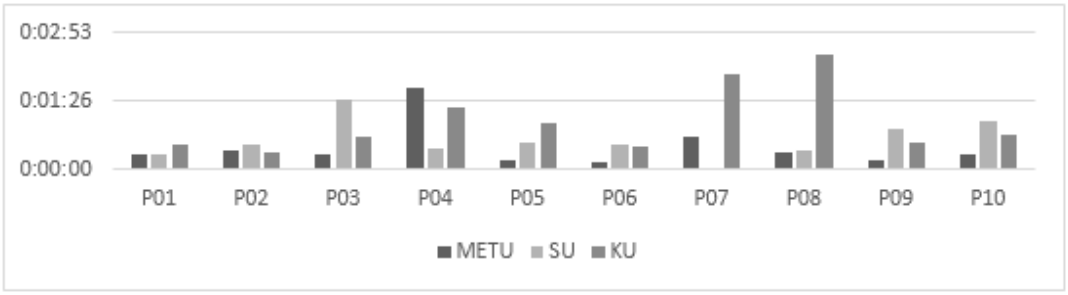

Figure 4.26: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 6

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.23 shows the Kruskal-Wallis Test analysis. Significant value (p=0.012) of the Kruskal-Wallis Test is less than the coefficient alpha (a=0.05). The null hypothesis (h0) is rejected. Therefore, there was a statistically significant difference in task completion times between the universities. The mean rank of task completion time is 8.80 for METU, 16.44 for SU and 19.90 for KU (Table 4.24).

Table 4.23: Test Statistics of the Desktop Experiment for Task 6 (Kruskal-Wallis Test)

	Task 6 - Completion Time
Chi-square	8.882
df	2
Asymp. Sig.	0.012

Table 4.24: Mean Ranks of the Desktop Websites of Universities for Task 6 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	8.80
Sabancı University	9	16.44
Koç University	10	19.90

According to the average number of steps that participants performed (Table 4.25) in the SU and KU websites, average number of steps are close to ideal number of steps but for METU, participants completed task in more steps than the ideal number of steps. Considering the mean rank of universities, completing the task in more steps does not increase the task completion time. This shows that scanning webpage was not sufficient for the participants to find the relevant information about whether there was a swimming pool, participants had to read the content. KU has the highest mean rank because webpages with which the participants interacted included large size visuals which might have increased cognitive load of participants while they sought the right link to complete task.

Table 4.25: Number of Steps of Three Universities for Task 6

	Number of Steps of Three Universities				
	N	**Mean of Participant's Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	10	4.2	3	4	6
SU	10	3.8	3	3	5
KU	10	3.5	3	3	5

4.1.1.6.2 Eye Tracking Results

For METU, most of the participants tried to discover whether the university had a pool using the menu. Figure 4.27 shows that intensity of the eye fixations is greater than shortcut links. The menu was helpful because the Campus Life / Sport Facilities webpage contained all the facilities of university. However, the Sport Facilities link in the shortcut links directed participants to the Office of Sports. More information about sport facilities could be found on that page but participants had to look at the menu and sub menu to obtain the appropriate information. Participants showed a tendency to say that they had finished the task after they saw the picture of sport activities. For this task the website navigation was good for all three universities and participants used the websites efficiently. SU had no swimming pool but the participants spent too much time making certain that this was the case.

Figure 4.27: Heat Map of Participants When Seeking Swimming Pool on METU Main Page (N=5)

4.1.1.7 WAMMI

The WAMMI questionnaire has 5 scales: Attractiveness, Controllability, Efficiency, Helpfulness, and Learnability and in this step each university website was evaluated after the experiments. The websites was rated according to the average score of 50 and the perfect score of 100. For METU, results of WAMMI in Figure 4.28 show that participants were in greater agreement that the website was more learnable (Learnability=76.5). The lowest average between the scales is controllability (Controllability=67), which shows that participants did not feel in control whilst using the website.

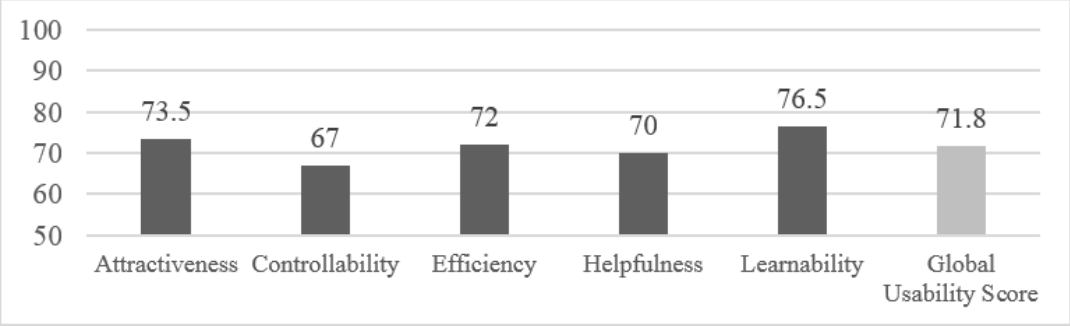

Figure 4.28: WAMMI Results of METU on Desktop Experiment

For SU, the WAMMI results given in Figure 4.29 shows that participants were in greater agreement about their actions being concluded with reasonable speed and they found the information they required during the tasks (Efficiency=76.5). The lower average between the

scales is learnability, which shows that the participants felt that terminology of the website was not easily understandable and also the website as a whole was not easy to understand (Learnability=59).

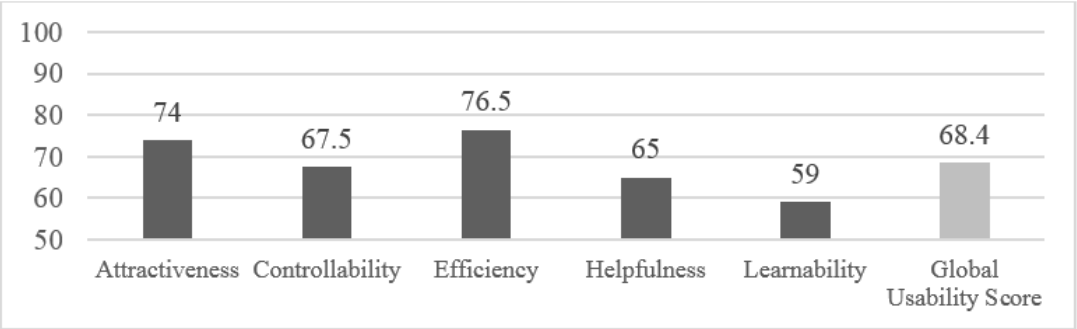

Figure 4.29: WAMMI Results of SU on Desktop Experiment

For KU, the results of WAMMI in Figure 4.30 shows that participants were satisfied with the navigation of the website (Controllability=67). The lower average in the scales is efficiency, which shows that participants thought that website did not work as they had expected (Efficiency=50.5).

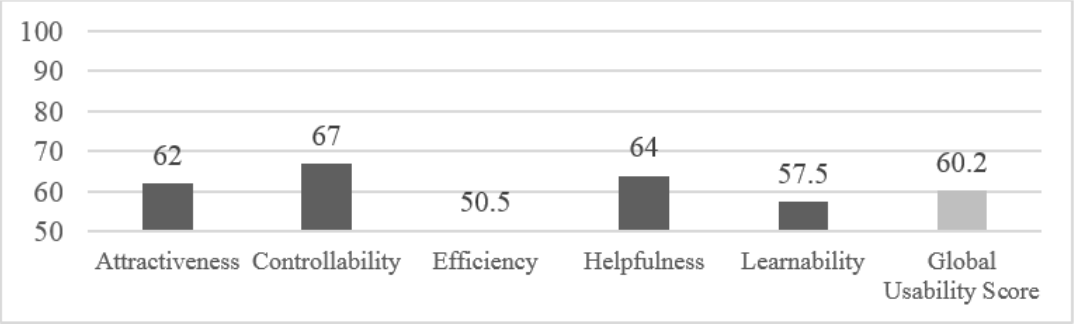

Figure 4.30: WAMMI Results of KU on Desktop Experiment

During the desktop experiments, the participants evaluated the three universities and the order of the university was changed for each participant to counteract the possible influence on the results. The results of WAMMI covering the three university websites are given in Figure 4.31 and in terms of the Global Usability Score (71.8) the participants were more satisfied with the METU website.

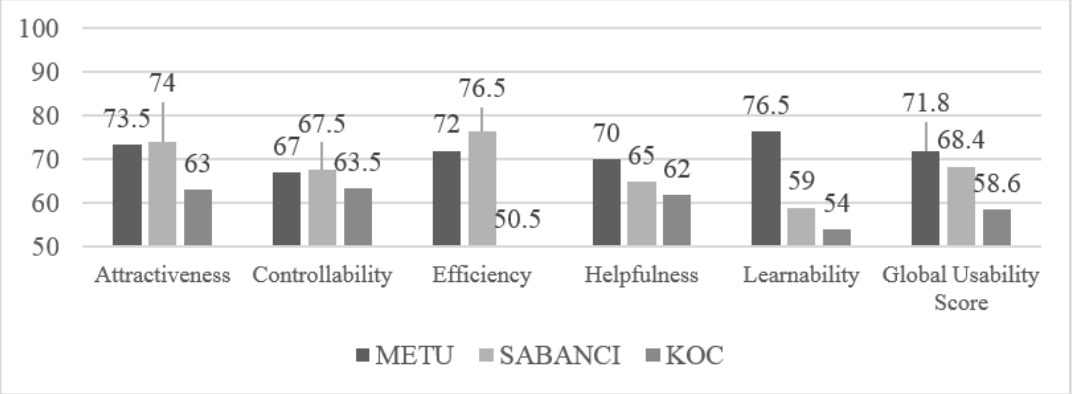

Figure 4.31: WAMMI Results of Three Universities on Desktop Experiment

4.1.2 MOBILE EXPERIMENT

4.1.2.1 Task 1 - Scanning the Main Page

The first task was that without clicking / tapping anywhere, the participants were to scan the main page of the university to gain an initial impression. When they had a general idea about the website, they asked which area had most attracted their attention and asked their opinions about the website. For Task 1, the number of steps or expected completion time were not meaningful because this task aimed to obtain individual first impressions of the website from the participants.

Figure 4.32: Area of Interests of METU, SU, and KU's Main Pages Respectively

4.1.2.1.1 Eye Tracking Results

The participants looked at the first page of the three universities and their total fixation dura-

tion provided the information on the most looked at area (Figure 4.32). The three universities did not have a common webpage layout so some content areas were not available for the first scene.

According to Table 4.26, for METU, the slider which contains announcement was the attention-grabbing area (1.38 / 3.00) for the first 3 seconds. SU has a main menu in the same place where METU has its slider announcement and for SU, the most attention-grabbing area (1.62 / 3.00) is the multi-level main menu and the first levels of the menu are apparent. Differing from METU and SU, KU has less content for the first scene where slider announcement is maximized and it is the largest area on that scene. Participants spent more time looking at slider announcement on the KU Website (2.32 / 3.00).

Table 4.26: Total Fixation Duration for the First 3 Seconds (N=10)

	Total Fixation Duration (Sec)					
	Header	**Main Menu**	**News**	**Slider Announcement**	**Slider Options**	**User Types**
METU	0.75	0.2	NA	1.38	0.36	0.31
SU	0.38	1.62	0.52	0.48	NA	NA
KU	0.67	0.01	NA	2.32	NA	NA

Figure 4.33 presents the Heat Map of Task 1 of participants (N=10) in Study 1. Most looked at area with the most intensity is shown in red and less looked at having the least intensity is shown in green. It can be seen that the participants focused more on the content in center of the scenes for all three universities. The heat map was created by combining data from 10 participants and superposing them.

Figure 4.33: Heat Maps of METU, SU and KU Websites Respectively

For KU, most of the participants commented that main page of the KU contained too many announcements and one of the participants said “this webpage is not like a university website, it is more like an art website and it seems that there is nothing except announcements”. Participants stated that it is not clear where the important operations are located for the student.

For the METU website, most of the participants stated that slider announcement area first caught their attention. The slider announcement area and options which belong to the slider announcement was not recognized by the participants, since they thought that those two area

had different content. The participants stated that the user types area have specialized operations for Students, Staff, Researchers and Alumni however, this area was misunderstood during Task 5. The METU main page has main menu and shortcut links which contain the most used operations, most of the participants agreed that "these shortcuts will be useful".

The most liked website was SU, this information was obtained from verbal feedback from the participants. The general comment was that the content placement was tidy unlike METU and KU. One participants said "I like the opened multi-level menu which allows me to reach information that I want quickly. Moreover, all the content seems to be in order."

The design of a website includes the appropriate incorporation of visual elements. Universities need to paid more attention to bringing web content into the forefront because it is the main page of the website that users see first and whether the welcome is cold or warm depends on the design of the webpage.

4.1.2.2 Task 2 - Finding Industrial Engineering Graduate Program

In this task, the participants were given a scenario that they had decided to apply to an industrial engineering graduate program and they were required to search the website of each of the three universities to determine where they had this program.

4.1.2.2.1 Completion Time

The number of participants who successfully completed Task 2 are shown in Table 4.27 with their task completion times for the three universities with minimum, maximum and median values. Table 4.27 reveals SU (00:01:46) has the longest task completion time with METU being the shortest time (00:00:55).

Table 4.27: Task Completion Times of Three Universities for Task 2

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:00:55	0:00:33	0:00:13	0:00:13	0:01:55	0:00:51
SU	9	0:01:46	0:00:38	0:00:25	0:00:32	0:02:36	0:01:52
KU	9	0:01:20	0:00:50	0:00:28	0:00:28	0:03:09	0:00:57

The difference between the task completion time of each participant and the ideal task completion time for METU is presented in Figure 4.34. During this task, most participants did not realize the main menu and scrolled down to use shortcut links. Although all the interfaces that with which the participants interacted in this task were mobile-friendly, small text sizes created the need to zoom in to read the texts. For those reasons, the task completion times are higher than the ideal.

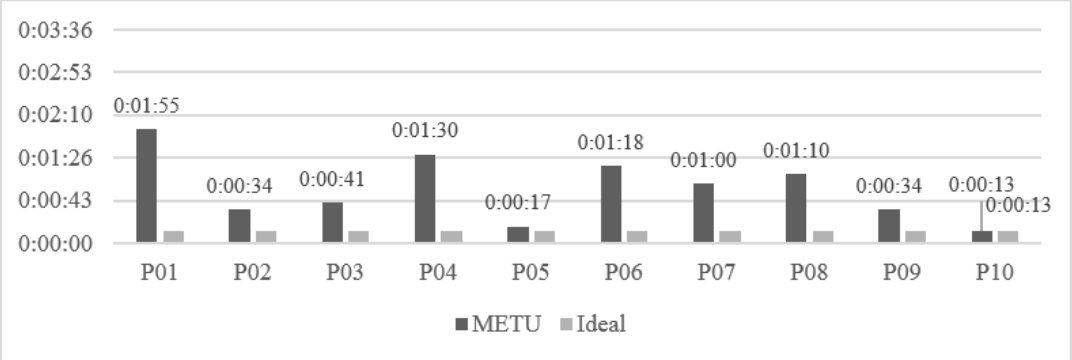

Figure 4.34: Task Completion Times of Each Participant for the METU Website for Task 2

The difference between the task completion time of each participant and the ideal task completion time for SU was presented in Figure 4.35. For this task the webpages of SU were mobile-friendly k but SU website had the highest task completion times. Unnecessary steps and misunderstood terminology gave the participants great difficulties in completing task.

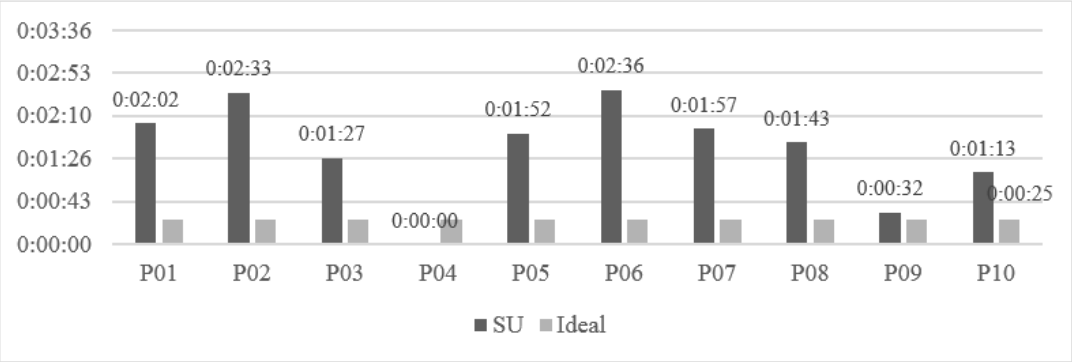

Figure 4.35: Task Completion Times of Each Participant for the SU Website for Task 2

The difference between the task completion time of each participant and the ideal task completion time for KU was presented in Figure 4.36. The main page and some subpages of KU were mobile-friendly but for this task, participants had to open the webpage of the Graduate School of Sciences and Engineering and this webpage was not mobile-friendly. In addition, design of this webpage created problems for the participants in terms of understanding the content in the desktop experiment.

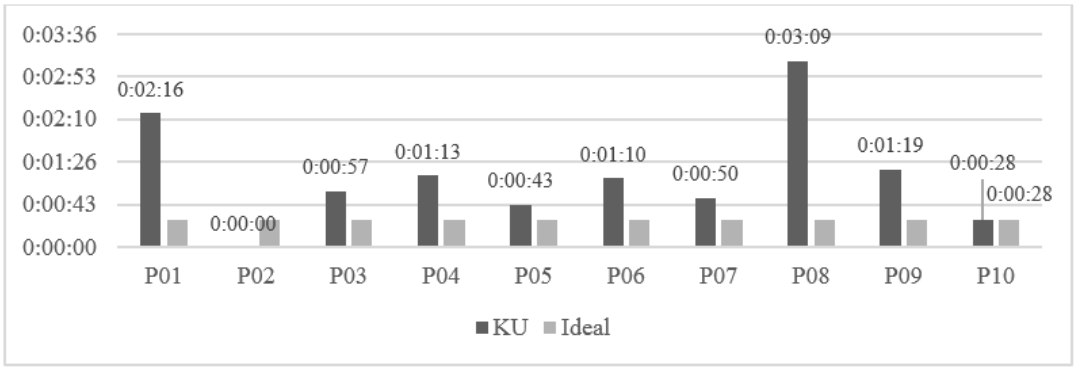

Figure 4.36: Task Completion Times of Each Participant for the KU Website for Task 2

The difference between the task completion times of each participant and the ideal task completion time for METU, SU and KU, respectively, was presented in Figure 4.37. As can be seen although it had a mobile-friendly design the SU website caused problems for the participants in completing this task.

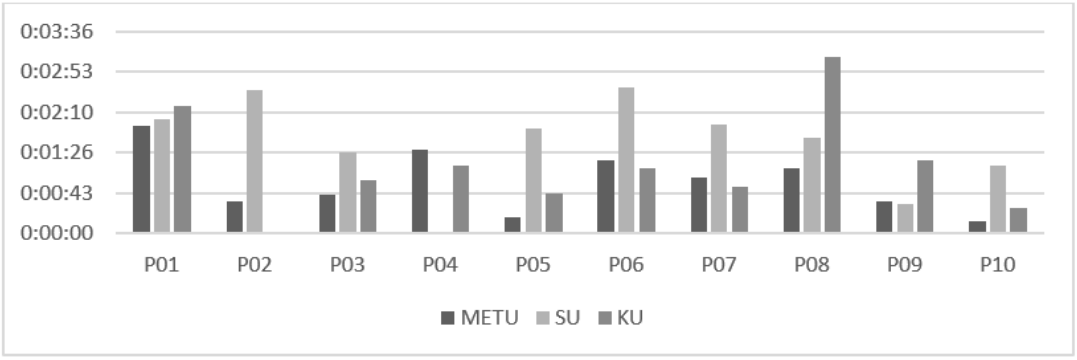

Figure 4.37: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 2

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.28 shows the Kruskal-Wallis Test analysis. The significant value (p=0.040) of the Kruskal-Wallis Test is less than the coefficient alpha (a=0.05). The null hypothesis (h0) is rejected. Therefore, there was a statistically significant difference in task completion times between the universities. The mean rank of the task completion time is 10.15 for METU, 19.72 for SU and 14.11 for KU (Table 4.29).

Table 4.28: Test Statistics of the Mobile Experiment for Task 2 (Kruskal-Wallis Test)

	Task 2 - Completion Time
Chi-square	6.449
df	2
Asymp. Sig.	0.040

Table 4.29: Mean Ranks of the Mobile Websites of Universities for Task 2 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	10.15
Sabanci University	9	19.72
Koç University	9	14.11

According to the average number of steps that participants performed (Table 4.30), the average number of steps are higher than the ideal number of steps. SU has the highest mean rank and number of steps compared to other universities. The participants tried to select the Faculty of Engineering and Natural Sciences but failed because to select a menu item it should be clicked twice. This requirement did not fit with usability principles since it is more usual to tap a menu item once. Moreover, the terminology used in the SU website did not match real-life. When participants searched for the words "Departments" or "Graduate Programs" and found the term "Graduate Programs", there was no information about graduate programs.

Table 4.30: Number of Steps of Three Universities for Task 2

	Number of Steps of Three Universities				
	N	**Mean of Participants' Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	10	3.9	3	3	6
SU	9	7.2	6	6	10
KU	9	6.3	6	5	10

4.1.2.2.2 Eye Tracking Results

For SU and KU, two participants did not complete Task 2 as shown in Table 4.27. In terms of the mobile experiment, websites were expected to be designed for or responsive to mobile screens which provide an optimal interface for a wide range of devices. During the experiment based on the METU website, all the interfaces with which the participants interacted were mobile-friendly and this might be one of the reasons for that participants could easily engage with the interface. However, the KU websites mobile interface became a desktop interface after few steps and the participants were obliged to zoom in to read the components and links and also to swipe to view other parts of the interface.

In Figure 4.38, the second visual shows the gaze plot of the participants on the KU website. When gaze plot is large, it means that participants focused for a long time to understand the

content or tried to read the text. For this screen, the larger dots indicated that webpage is not mobile-friendly.

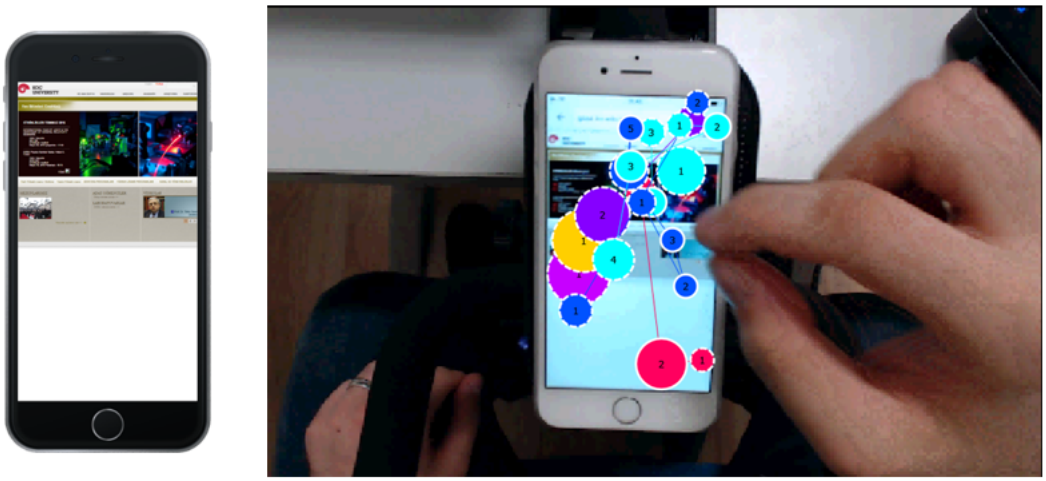

Figure 4.38: Appearance of Not Mobile Friendly Website of KU and Its Gaze Plots

When designing a webpage for mobile users it is important to create rational steps because the smaller screen cannot contain as much as information as the desktop. During this task, the SU website has the longest task completion times and the confusing steps and unnecessary selections might be the reasons as to why this task was hard to complete. In order to discover whether there is a graduate program for Industrial Engineering, all participants tried to select Faculties on the multi-level menu on the first page but to select this menu item, it has to be tapped twice. However, participants did not recognize that this was required since tapping twice on mobile websites is not usual user behavior. Participants tapped on Faculties and waited to see the sub-menu. After a while, they commented "I think I did not tap the right place so I have to tap again" and tapped second time. Creating a page which makes users blame themselves for a mistake is not a recommended user experience. After tapping Faculties and then Faculty of Engineering and Natural Sciences, webpage which contains detailed information about Faculty of Engineering and Natural Sciences and related programs were opened. 80% of the participants tapped Admission (Lisansüstü Başvuruları) because they thought that this would lead them to information about programs which they could apply to however, the Admission Page only gave application requirements, and information about fees and scholarships. The heat map of the participants actions during the task are shown in Figure 4.39, including the Admission page, Area of Interests were created to obtain the time to first fixation.

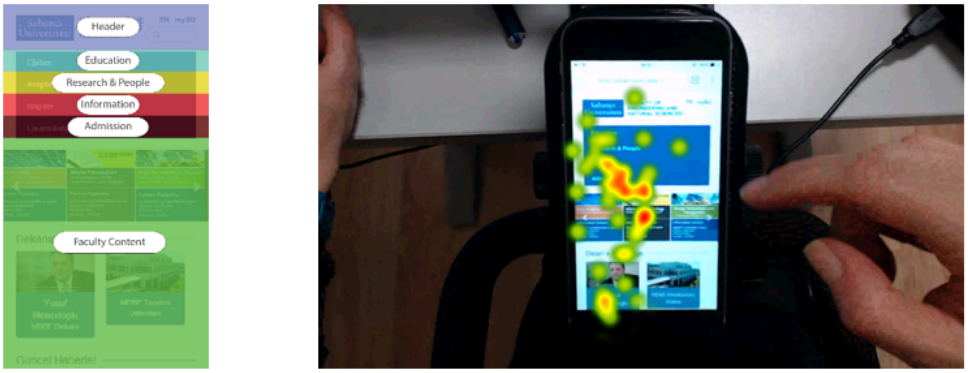

Figure 4.39: Area of Interests of Admission Page of SU and Its Heat Map

Before they clicked one of the four links under the Header, it was calculated the area that grabbed the participants' attention was calculated. According to results concerning the average time to first fixation (Table 4.31), the Admission area (Mean=00:00:33) received the first fixations.

Table 4.31: Number of Participants Who Completed Task 2

	Admission (hh:mm:ss)	**Education (hh:mm:ss)**	**Faculty Content (hh:mm:ss)**	**Header (hh:mm:ss)**	**Information (hh:mm:ss)**	**Research & People (hh:mm:ss)**
All Participants Recording	0:00:33	0:05:38	0:02:27	0:05:14	0:01:09	0:01:41

The results indicate that universities considering themselves to be entrepreneurial and innovative need to design all their content for mobile devices. Moreover, appropriate and accurate terms must be used to ensure that the user can understand the website and rapidly access the areas and information they wish to access.

4.1.2.3 Task 3 - Finding the Spring Classes Start Date

In this task, the participants were given the scenario that they had been accepted on the Industrial Engineering program and they wanted to know when the classes would begin in the 2014-2015 Spring Semester.

4.1.2.3.1 Completion Time

The number of participants who successfully completed the Task 3 are shown in Table 4.32 with their task completion times for the three universities with minimum, maximum and median values. The Table 4.32 reveals that KU (00:01:48) has the longest task completion time with METU having the shortest (00:01:16).

Table 4.32: Task Completion Times of Three Universities for Task 3

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:01:16	0:00:39	0:00:30	0:00:41	0:02:22	0:01:01
SU	10	0:01:34	0:01:02	0:00:31	0:00:33	0:03:47	0:01:26
KU	8	0:01:48	0:00:56	0:00:35	0:01:22	0:04:01	0:01:29

The difference between the task completion time of each participant and the ideal task completion time for METU was presented in Figure 4.40. The Academic Calendar webpage was not mobile-friendly. This academic calendar had two versions; a normal version and the Google Calendar. Those who selected the normal version completed the tasks shorter time than those who selected the Google Calendar.

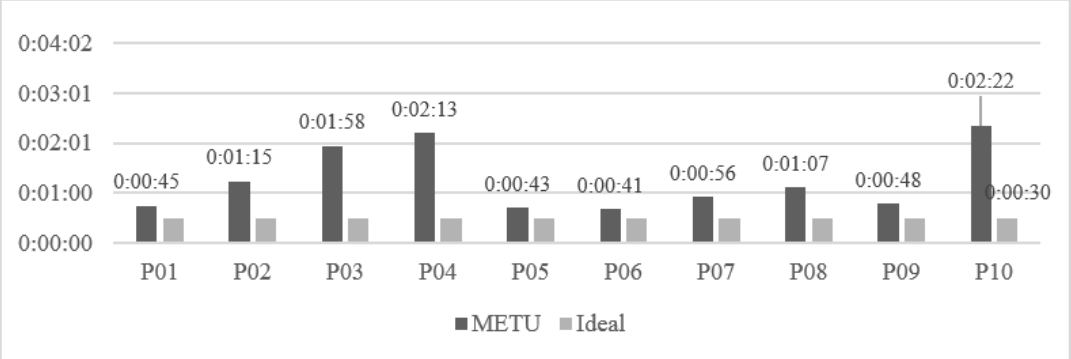

Figure 4.40: Task Completion Times of Each Participant for the METU Website for Task 3

The difference between the task completion time of each participant and the ideal task completion time for SU was presented in Figure 4.41. As with the desktop version of the SU website, the Academic Calendar link was at the footer of main page. Finding that link was difficult for the participants even when they eventually found it they encountered a webpage which is not mobile friendly. They had to scroll horizontally and vertically, which made the task completion time longer.

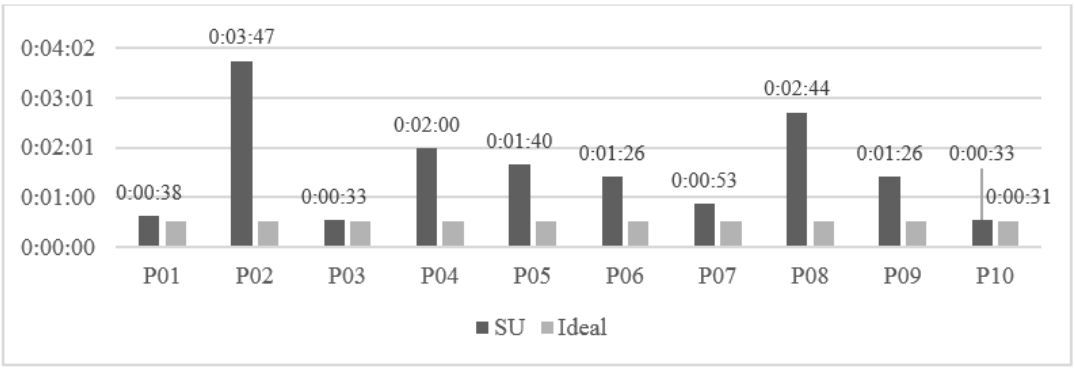

Figure 4.41: Task Completion Times of Each Participant for the SU Website for Task 3

The difference between the task completion time of each participant and the ideal task completion time for KU was presented in Figure 4.42. KU only has the Google Calendar with no other options for participants as given in the METU website. Using a webpage which is not mobile-friendly made it impossible to find any information.

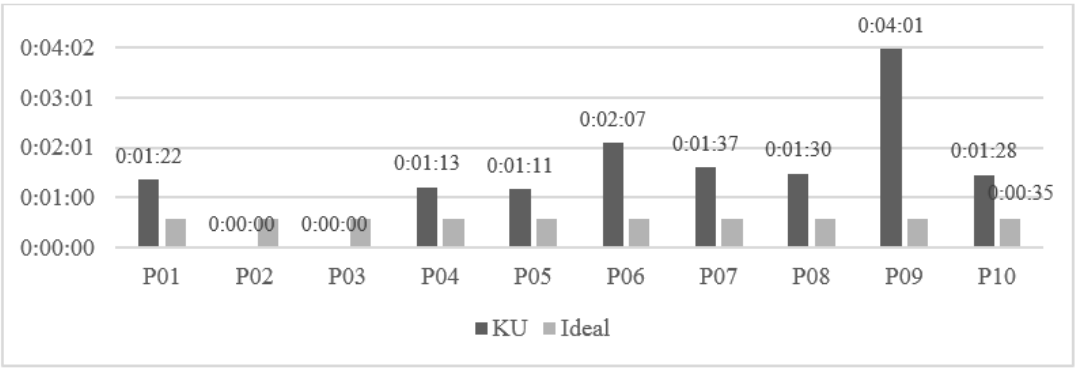

Figure 4.42: Task Completion Times of Each Participant for the KU Website for Task 3

The difference between the task completion times of each participant and the ideal task completion time for METU, SU and KU, respectively, was presented on Figure 4.43. Comparing universities according to the task completion time needed to be undertaken using the independent samples t-test mentioned below because the task completion of each participant is not generalized according to this table 60.

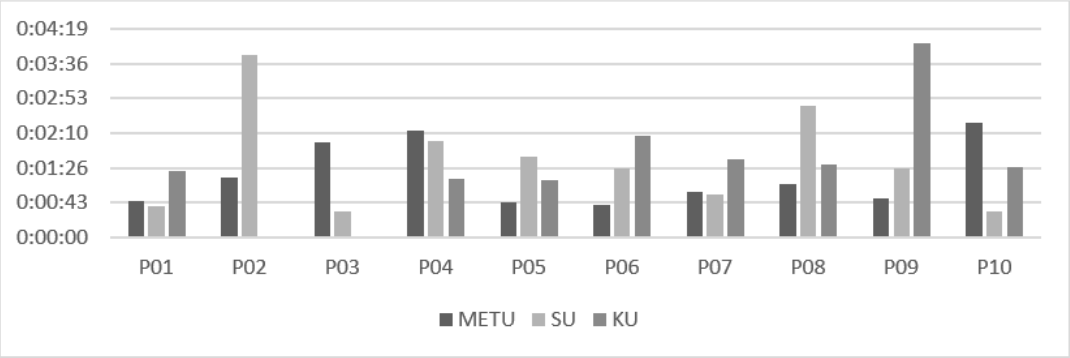

Figure 4.43: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 3

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.33 shows the Kruskal-Wallis Test analysis. The significant value (p=0.379) of the Kruskal-Wallis Test is greater than the coefficient alpha (a=0.05). The alternative hypothesis (ha) is rejected. Therefore, there was not a statistically significant difference in the task completion times between the universities.

Table 4.33: Test Statistics of the Mobile Experiment for Task 3 (Kruskal-Wallis Test)

	Task 3 - Completion Time
Chi-square	1.938
df	2
Asymp. Sig.	0.379

For the KU website, two participants did not complete Task 3 the results are shown in Table 4.32. According to the average number of steps that participants performed (Table 4.34), the average number of steps are higher than the ideal number of steps, which shows that some participants had difficulties in finding Academic Calendar links. The mean of the participants' number of steps for METU is low compared with the mean of ideal number of steps, which is the reason why most of the participants completed tasks using the minimum number of steps.

Table 4.34: Number of Steps of Three Universities for Task 3

	Number of Steps of Three Universities				
	N	**Mean of Participants' Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	10	5.1	5.5	3	8
SU	10	5.3	3	3	10
KU	8	11.4	9	9	14

4.1.2.3.2 Eye Tracking Results

During the experiment of METU, 40% of the participants found the academic calendar using the navigation icon which brings up a menu over the screen and they followed the steps Menu / Academic / Academic Calendar. The METU website chose to show both the Google Calendar and a normal version. 30% of the participants selected the normal version of the calendar which shows the dates and their explanation as a list. They stated that it was easy to use the list to find the academic calendar and when the lessons began. Moreover, METU emphasized some dates which made it easier to find the right date. However, participants who used Google Calendar had difficulties in understanding the dates and reading their explanations. One of the participants commented: "Reading explanations is hard, I have to click to read them but I don't know the exact date so I have to click all dates to find the information". Furthermore, the Academic Calendar page is not mobile-friendly, all the participants had to zoom in and swipe the screen. This process increased the amount of interaction and affected the task completion times.

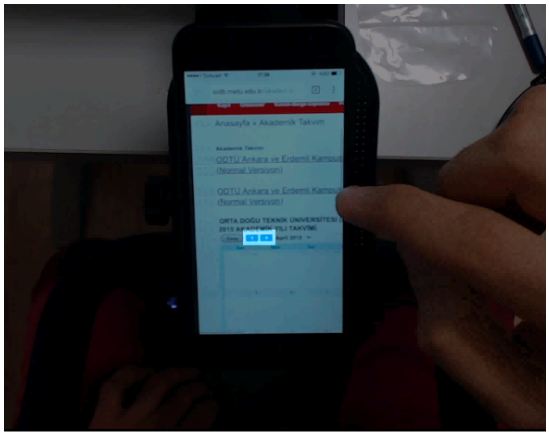

Figure 4.44: Academic Calendar Page of METU

Navigating Google Calendar was difficult for the participants. The Academic Calendar page opened in desktop sizes and the participants had to zoomed in to go back and forth to find the right date but the previous and next buttons were too close to each other, which made it difficult to tap the appropriate button (Figure 4.44). In terms of mobile web design, firstly websites have to be mobile-friendly and in this case, spacing between components to be touched

need to be considered in the context of preventing tapping mistakes. In addition, components need to be an optimum size for touching.

On the SU website, the academic calendar was shown as a list for all programs. However, the task completion times were affected by the webpage design where the multi-level menu was displayed in a compatible format for mobile users but the academic calendar was displayed in desktop sizes and the placement of the link to the academic calendar. Participants had to zoom in to examine the dates and read their explanation.

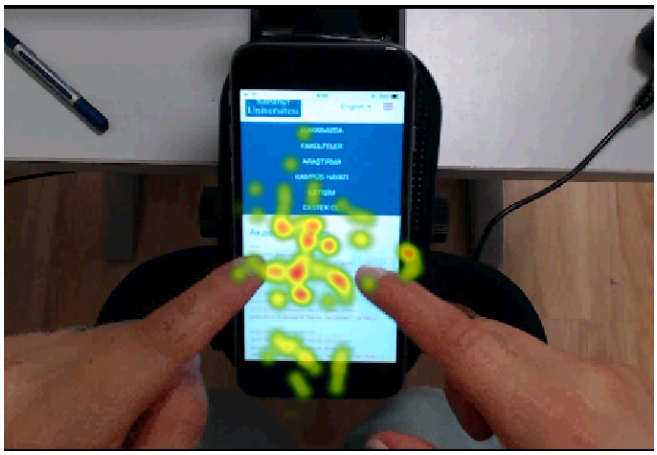

Figure 4.45: Heat Map of Academic Calendars' List of SU (N=10)

Most of the participants stated that academic calendar of SU was easy to read compared to the other two universities. Nonetheless, for the academic calendar table, participants suggested that keeping the top row visible while scrolling through the rest of the table might be helpful and prevent the need to go up and down to maintain the column name. The Academic Calendar link is at the bottom of the page so participants had to scroll down to find this link. There are four shortcut links for participants but they only found the link after searching for a long time. The Academic Calendar link has to be on the multi-level menu and an effective way of arriving at the link should be provided.

Before obtaining the academic calendar , it is necessary for the participant to select the required semester. SU had put the all semesters from 2011 to date in the page since one academic year has 4 links: full year calendar, fall semester, spring semester and summer school this required the participants to sort through a large amount of content. Figure 4.45 shows the heat map of the list of the calendars on SU which reveals that participants tried to read the content and spent time on trying to tap right link.

The task completion times for Task 2 are closer to each other for the three university but KU has the highest task completion time and the average number of steps. KU has a similar webpage design as METU, but in contrast to METU, KU did not have a normal version of calendar. Using the Google Calendar, involved participants going back and forth through the dates which was difficult. The Google Calendar of KU was in agenda view in which the explanations are under the dates, which makes it hard to read and create uncertainty in the user about which explanation belongs to which date. For this task two participants, found the academic calendar but after seeking the calendar for a long time they could not find it. The usability of academic calendars must be considered an important issue because universities

have a wide range of users and the academic calendar might be frequently for different reasons. Moreover, participants tried to find academic calendar under the faculty webpage so this placement might be considered as a requirement.

4.1.2.4 Task 4 - Searching Information about Scholarship

In this task, the scenario given is that participants wished to obtain information about the scholarship opportunities of the university using the search field. In this task, the required information was not specifically given since the purpose of this task was to observe participants' behaviors concerning searching and examining the usability of the attributes of searching such as placement and results in the context of task.

4.1.2.4.1 Completion Time

All the participants successfully completed task and the participants task completion times for the three universities with minimum, maximum and median values are shown in Table 4.35. According to the Table 4.35, SU (00:00:17) has the longest task completion time and METU has the lowest task completion times. The completion times were calculated as starting from the time the researcher finished reading the task and participants beginning to write in a search box. The searching information and examination of search results were not calculated because SU search engine was not working. Finding information was not examined in detail because the adequacy of the information found by the participants changed from person to person.

Table 4.35: Task Completion Times of Three Universities for Task 4

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:00:06	0:00:02	0:00:03	0:00:03	0:00:09	0:00:07
SU	10	0:00:17	0:00:10	0:00:06	0:00:11	0:00:47	0:00:15
KU	10	0:00:11	0:00:02	0:00:08	0:00:08	0:00:17	0:00:11

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean difference in duration finding search box between the university websites.

h1: There is no significant mean difference in duration of finding search box between the university websites.

The independent samples t-test was conducted and Table 4.36 shows the Kruskal-Wallis Test analysis. Significant value (p=0.000) of the Kruskal-Wallis Test is less than the coefficient alpha (a=0.05). The null hypothesis (h0) is rejected. Therefore, there was a statistically significant difference in difference in duration of finding search box between the universities. The mean rank of task completion time is 6.25 for METU, 24.05 for SU and 16.20 for KU (Table 4.37).

Table 4.36: Test Statistics of the Mobile Experiment for Task 4 (Kruskal-Wallis Test)

	Task 4 - Completion Time
Chi-square	20.711
df	2
Asymp. Sig.	0.000

Table 4.37: Mean Ranks of the Mobile Websites of Universities for Task 4 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	6.25
Sabancı University	10	24.05
Koç University	10	16.20

SU has the highest mean rank and the statistically significant difference was analyzed. On mobile websites, due to the small screen size of the devices placing content should be held considering usability principles. Components on webpages should be efficient in use and more importantly visible. The search field of SU was not easily visible thus finding the search field took participants a long time.

4.1.2.4.2 Eye Tracking Results

The reason why task completion time of SU was greater than the other two universities might be due to the fact that search box was not easily visible and participants had to search for it. The heat map given in Figure 4.46 shows the intensity of the first fixations on the right top of the main page, supporting the problems encountered by the participants trying to find search box or icon.

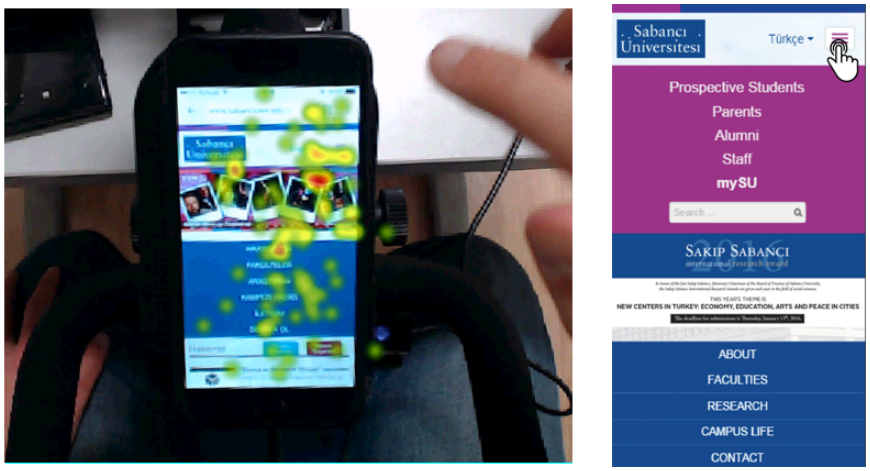

Figure 4.46: Heat Map of Main Page of SU during Finding Search Fıeld and Its Placement

Participants scrolled the main page then stated that “Maybe SU has no search box because if it has, it would be displayed explicitly”. After a while, they tried to tap the side bar menu which is called a hamburger menu and then they saw the search box.

The KU website has a magnify icon which turns on a search box when participant tap on it. Some of the participants tried to write after tapping on the magnify icon but then they realized that cursor did not automatically become active, it had to be tapped inside the box. KU offers two search options; Search in only ku.edu.tr and Search in all the KU website. Most of the participants did not realize that these options existed however, the participants who did see them asked "Why does search engine limit searching? I think the default search option should be Search in all the KU website and maybe these options could be on the page where search results listed". During the experiment for all the universities participants' behavior in relation to searching using the magnify icon or the keyboard of the mobile device was observed. Most of the participants tapped the magnify icon to find information they had written. The number of search results and the time taken to find the results were shown for all the universities. The METU search results were displayed with the title of the result and a brief explanation and the KU search results gave the title of the result, a brief explanation and an image related to the results.

4.1.2.5 Task 5 - Finding E-Mail Address of a Teacher

In this task, the scenario was that participants had noticed that they would not be able to attend one of their graduate program classes because of work commitments and since they wanted to inform their teacher about this situation they needed to find the e-mail address of any teacher in industrial engineering.

4.1.2.5.1 Completion Time

According to the task completions, task 5 was not successfully completed six times. Participants spent a long time trying to complete the task but eventually they gave up. The terms used on the KU website misguided participants and on some pages, links which would help participants' complete task were not visible. The task completion times for three universities are shown in Table 4.38 with the minimum, maximum and median values. According to the table, KU (00:01:45) has the longest task completion time with SU having the lowest task completion times.

Table 4.38: Task Completion Times of Three Universities for Task 5

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	9	0:01:22	0:00:36	0:00:30	0:00:37	0:02:14	0:00:58
SU	9	0:01:01	0:00:12	0:00:42	0:00:46	0:01:19	0:01:02
KU	6	0:01:45	0:01:01	0:00:32	0:00:41	0:03:18	0:01:26

The difference between the task completion time of each participant and the ideal task completion time for METU are presented in Figure 4.47. In this task, the information that was to be found to complete the task was under the department of Industrial Engineering but the department webpage was not mobile-friendly. Furthermore, the language of main page was in Turkish but the webpage of department was in English. Using not mobile-friendly website affected the task completion time.

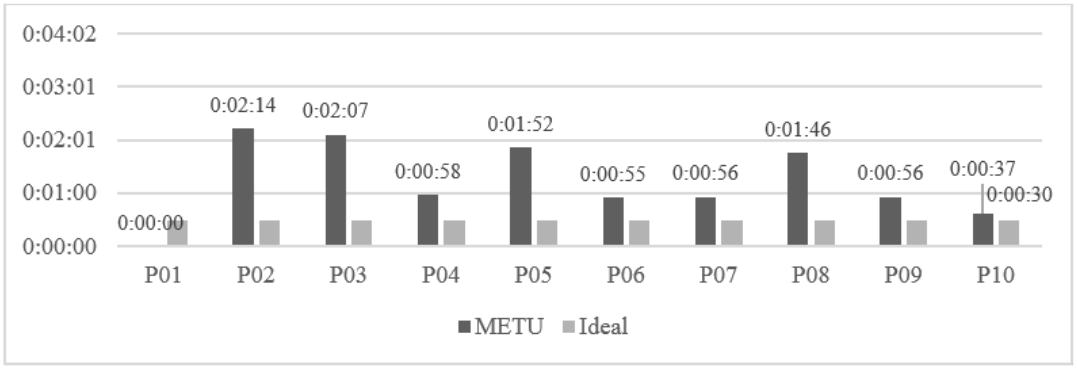

Figure 4.47: Task Completion Times of Each Participant for the METU Website for Task 5

The difference between the task completion time of each participant and the ideal task completion time for SU is presented in Figure 4.48. All the interfaces with which the participants interacted were mobile-friendly and participants used the website easily, which might be the reason for them to become familiar with the design at task 2.

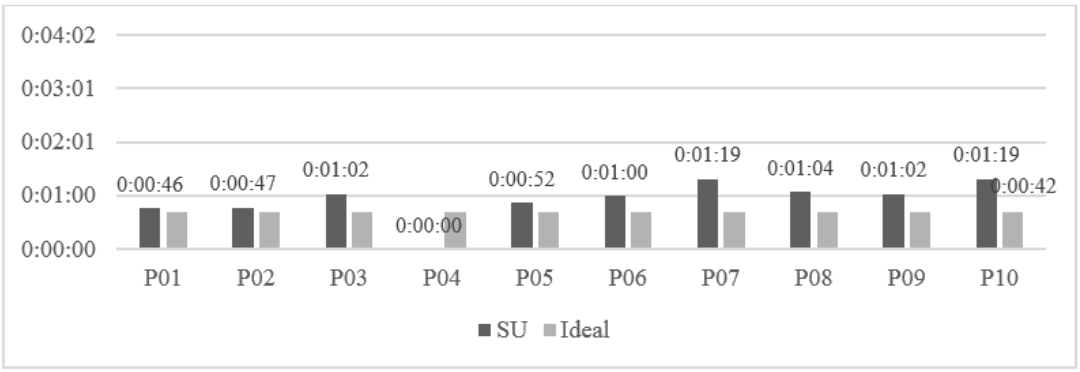

Figure 4.48: Task Completion Times of Each Participant for the SU Website for Task 5

The difference between the task completion time of each participant and the ideal task completion time for KU is presented in Figure 4.49. As with Task 2, the webpages that were not mobile friendly and design of the webpage caused problems for the participants. For this task, four participants could not find their way through the website and gave up.

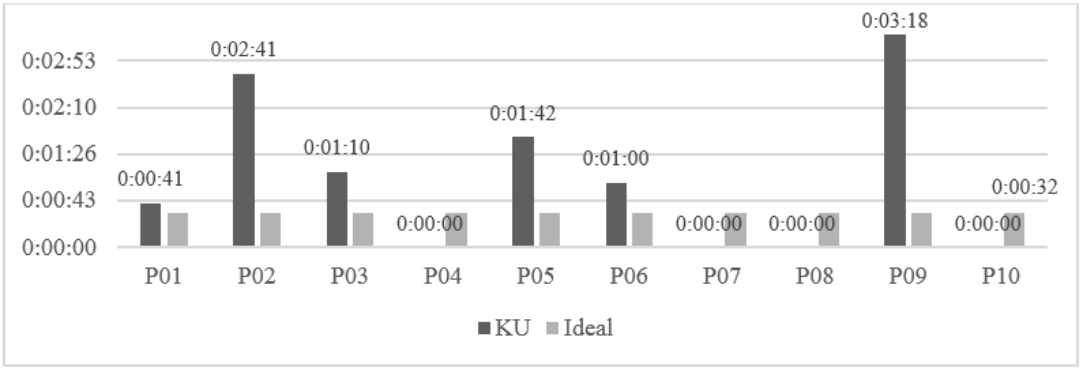

Figure 4.49: Task Completion Times of Each Participant for the KU Website for Task 5

The difference between the task completion times of each participant and the ideal task completion time for the METU, SU and KU websites, respectively, is presented in Figure 4.50. The webpages of SU were mobile-friendly and even if the design somewhat confused the participants, they were able to complete the tasks in a shorter time compared to task completion times for the METU and KU websites.

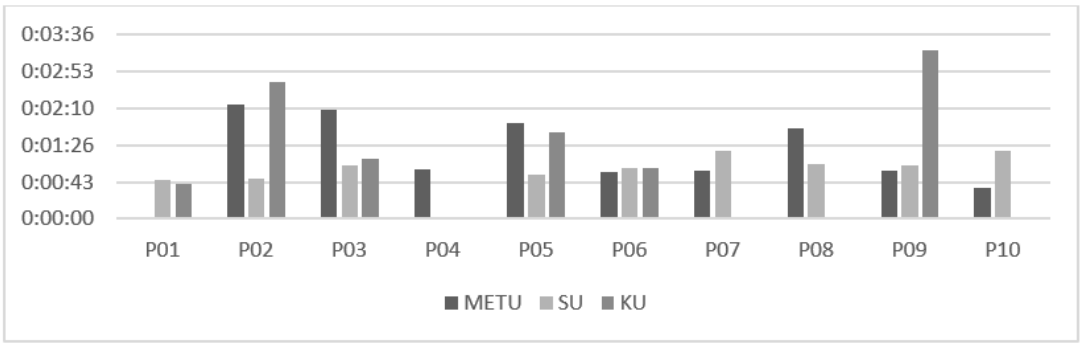

Figure 4.50: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 5

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between the university websites.

h1: There is no significant mean of completion time difference between the university websites.

The independent samples t-test was conducted and Table 4.39 shows the Kruskal-Wallis Test analysis. The significant value (p=0.418) of the Kruskal-Wallis Test is greater than the coefficient alpha (a=0.05). The alternative hypothesis (ha) is rejected. Therefore, there was not a statistically significant difference in task completion times between the universities.

Table 4.39: Test Statistics of the Mobile Experiment for Task 5 (Kruskal-Wallis Test)

	Task 2 - Completion Time
Chi-square	1.744
df	2
Asymp. Sig.	0.418

According to the average number of steps that the participants performed (Table 4.40), the average number of steps are higher than the ideal number of steps, which shows that some participants had difficulties in finding e-mail of a teacher. More participants were not able complete task 5 in the KU website and in addition, the number of steps for completing task was higher than the other universities.

Table 4.40: Number of Steps of Three Universities for Task 5

	Number of Steps of Three Universities				
	N	**Mean of Participants' Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	9	9	6	6	14
SU	9	9	9	9	10
KU	6	10.7	6	6	18

4.1.2.5.2 Eye Tracking Results

In this task, it was found that the KU and METU had webpages that were not mobile-friendly or usable. In the experiment, wireless network connections were used to avoid network disconnections by the cellular carriers. Therefore, if the network connection was not good, loading desktop size webpages might take too much time. For the METU website, participants reached the department website using the shortcut link "Faculties, Institutes & Schools" at the bottom of the main page. The Faculties, Institutes & Schools webpage contains a list which is grouped based on the faculty, institute and school. Most of the participants stated that the list should be sorted alphabetically because without this sorting it would be difficult to find the Department of Industrial Engineering under the Faculty Engineering. The webpages of the Department of Industrial Engineering were not mobile-friendly and had no Turkish language options. In order to see menu titles, zooming in and swiping was required.

For SU, all the webpages with which the participants interacted during this task were mobile-friendly. 70% of the participants thought that teacher information could be under the department of Industrial Engineering and first they tried to find that department. The webpage of Industrial Engineering had a different design and the navigation components differed from the main page. Figure 4.51 shows the main page of the SU had a hamburger menu on the top right of the page on the other hand the Industrial Engineering webpage had the same menu icon on the top left of the page. According to the user experience comments different designs on same website might confuse participants and an inconsistent design might increase the cognitive load on participants. The heat map shown in the Figure 4.51 shows the first 3 seconds of the participants viewing and eye fixations were focused on the top right of the page. 30% of the

participants found the required information on the faculty page. After finding the teacher list, it was necessary to tap the mail icon under the teacher's name but one participant stated that the e-mail information could be open and there was no need to click.

SU - Main Page

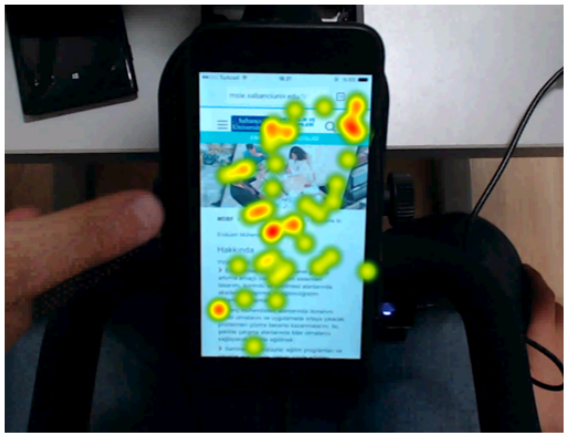
SU - Webpage of Industrial Engineering (N=7)

Figure 4.51: Main Page of SU and Heat Map of Industrial Engineering's Webpage of SU

The KU website had the highest number of participants that could not complete the task. Some of the participants ignored the menu on the main page and under the Gateways links, and tapped on the link labelled KU Staff (Öğretim Üyesi) seemingly considering the teachers to be staff. However, they found no information under that link about staff. In the same way, most of the participants tried to find e-mail address of teachers under the department webpage. On the main page, Menu / Academic page, there was a list of academic programs but it listed Engineering, and Sciences & Engineering. Participants were as to which program contained Industrial Engineering. To find the teacher list, engineering program had to be clicked, the participants who had selected Sciences & Engineering searched for a long time but they could not find the information and gave up. The Engineering webpage had a top and center menu; the top menu directed participants to the main page, center menu had information about the faculty. Participants tapped Academic on the top menu but when the page appeared they were directed to the main page again.

Determining links on the webpages should be consistent and visible for all webpages. Efficiency of use should be considered while designing a webpage.

4.1.2.6 Task 6 - Finding Whether There is a Swimming Pool

In this step, the scenario given was that participants had free time after their graduate program classes and considered going to the swimming pool if there was one on the campus. The task was for the participants to find out whether the university had a swimming pool.

4.1.2.6.1 Completion Time

The participants' task completion times for the three universities with minimum, maximum and median values are shown in Table 4.41. According to the Table 4.41, SU (00:01:18) has the longest task completion time and KU (00:00:42) has the lowest task completion times.

Table 4.41: Task Completion Times of Three Universities for Task 6

	Task Completion Times (hh:mm:ss)						
	N	**Mean**	**Standard Deviation**	**Ideal**	**Minimum**	**Maximum**	**Median**
METU	10	0:01:00	0:00:38	0:00:20	0:00:25	0:02:25	0:00:47
SU	9	0:01:18	0:00:38	0:00:30	0:00:35	0:02:22	0:01:08
KU	10	0:00:42	0:00:28	0:00:18	0:00:17	0:01:38	0:00:26

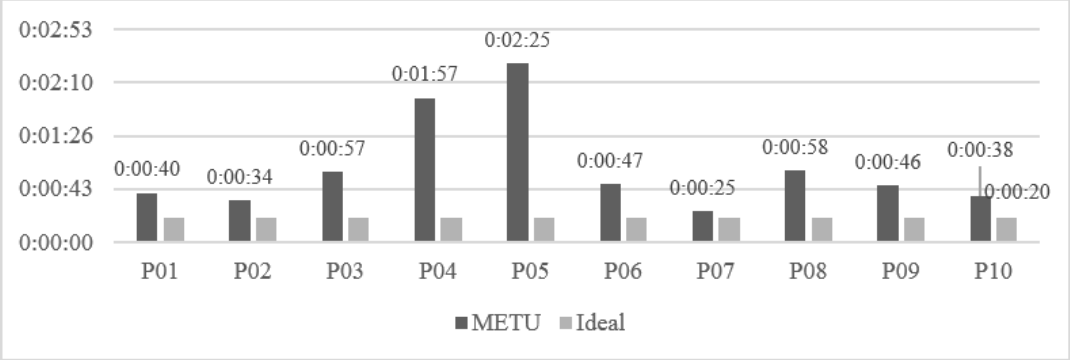

Figure 4.52: Task Completion Times of Each Participant for the METU Website for Task 6

The difference between the task completion time of each participant and the ideal task completion time for METU is presented in Figure 4.52. Participants who did not see the main menu and selected the shortcut link at the bottom of the page were directed to the webpage that was not mobile friendly. Therefore, finding information from a not mobile-friendly webpage became difficult.

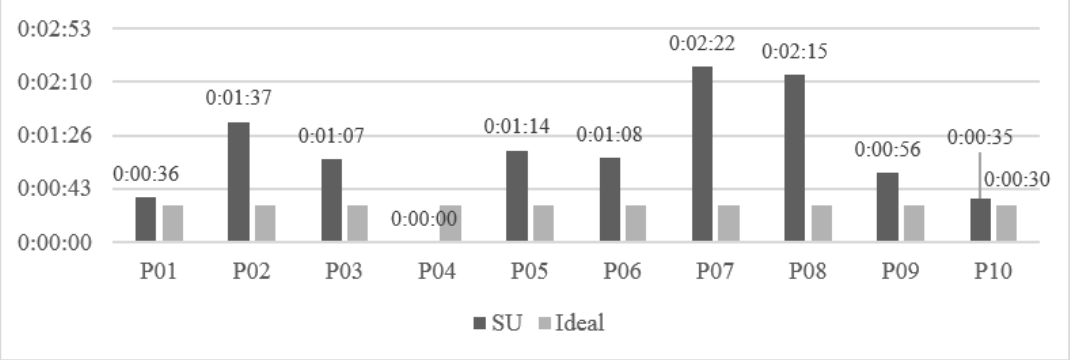

Figure 4.53: Task Completion Times of Each Participant for the SU Website for Task 6

The difference between the task completion time of each participant and the ideal task completion time for SU is presented in Figure 4.53. SU did not have a swimming pool, participants spent too much time determining whether there was a pool or not. Besides, after tapping on the main menu, the webpage did not give any reaction so participants waited until they realized that new content had been opened under the fold, visible page.

The difference between the task completion time of each participant and the ideal task completion time for KU is presented in Figure 4.54. The need to increase the amount of scrolling because of larger images slowed down the participants' completion of the task.

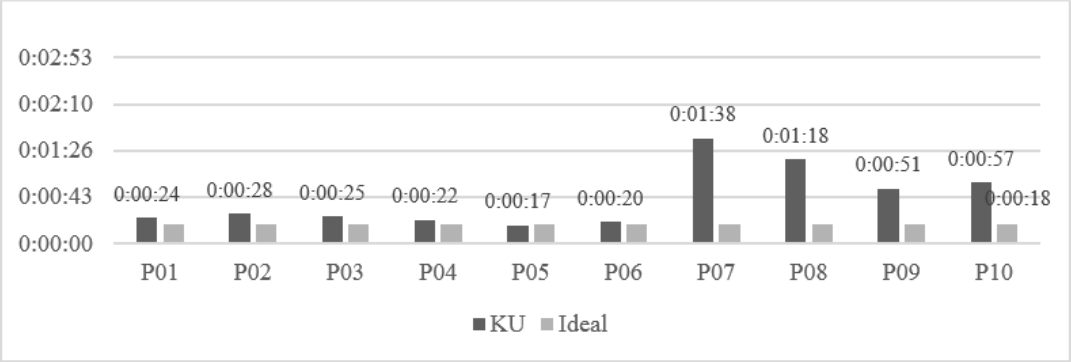

Figure 4.54: Task Completion Times of Each Participant for the KU Website for Task 6

The difference between the task completion times of each participant and the ideal task completion time for METU, SU and KU, respectively, was presented in the graph in Figure 4.55. In comparison with the desktop experiment, the task using the METU website was not easily completed in the mobile version.

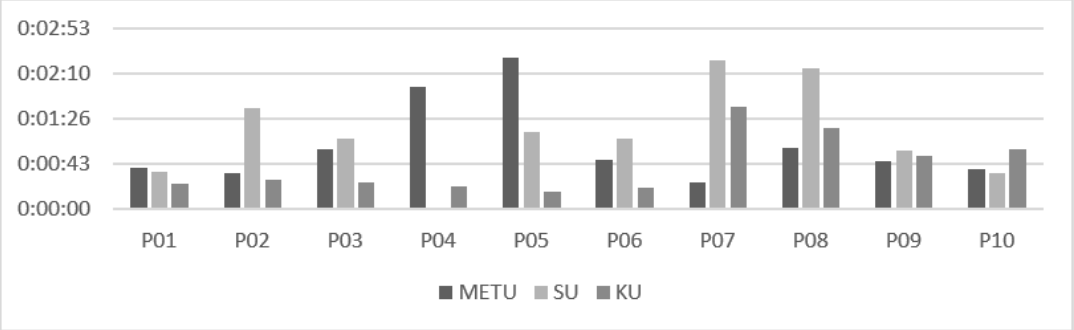

Figure 4.55: Task Completion Times of Each Participant for the METU, SU and KU Website for Task 6

For this task, there were the following two hypotheses as follows:

h0: There is no significant mean of completion time difference between university websites.

h1: There is no significant mean of completion time difference between university websites.

The independent samples t-test was conducted and Table 4.42 shows the Kruskal-Wallis Test analysis. The significant value (p=0.055) of the Kruskal-Wallis Test is equally acceptable with coefficient alpha (a=0.05). The null hypothesis (h0) is rejected. Therefore, there was a statistically significant difference in task completion times between the universities. The mean rank of the task completion time is 15.50 for METU, 19.67 for SU and 10.30 for KU (Table 4.43). The reason for highest mean rank of SU was that after tapping a link, related content was opened below the fold, visible page, of the screen. It was not easy for the participants to

realize that the content could be visible after scrolling vertically when there was no change after tapping the link.

Table 4.42: Test Statistics of the Mobile Experiment for Task 6 (Kruskal-Wallis Test)

	Task 6 - Completion Time
Chi-square	5.788
df	2
Asymp. Sig.	0.055

Table 4.43: Mean Ranks of the Mobile Websites of Universities for Task 6 (Kruskal-Wallis Test)

	N	**Mean Rank**
METU	10	15.50
Sabancı University	9	19.67
Koç University	10	10.30

According to the average number of steps that participants performed (Table 4.44), the average number of steps is close to the ideal number of steps, which shows that most of the participants completed tasks in the expected way.

Table 4.44: Number of Steps of Three Universities for Task 6

	Number of Steps of Three Universities				
	N	**Mean of Participants' Number Of Steps**	**Mean of Ideal Number of Steps**	**Minimum**	**Maximum**
METU	9	4.7	4	4	10
SU	9	4.7	4	4	7
KU	6	4.9	4	4	8

4.1.2.6.2 Eye Tracking Results

During the experiments for all Tasks on the METU website, participants showed a tendency to use shortcut links under the main page and they stated that seeing links explicitly made it easier. According to the eye tracking results, they did not see the main menu on the top of the page until Task 6. 50% of the participants used Menu to find information about sports facilities.

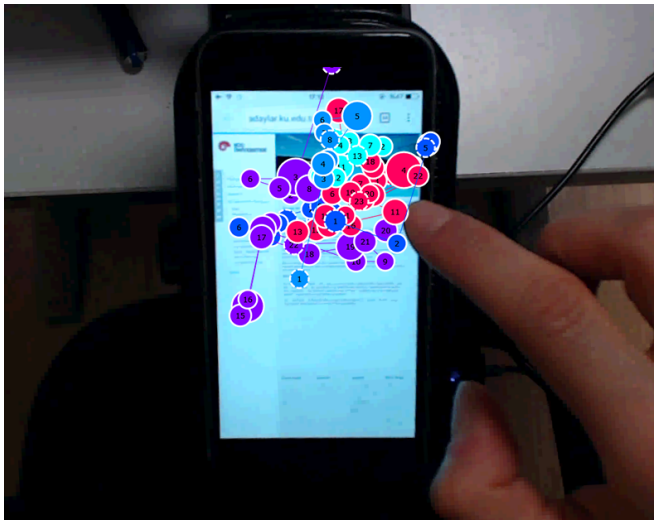

Figure 4.56: Gaze Plot of the Social and Sporting Activities webpage of KU (N=6)

The KU website includes a picture of pool so participants did not read the webpage of Social and Sporting Activities webpage in detail. Figure 4.56 shows the gaze plot of the participants whose eye fixations gathered on the pool picture. Therefore, since pictures became more meaningful for mobile devices, universities might show their facilities or bring them to forefront by using pictures. During the task, the succeeding web pages began to be not as mobile-friendly as in the previous tasks.

Webpages on SU might open under the screen thus participants may not notice that their action has opened a new page. For this task, participants were asked to find to find sports activities using a multi-level menu. Even if they tapped on the Sports Activities link, nothing changed on the screen because content about sports activities opened under the main page (Figure 4.57). Unless participants scrolled down, the content was not visible.

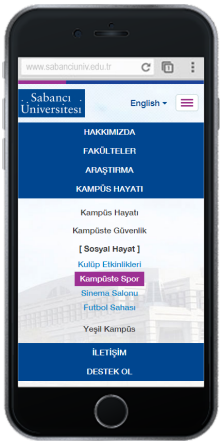

Figure 4.57: Example View of After Tapping Sport Activities on Main Page of SU

The visibility of the webpage has a significant impact on the user and care should be taken not to create websites that are unclear. Visibility prevents interaction cost making participants' usage performance decrease.

4.1.2.7 WAMMI

Each university has evaluated after experiments by the participants. Rating websites was evaluated according to the average score which is 50 and perfect score is 100. For METU, results of WAMMI on the Figure 4.58 shows that participants were more agreed about that websites were understandable and terminology used in the websites were familiar (Learnability=71). The less average between the scales is efficiency (Efficiency=55), which shows that participants did not feel that webpages were efficient to use and adapted to the mobile device size.

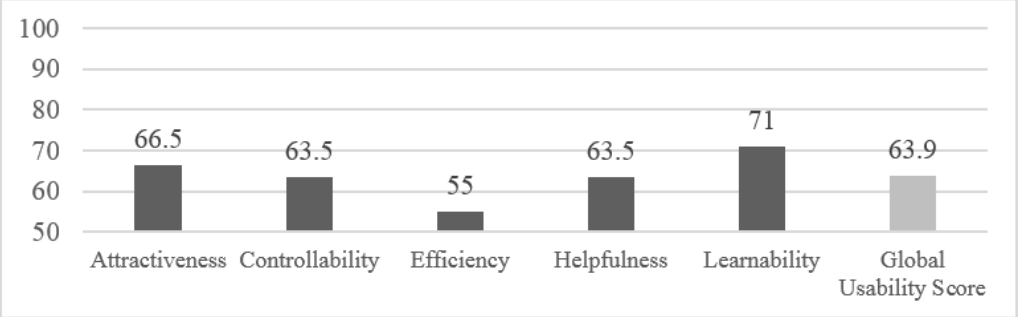

Figure 4.58: WAMMI Results of METU on Mobile Experiment

For SU, results of WAMMI on the Figure 4.59 shows that participants liked the webpage and they thought website was pleasant to use (Attractiveness=70.5). The less average between the scales is learnability, which shows that participants felt that terminology of the website was not understandable easily and also website was not easy to understand (Learnability=55).

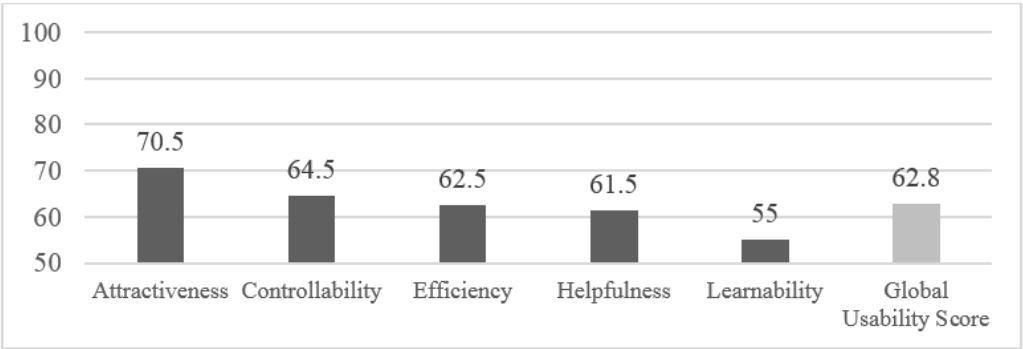

Figure 4.59: WAMMI Results of SU on Mobile Experiment

For KU, results of WAMMI on the Figure 4.60 shows that participants thought that they had control when navigating through the pages (Controllability=67). The less average between the scales is efficiency, which shows that participants thought that website did not work as they were expected and some situations they encountered did not make sense to them (Efficiency=50.5).

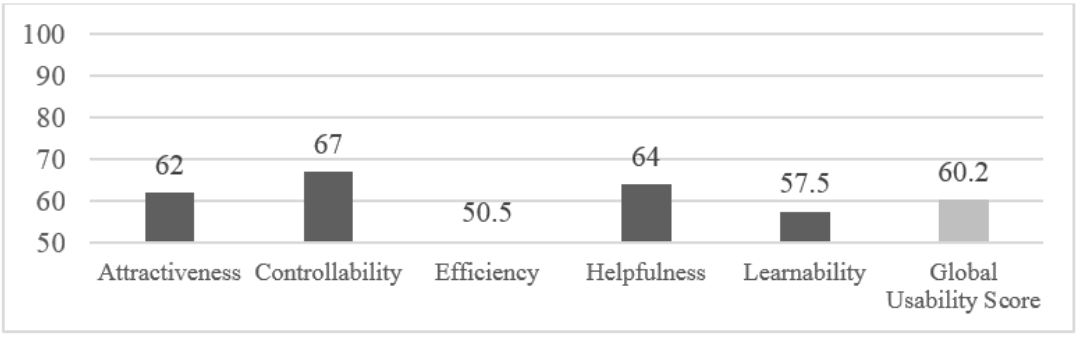

Figure 4.60: WAMMI Results of KU on Mobile Experiment

WAMMI results were presented separately but Figure 4.61 shows the comparison of results of universities. Considering to the Global Usability Score, participants were more satisfied about website of METU but SU has Global Usability Score which is close to the METU.

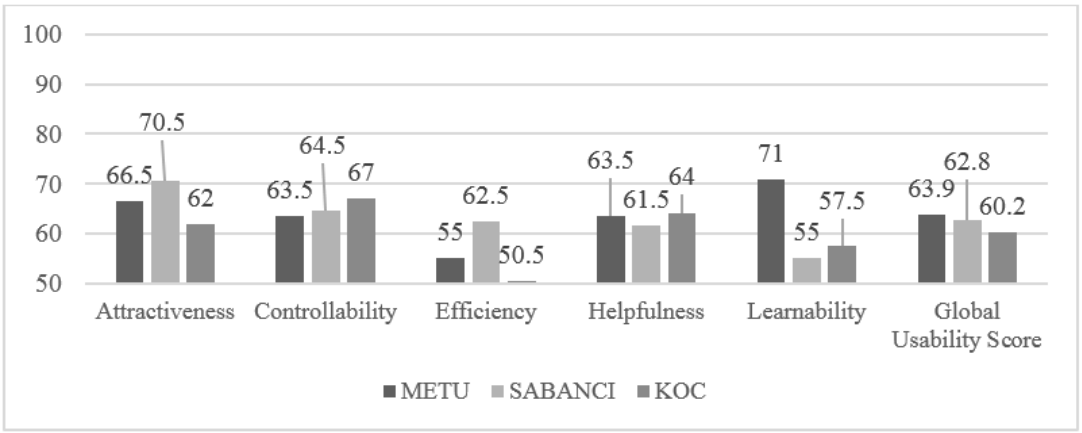

Figure 4.61: WAMMI Results of Three Universities on Mobile Experiment

4.2 STUDY 2 (EXPERT - BASED) EXPERIMENT RESULTS

Experts examined the websites of three universities on both desktop and mobile platforms. Usability problems experts found, their level of severity and related heuristics were determined. Results of experts' evaluation were categorized on the basis of university. Common problems for both experiments and problems which were specific to mobile are presented under the following headings.

4.2.1 USABILITY PROBLEMS OF METU

Usability problems found by usability experts for both desktop and mobile websites of METU are shown on Table 4.45. Experts stated 15 usability problems including 6 severe problems,

7 medium and 2 mild problems. Usability experts focused on tasks of participants in the context of heuristics. Moreover, they grouped the usability problems with the related heuristics. According to the experts, METU has 6 flexibility and efficiency of use, 4 consistency and standards, 2 recognition rather than recall, 1 aesthetic and minimalist design, 1 error prevention and 1 visibility of system status problem.

Most usability problems are related with the heuristic named "flexibility and efficiency of use" which is due to the fact that some components of the website are not clearly seen by the users and this causes inefficient usage. Moreover, experts found that the design was inconsistent through the pages, which refers to the heuristics "consistency and standards". They stated that users might be uncomfortable as a result of inconsistency and to help users use the website efficiently, consistent design is an issue to be considered.

Table 4.45: Common Usability Problems of METU with Related Heuristics and Level of Severity

Common Usability Problems	*Related Heuristics*	*Level of Severity*
1. Lists do not have consistent items: some items are links while some of them are not	Consistency and standards	Severe
2. Navigation menu was not easy to use because moving cursor outside the menu might close the menu and open other menu items. Accidentally moving the cursor just inside or outside the target area will immediately activate or close the menu	Flexibility and efficiency of use	Severe
3. On subpages, METU logo does not allow you to go to the main page of METU. There is a little link named "METU Main Page" which is difficult to see	Recognition rather than recall	Severe
4. Full explanations of dates on Academic Calendar looking as a Google Calendar do not seem until they are clicked	Flexibility and efficiency of use	Severe
5. On Google Calendar, when one description is opened, it overlaps with some dates and their descriptions	Flexibility and efficiency of use	Severe
6. There is no Turkish language option for some webpages of departments	Consistency and standards	Severe
7. Lists should be sorted alphabetically or operations from most used to least used	Flexibility and efficiency of use	Medium
8. If there is no content for one topic, there is not any statement like "There is not any information about the related topic"	Visibility of system status	Medium
9. Links of academic calendars for this year and next year are listed. However, these two options are not clearly distinguishable because their links are too long and similar	Recognition rather than recall	Medium
10. The word being searched is not presented on the page of search results	Flexibility and efficiency of use	Medium
11. Main page and subpages or university website might have different designs, but key components such as search box, language option etc. should be placed at close places	Consistency and standards	Medium
12. By using slider option on the main page, the chance of accidentally clicking links on slider options is high	Error prevention	Medium
13. Search results are not listed from most relevant to less relevant	Flexibility and efficiency of use	Medium
14. Multiple words cannot be searched together	Consistency and standards	Mild
15. To find information about teachers, users have to follow extra steps	Aesthetic and minimalist design	Mild

Different from the common usability problems, experts stated 12 usability problems which includes 8 severe, 3 medium and 1 mild problem (Table 4.46). According to the experts, METU has 6 flexibility and efficiency of use, 2 user control and freedom, 2 aesthetic and minimalist design, 1 consistency and standards and 1 match between system and the real world problem.

Table 4.46: Mobile-Specific Usability Problems of METU with Related Heuristics and Level of Severity

Mobile-Specific Usability Problems	*Related Heuristics*	*Level of Severity*
1. Navigation menu is not clearly visible	Flexibility and efficiency of use	Severe
2. Slider options take up a lot of space and also the relation between the image of slider and slider options is not clearly understandable	Aesthetic and minimalist design	Severe
3. At the top of the main page, there are user types' links, but they seem like menu bar	Match between system and the real world	Severe
4. Most used subpages such as faculties, student information systems etc. are not mobile-friendly	Flexibility and efficiency of use	Severe
5. Not mobile friendly webpages cause zooming and swiping which cause participants have trouble using the website	Flexibility and efficiency of use	Severe
6. Reaching a webpage which is not mobile-friendly after mobile-friendly webpage is not acceptable	Consistency and standards	Severe
7. Clickable areas are too small for tapping on the mobile-friendly webpages	Flexibility and efficiency of use	Severe
8. Webpages which are not mobile-friendly make users use the horizontal and vertical scrolling to see the content	Flexibility and efficiency of use	Severe
9. Readability was not good through the pages, texts are too small to read	User control and freedom	Medium
10. It is tried to put every content on the desktop to the mobile website, which is not a good idea for mobile platforms	Aesthetic and minimalist design	Medium
11. Links on the mobile website were not big enough and easily noticeable	User control and freedom	Medium
12. Sliders cannot be controlled by swiping.	Flexibility and efficiency of use	Mild

Severe problems are related mostly with flexibility and efficiency of use. Based on those usability problems, they expressed that METU website is not compatible with mobile devices. Placements of the contents, sizes of links and clickable areas are not designed for the mobile platforms. In addition to this, some subpages are not designed for mobile yet, therefore; those pages are still viewed as desktop sizes. Moreover, experts stated that all the texts, icons or buttons should be clearly visible. Visible components help users recognize them easily.

4.2.2 USABILITY PROBLEMS OF SU

Usability problems found by usability experts for both desktop and mobile websites of SU are shown on Table 4.47. Experts stated 15 usability problems which include 5 severe, 7 medium and 3 mild problems. According to the experts, SU has 4 consistency and standards, 3 error prevention, 3flexibility and efficiency of use, 2 match between system and the real world, 2 aesthetic and minimalist design and 1 user control and freedom problem.

Most usability problems are related with the heuristic named consistency and standards. Consistency is crucial because inconsistent designs distract users and they feel uncomfortable/disturbed. Moreover, for KU, severe usability problems are related with different heuristics, which shows that usability of KU need to be enhanced by considering requirement of those heuristics.

Table 4.47: Common Usability Problems of SU with Related Heuristics and Level of Severity

Common Usability Problems	*Related Heuristics*	*Level of Severity*
1. Some terminology does not match the real-life context	Match between system and the real world	Severe
2. Main page and subpages do not have a consistent design	Consistency and standards	Severe
3. Explanations on Academic Calendar have different text cases	Consistency and standards	Severe
4. Mail icon which includes the e-mail address of a teacher directs users to the MS Outlook but the e-mail address is copied incorrectly	Error prevention	Severe
5. On Academic Calendar webpage, top row which includes student groups disappeares because of scrolling but there is a need to see top row	Flexibility and efficiency of use	Severe
6. Navigation menu was not easy to use because outside the target area might close the menu and open other menu items. Accidentally moving the cursor just inside or outside the target area will immediately activate or close the menu	Flexibility and efficiency of use	Medium
7. Placement of the navigation menu is changing through the subpages	Consistency and standards	Medium
8. When language of any webpage is Turkish, there are also English statements such as Search.	Consistency and standards	Medium
9. Terms and abbreviations (BT, MIF, ETM, SUMED) are not meaningful and familiar for people out of the university	Match between system and the real world	Medium
10. Academic Calendar has all semesters from 2011 until today, which is not necessary	Aesthetic and minimalist design	Medium
11. Some links or buttons are too small to click	User control and freedom	Medium
12. Academic Calendar shows all dates and their explanations for different student groups, which makes the webpage inefficient to use	Aesthetic and minimalist design	Medium
13. Language options of the webpage has an arrow which seems like a dropdown menu	Error prevention	Mild
14. Even if there is an enough space, some information is represented by icons. For example, e-mail addresses of teachers are not visible until moving the mouse over the mail icon	Error prevention	Mild
15. Directing users to an external document such as MS Word, Excel or PDF was not available	Flexibility and efficiency of use	Mild

Different from the common usability problems, experts stated 13 usability problems which includes 8 severe, 2medium and 3 mild problems (Table 4.48). According to the experts, SU has 5 consistency and standards, 4 aesthetic and minimalist design and 4 flexibility and efficiency of use problem.

Table 4.48: Mobile-Specific Usability Problems of SU with Related Heuristics and Level of Severity

Mobile-Specific Usability Problems	*Related Heuristics*	*Level of Severity*
1. Main menu is opened by double click which is not a frequently encountered usage and is not appropriate for websites	Consistency and standards	Severe
2. Some contents are opened below the fold, visible page of the screen.	Consistency and standards	Severe
3. Some webpages are half mobile friendly, which causes confusion.	Consistency and standards	Severe
4. Search box is not clearly visible.	Flexibility and efficiency of use	Severe
5. Search function does not work on mobile devices.	Consistency and standards	Severe
6. Reaching a webpage which is not mobile-friendly after mobile-friendly webpage is not acceptable	Consistency a ndstandards	Severe
7. Some subpages are not mobile-friendly.	Flexibility and efficiency of use	Severe
8. Webpages which are not mobile-friendly force users to use the horizontal and vertical scrolling to see the content.	Flexibility and efficiency of use	Severe
9. Using too many pictures increases interaction cost because to see the required contents, users have to scroll down too much to pass the pictures.	Aesthetic and minimalist design	Medium
10. Every content on the desktop is placed on the mobile website, which is not a good idea for mobile platforms.	Aesthetic and minimalist design	Medium
11. Sliders cannot be controlled by swiping.	Flexibility and efficiency of use	Mild
12. Selected submenu on the main menu is not clearly understandable.	Aesthetic and minimalist design	Mild
13. There are too many shortcut icons at the bottom of the main page	Aesthetic and minimalist design	Mild

SU has more mobile friendly pages compared to other universities and they tried to fit all the content in a mobile website. However, according to the usability experts, being mobile-friendly is not enough for usability. Most usability problems are related with consistency and standards, which suggest that users should not wonder about different situations. SU website has a design which is inconvenient to general usage habit of mobile devices. Besides that, consistency affects the flexibility and efficiency of usage. Design of websites for mobile and desktop need to be prepared taking the requirements of heuristics into consideration.

4.2.3 USABILITY PROBLEMS OF KU

Usability problems found by usability experts for both desktop and mobile websites of KU are shown on Table 4.49. Experts stated 14 usability problems including 4 severe, 6 medium and 4 mild problems. According to the experts, KU has 4 error prevention, 4 flexibility and efficiency of use, 3 user control and freedom, 2 aesthetic and minimalist design and 1 consistency and standards problem.

Usability experts emphasized that the design of KU website might cause users to make mistakes frequently. The website should not have confusing statements, proximity problems and force users to go back and forth too much to find the desired information.

Table 4.49: Common Usability Problems of KU with Related Heuristics and Level of Severity

Common Usability Problems	*Related Heuristics*	*Level of Severity*
1. There are too many announcements which makes seeking information on the main page hard	Aesthetic and minimalist design	Severe
2. Links do not direct you to the expected page. For example, clicking graduate programs' link directs users automatically to the graduate program of school of business,Error	Error prevention	Severe
3. Some subpages have two navigation menus on the same page	Consistency and standards	Severe
4. Links which have the same statements are confusing. For example, there are two links named "TezliveTezsizYüksekLisans" and "DoktoraveTezli YüksekLisans". If users are looking for an MSc Program with thesis, which one is appropriate is not clear	Error prevention	Severe
5. Lists should be sorted alphabetically, or operations from most used to least used	Flexibility and efficiency of use	Medium
6. After clicking search icon, cursor does not automatically appear	Flexibility and efficiency of use	Medium
7.Left menu on the main page is not sorted alphabetically or operations from most used to least used	Flexibility and efficiency of use	Medium
8.Academic calendar opens Agenda view by default and this view is not easy to navigate	Flexibility and efficiency of use	Medium
9. On Google Calendar, dates and their description are not close to each other, so they were confused with other dates and descriptions,Error	Error prevention	Medium
10. In order to find any information, the website forces you to use pogo sticking which is bouncing back and forth in a hub-and-spoke pattern between a routing main page and subpages which has a link of main page	User control and freedom	Medium
11. Language options are too small to click	User control and freedom	Mild
12. Contents are supported with visuals, but visuals do not seem to be clickable	Error Prevention	Mild
13. Search options like "Search in only ku.edu.tr" and "Search in all KU websites" during the first search are not necessary	Aesthetic and minimalist design	Mild
14. Slider on the subpages is not controlled by users	User control and freedom	Mild

Different from the common usability problems, experts stated 10 usability problems which include 7 severe, 2 medium and 1 mild problems (Table 4.50). According to the experts, SU has 3 flexibility and efficiency of use, 2 aesthetic and minimalist design, 2 consistency and standards, 2 error prevention and 1 visibility of system status problem.

The mobile website of KU has different usability problems. KU website lacks clear labels and mobile-friendly webpages. On desktop, there are too many announcements, but the main menu is visible. However, on mobile, the menu can be reached by using a small icon. Experts stated that KU website is hard to use and has different usability problems.

Table 4.50: Mobile-Specific Usability Problems of KU with Related Heuristics and Level of Severity

Mobile-Specific Usability Problems	*Related Heuristics*	*Level of Severity*
1. Icons are too close to each other and it is hard to select	Flexibility and efficiency of use	Severe
2. Main page has too many announcements, which makes the icon of the main menu hard to find	Aesthetic and minimalist design	Severe
3. On the main menu, there are menu groups named "Gateways" and "Links" and they have sub menu items. However, it was not understandable how those sub menu items are grouped	Error prevention	Mild
4. When webpages are opened in a new tab, users might have trouble returning to the main page	Visibility of system status	Medium
5. Not mobile-friendly webpages force users to use the horizontal and vertical scrolling to see the content	Flexibility and efficiency of use	Severe
6. Functions of icons are not clearly understandable. For example, calendar icon could be an event calendar or academic calendar	Error prevention	Severe
7. Reaching a webpage which is not mobile-friendly after a webpage which is mobile-friendly is not acceptable	Consistency and standards	Severe
8. Using too many picture increases interaction cost because to see the required contents, users have to scroll down too much to pass the pictures.	Aesthetic and minimalist design	Medium
9. Text links are very close to each other and it makes links hard to click	Flexibility and efficiency of use	Severe
10. In order to select an announcement on the main page, it has to be clicked twice unnecessarily	Consistency and standards	Severe

4.3 COMPARISON OF STUDY 1 AND STUDY 2

Two studies, user-based (Study 1) and expert-based (Study 2), were conducted in this study. In both studies, usability problems with related heuristic and level of severity were found by utilizing usability evaluation methods. In user-based experiment, usability problems found by users and observed by the researcher were related with heuristics and their level of severity was identified by the researcher and a usability expert.

In both user-based and expert-based studies, usability problems were found in the tasks given by the researcher and Table 4.51 shows the number of common usability problems with their level of severity for the websites of the three universities. Common usability problems were encountered by participants on both mobile and desktop platforms. According to Table 4.51, for METU and SU, experts found more usability problems compared with user-based experiments. The number of usability problems found during user-based experiments for KU is close to expert-based experiments. In the same vein, for METU and SU, more severe and medium usability problems were found during experts' evaluation.

Table 4.51: Comparison of Study 1 and 2 for over Common Usability Problems with Their Level of Severity

	Comparison of Study 1 and 2 over Common Usability Problems				
		Number of Usability Problems	**Severe**	**Medium**	**Mild**
METU	Study 1	11	3	4	4
	Study 2	**15**	6	7	2
SU	Study 1	10	3	4	3
	Study 2	**15**	5	7	3
KU	Study 1	**15**	7	5	3
	Study 2	14	4	6	4

Table 4.52 shows the number of mobile-specific usability problems with their level of severity for the websites of the three universities. Different from common usability problems, the number of mobile-specific usability problems found during experts' evaluation was higher than the number of usability problems found during user-based experiments. Moreover, the number of severe mobile-specific problems found by experts were more than user-based experiments. For both Study 1 and Study 2, the design of mobile websites had more severe problems. Experts stated that usability problems on desktop website might be handled to a certain extent by users, but mobile devices need to be designed by considering mobile devices' limitations such as size, performance etc. Therefore, they expressed that mobile devices should meet all the usability needs and be designed differently from desktop.

Table 4.52: Comparison of Study 1 and 2 for Mobile-Specific Problems with Their Level of Severity

	Comparison of Study 1 and 2 over Common Usability Problems				
		Number of Usability Problems	**Severe**	**Medium**	**Mild**
METU	Study 1	5	4	1	0
	Study 2	**12**	8	3	1
SU	Study 1	8	7	1	0
	Study 2	**13**	8	2	3
KU	Study 1	**5**	4	1	0
	Study 2	**10**	7	2	1

Usability problems found on both Study 1 and Study 2 were linked with the heuristics. Table 4.53 shows how many common usability problems for both studies were found in the context

of heuristics. It was indicated that usability problems were not focused on one or more heuristics while comparing Study 1 and 2 because they were scattered on different heuristics, which cannot be generalized. However, considering the total number of common usability problems related with heuristics, it was found that websites of the three universities have issues about flexibility and efficiency of use. Besides that, error prevention and consistency and standards have been related to more usability problems. Websites of the universities should be revised considering those heuristics to have more user-friendly websites.

Table 4.53: Number of Common Usability Problems Number of Related Heuristics for Study 1 and 2

	Comparison of Study 1 and 2 over Common Usability Problems						
	METU		**SU**		**KU**		**Total**
	Study 1	**Study 2**	**Study 1**	**Study 2**	**Study 1**	**Study 2**	
Aesthetic and minimalist design	-	-	1	2	4	2	**9**
Consistency and standards	3	4	1	4	-	1	**13**
Error prevention	2	1	-	3	4	4	**14**
Flexibility and efficiency of use	5	6	3	3	4	4	**25**
Match between system and the real world	-	-	2	2	2	-	**6**
Recognition rather than recall	1	2	2	-	-	-	**5**
User control and freedom	-	-	-	1	-	3	**4**
Visibility of system status	-	1	1	-	1	-	**3**

The number of mobile-specific usability problems with related heuristics found on both Study 1 and Study 2 was shown on Table 4.54. Like common usability problems, mobile-specific usability problems were related with flexibility and efficiency of use. Moreover, consistency and standards and aesthetic and minimalist design lead to more usability problems. It shows that interaction with components on mobile websites should be prioritized as much as possible. Besides that, not to cause users to slow down due to inconsistent and unaesthetic design, mobile websites need to be designed considering usability principles and mobile devices' limitations.

Nielsen has 10 heuristics, but considering both common and mobile-specific usability problems, apart from two heuristics which are help and documentation and help users recognize, diagnose, and recover from errors, the rest were related with usability problems.

Table 4.54: Number of Mobile-Specific Usability Problems Number of Related Heuristics for Study 1 and 2

	Comparison of Study 1 and 2 over Common Usability Problems						
	METU		**SU**		**KU**		**Total**
	Study 1	**Study 2**	**Study 1**	**Study 2**	**Study 1**	**Study 2**	
Aesthetic and minimalist design	-	2	1	4	-	2	**9**
Consistency and standards	-	1	3	5	-	2	**11**
Error prevention	1	-	1	-	2	2	**6**
Flexibility and efficiency of use	3	6	2	4	3	3	**21**
Match between system and the real world	-	1	-	-	-	-	**1**
Recognition rather than recall	-	-	-	-	-	-	**0**
User control and freedom	1	2	1	-	-	-	**4**
Visibility of system status	-	-	-	-	-	1	**1**

CHAPTER 5

DISCUSSION & CONCLUSION

In this chapter, examinations about findings of Study 1 and Study 2 are presented. Discussions of the results are interpreted in the light of previous studies and research questions mentioned before will be tried to answer. In addition to this, recommendations and directions are presented.

5.1 DISCUSSION

In spite of the common belief that usability has become a popular topic in recent years, actually it is in our lives, technology, production and so many fields. The popularity of usability has increased with rapidly changing technology. The focus shifted from technology-centered design to user-centered design, so to make users more satisfied, it is required to make usable products, websites or services. Advance of the Internet makes it possible for many people to interact with information easily and quickly on websites. Besides the Internet, mobile devices provide easy access to the Internet independent of time and place. Website usability has become more important not only for desktop but also for mobile devices. Different from the desktop, factors such as screen size and performance of a mobile, time and place factors which affects the usability and satisfaction of users need to be considered. In order to increase the usability of websites on desktops and mobile platforms, there are many usability evaluation methods used. Usability evaluation methods are categorized into two groups [18]. First usability evaluation method is usability testing which includes users during the evaluation and acquires data from users' evaluation. Usability testing is user based and conducted considering a procedure which starts with developing a test plan and ends with reporting findings [49]. The second usability evaluation method is usability inspection method which includes experts and designers. This method is easier than usability testing and it might be conducted before finishing the design of the website [24].

Usability evaluation methods might be used iteratively. Rosenbaum [47] recommends that expert evaluation is more appropriate before applying user testing to find out general usability problems. User testing and expert based evaluation methods cover different types of problems and it is stated that one usability evaluation method might not provide all usability problems [58]. In our study, academic websites were evaluated by using four types of usability evaluation methods. One of the used evaluation method is laboratory experiment which includes desktop and mobile eye tracker. During the laboratory experiment, concurrent think aloud method, which is conducted during the experiment in order not to make users forget their thought after the experiment [21] was used. WAMMI questionnaire was given after each

website evaluation to get information about satisfaction of users relating to their user experiences. In addition to these two methods, usability experts examined the websites for both mobile and desktop to find usability problems. They were informed about users' tasks and asked to get opinions about usability of interfaces by considering Nielsen's heuristics.

Following research questions have been answered by considering the results of Study 1 and Study 2:

RQ1 - How usable are mobile and desktop websites of the entrepreneurial and innovative universities?

It was assumed that websites of entrepreneurial and innovative universities should have usable mobile and desktop websites. To find out whether they are usable or not, laboratory experiment was conducted and by using eye trackers, task completion times with minimum and maximum times, heat maps and gaze plots of the interfaces were gathered. Satisfaction of the participants were analyzed considering the scale of WAMMI questionnaire. Besides that, results of experts' evaluations were used to find usability problems in the context of heuristics and their level of severity.

Eye tracking results indicated that for desktop websites of the universities, same tasks were completed on KU website with the longest task completion times. Table 5.1 shows the mean of the tasks of participants who completed tasks for each university.

Table 5.1: Mean of Tasks of Desktop Experiment for Each University

	Comparison of Task Completion Times of the Three Universities (hh:mm:ss)				
	Task 2	**Task 3**	**Task 4**	**Task 5**	**Task 6**
METU	0:00:23	0:00:53	0:00:02	0:00:36	0:00:28
SU	0:00:31	0:01:59	0:00:03	0:00:40	0:00:41
KU	0:01:05	0:02:10	0:00:10	0:01:50	0:01:00

During the desktop experiments, usability problems were found by observing the participants, eye tracking recordings with heat maps and gaze plots and think aloud method. By using mobile eye tracker, results acquired from mobile experiments shows that KU and SU have the highest task completion times compared to METU (Table 5.2).

Table 5.2: Mean of Tasks of Desktop Experiment for Each University

	Task 2 (hh:mm:ss)	**Task 3 (hh:mm:ss)**	**Task 4 (hh:mm:ss)**	**Task 5 (mm:ss:SS)**	**Task 6 (mm:ss:SS)**
METU	0:00:55	0:01:17	0:00:07	0:01:22	0:01:01
SU	0:01:46	0:01:34	0:00:18	0:01:01	0:01:19
KU	0:01:21	0:01:49	0:00:11	0:01:45	0:00:42

When task completion times are compared on the basis of mobile and desktop, some task completion times of desktop are higher than mobile. However, task completion times of mobile are higher than the desktop in general.

After Study 1, to get usability problems based on the perspective and knowledge of usability experts, expert-based study was conducted. They examined both mobile and desktop experiments and stated usability problems with their severity level.More usability problems were found during the user-based experiment, but more mobile-specific usability problems were gathered from experts' evaluation. According to the experts' results, it can be said that websites of the universities need to be designed by considering usability and users' requirements, but mobile websites need more consideration to enhance usability.

One important usability problem found during the studies is the fact that mobile websites are not mobile-friendly. Websites should be mobile-friendly because increasing engagement of users with webpages should be provided by designing mobile-friendly webpages. When a webpage opens on mobile device in desktop sizes, it caused too much mental effort. Users have to zoom and swipe to see the required content. Nielsen [38] stated that there should be mobile-optimized design. Moreover, he indicates that three ideas have to be considered during the design: Cut features and content to prioritize the content and placement. In addition to this, interface components should be enlarged in order to tap them easily.

- **Navigation, Searching and Interface Attractiveness**

Considering the usability problems found, during the experiments, menus were used for each task. It was seen that the location of the menu is important for both mobile and desktop websites. On desktop, the location of navigation menu at top of the page is familiar to the users and it has become a habit. In this study, the menu at the center of the page was not noticeable at first and eye tracker showed that eye fixations of users start at the top of the page. According to Nielsen [34], users start to read webpages in an F shaped pattern. Users start at the left top of the page and first read in a horizontal movement, usually across the upper part of the content area. Therefore, the location of menu should be preferred at the top of the webpage. For mobile websites, users are familiar with the hamburger menu ( ) and except SU, other two universities have this menu. Menu was placed at the right top of the main page because most people use their right hands and menu will be close to touch the right top of the page. In this study, for METU, participants stated that they did not notice the main menu. Therefore, significant contents and links should be visible on the webpages [6]. Moreover, those contents and links should be visible without scrolling. On desktop websites, there should not be more than one navigation menu because this makes users wonder about which one consists of operations that they need.

Search functions have importance for the websites to find information quickly. It was found in usability experiments that the location of search is significant [7]. Gaze plots of the users show that users focused on the right top of the page to find search field. Search field should be clearly visible and located at the right top of the page. Shervin [52] states that users tend to find a box which represents search field, so to make search field easier to spot, it is important to use a box for search field. Moreover, search should work appropriately. For mobile website of SU, search box is visible after clicking a word named Search. However, after spending too much effort for finding search box, participants were disappointed when search did not work. Functionality of the interface has as much importance as visibility of the components [45].

Size of the components such as buttons, texts etc. need to be designed to read and click easily. Visibility of those components affects users' performance, which is why small texts or buttons are not realized with ease and users spend extra time to find the required information

or operation. In the experiment of METU, going to the main page from subpages was not easy for participants because the link of the main page is too small. Moreover, this problem becomes more critical on mobile websites because screen size of the mobile devices is smaller than desktop computers. Touchable areas need to be appropriate size to make interfaces easy to use. Seward [50] argues that users might have fat fingers and targets of the interface for touching should be big enough to click. Besides the size of the components, alignment has become critical for both desktop and mobile design. The proximity of components is perceived as a group by users [63]. On the academic calendar shown as a list, dates and their descriptions were placed under each other and it was hard to understand which description belongs to which date. Components which are too close to each other cause users slow down during the usage of the website. Therefore, related components should be placed close to each other and there has to be some space between groups.

Lists which might be texts, links, and images enable components to be scanned easily. Users in this study showed tendency for preferring lists which include texts as sorted alphabetically. Although other sorting types such as logical order, prioritization etc. were found better than alphabetical order [38], interaction cost is increasing when users search an item from an unsorted list. Therefore, if there is no way to make the lists sort in a logical order or other sorting types, alphabetical sorting should be chosen.

- **Interactivity and Functionality**

The medium of instruction at all the three universities is English, so webpages have language options. During the evaluation, it was observed that not all the websites have both Turkish and English languages. For METU, the department of Industrial Engineering did not have a Turkish language option. Participants were directed from the main page whose language is Turkish to the website of Industrial Engineering whose language is English. This makes participants slow down. Consistency between pages should be provided considering the language of websites.

Users have difficulties about academic calendar because the design of the academic calendars differs from each other even if two universities are using Google Calendar. Google calendar might be useful, but full explanations of dates are not visible until you click on them. There should be an alternative view like METU website, where the normal version of academic calendar was preferred more than Google calendar. Web pages should present information clearly and accurately. According to Nielsen's heuristics, users should have control during the user experience, so information should be visible. Moreover, it has to be paid more attention to that language of the components on the website should be active language, for example if the language of the website is Turkish, there should not be any English word on components.

During the mobile website experiment of SU, when users tapped on one of the multi-level items, there was no change on the screen because in order to select a menu item, it is required to click twice. Participants could not realize this requirement and blamed themselves for not tapping the right place appropriately. Websites should give status information of an action; otherwise users might think that they are not capable of using the mobile website.

- **Accuracy, Currency and Authority Of Information**

Users encountered a black page during the Task 4 on METU website. When there were no announcements about scholarship, there is no information or statement under the title named Scholarship Announcements. Blank page aroused a feeling that page was not loaded yet, so participants waited for a while. Nielsen and Loranger [34]. Moreover, experts emphasize that information should be easy to find and search. In this situation, there should be a statement saying that there is not any announcement about scholarship found.

Academic websites need to be designed considering the usability principles, but it is important that they include up-to-date information. SU has an up-to-date academic calendar, but besides that SU shows academic calendars of all semesters from 2011 until today. The amount of information is critical because too much information makes the information hard to find. Therefore, designers should avoid unnecessary information to make content of the website easy to read [56].

During the mobile experiments of SU and KU, it was observed that some links were opened by double tapping. However, tapping twice is not a usage habit of participants, so when they tapped once, they waited websites to open. One of Nielsen's heuristics, consistency and standards, indicates that users should not wonder about the actions of the website. Moreover, double tapping has become a gesture which allows zooming the picture or making text content fit to the screen on mobile devices [65]. Therefore, breaking the routines may not be good in this situation, so the design of the mobile website should include one tap to open a link.

- **Accessibility, Understandability, Learnability and Operability**

Nielsen [35] indicates that users should not have to wonder about whether different words, situations, or actions mean the same thing. In this study, actions of users ended with a different actions' results. In order not to make users confused and spend too much effort about their actions, actions should end with expected results. As it is mentioned before contents and their placement should match real-world contents and users should not wonder about using the website. Moreover, during the mobile design, every content was tried to be put into mobile by changing or shortening. Scenarios of operations should be created by conducting user testing or cognitive walk-through with experts. Experts could go over the steps of all scenarios and examine if websites match real-life contexts.

Desktop websites of universities have all the content and operations that users need, but website design should be different for mobile. Most importantly, focus should be on the content and mobile-specific design should be prioritized considering mobile design' constraints [65]. In this study, it was seen that mobile websites include all the content of desktop. This does not mean that all the content is presented mobile-friendly. Before designing a mobile website, most used operations need to be analyzed and selected. Moreover, it is required to design mobile-friendly websites because opening a webpage which is desktop size makes users zoom in and swipe to see the content, which decreases the efficiency.

For both desktop and mobile, webpages should not include too many components such as announcements, news, shortcut links etc. because those components distract users while using the website. Experts stated that there should be accelerators which increase the speed of

novice users and make website more efficient to use. In this study, main pages of all universities have sliders consisting of latest announcements of universities. However, the main page of KU has too many announcements and finding the most used information takes extra time. It is required to put all the needed content on the page and they should be easily noticeable and selectable [53]. For mobile website of KU, several important links are placed at the bottom of the page. Users have to scroll to skip announcements and reach those links.

The ideal number of steps for each task must be presented before and in order to prevent users from having cognitive load, unnecessary steps have to be omitted. Users in this study completed tasks with more number of steps. In usability design, some designers stick up for 3 click rule which is why users have to reach information with no more than 3 clicks. However, the number of clicks does not show that there is a problem, but the success of those steps should be considered [44]. In this study, users move back to the main page of the universities to find another way for finding the required information. Clearly organized information provides quick understandability.

- **Efficiency and Reliability**

Finding information within a reasonable time was not possible for most participants. For both desktop and mobile websites, content, placement of the components, text sizes, order of the lists, differences about terminology and inconsistent design cause the completion time to increase. For example, users need to scroll down to get more information, but all information should be above the fold [55]. In this study, seeking information was opened below the screen of the mobile device and users did not realize it. All the content should be visible and the design of the website needs to be understandable for all target users.

Usability has a significant role in the satisfaction of the website users, which usability provides to increase the satisfaction and additionally intention to use through the satisfaction [5]. Therefore, the result of WAMMI questionnaire indicated how participants represent their satisfaction. Table 5.3 shows that desktop experiments of METU and SU made participants more satisfied during mobile experiments.

Table 5.3: WAMMI Results of All University Websites for both Mobile and Desktop

	METU		**SU**		**KU**	
	Desktop	**Mobile**	**Desktop**	**Mobile**	**Desktop**	**Mobile**
Attractiveness	73.5	66.5	74	70.5	63	62
Controllability	67	63.5	67.5	64.5	63.5	67
Efficiency	72	55	76.5	62.5	50.5	50.5
Helpfulness	70	63.5	65	61.5	62	64
Learnability	76.5	71	59	55	54	57.5
Global Usability Score	**71.8**	**63.9**	**68.4**	**62.8**	**58.6**	**60.2**

RQ2 - What are the methodological differences of mobile and desktop websites in usability evaluation?

Usability evaluation methods differ according to the needs of experiments. In this study, usability testing and user inspection methods were used to understand which method is more efficient for mobile and desktop experiments.

- **Desktop Eye Tracking and Mobile Eye Tracking**

When task completion times were compared, users completed their tasks on desktop experiment faster than the mobile experiment. Few websites of METU and KU are mobile friendly and when websites are opened in desktop sizes, task completion time increased automatically. Although websites of SU were mobile-friendly, the design of the mobile websites did not meet all the requirements of usability principles. Besides these reasons, mobile eye tracker affected participants in a bad way and this is one of the main reasons why task completion times were higher than desktop. Mobile eye tracker was not as good as desktop eye tracker in the context of technical specifications. Calibrating participants' eyes took approximately 5 minutes and a slight change in head positioning caused losing calibration and data loss. Participants were informed before the experiments not to change their positioning even a little bit. However, when they were using the website, they changed their positioning unwittingly. For this reason, for mobile experiments, mobile eye tracker was difficult to gather data. Moreover, some participants tried not to change their positioning so hard but this affected their mobile device usage. According to Duh, Tan & Chen's [10] study, mobile device was used during usability evaluation in laboratory and field. At the end of the study, it was revealed that more important usability problems were found in the field than in the laboratory. In order to get eye tracking data such as first fixation durations, heat maps, gaze plots, it is required to use eye tracker, but today's technology does not provide appropriate usage for mobile experiments. Kjeldskov & Stage [25] found that when participants sat in the laboratory and complete the tasks, more usability problems were found. Controlling experiment conditions was helpful and sufficient results were gathered. During the mobile experiment, the researcher read the tasks and then participants started completing the task. When researcher read the tasks, there could be be misunderstanding or sometimes the researcher had to repeat the task again at the request of participants. Desktop eye tracker allows to create tasks on the screen, so there is no interruption during the evaluation.It was found in this study that mobile eye tracker was not efficient to use compared to the desktop eye tracker.

- **Think Aloud Method**

Concurrent think aloud method was used during both mobile and desktop experiments. Jaspers [21] stated that, concurrent method is more appropriate because after the experiment, participants forgot the reasons of their actions even if they watched them from video in retrospective. In this study, think aloud method was helpful to get thoughts of users from desktop experiment concurrently. When participants became silent, the researcher reminded them to think aloud. However, during the mobile experiment, participants did not think aloud too much and the researcher realized that reminding participants about thinking aloud while completing tasks made participants slow down. Therefore, before the mobile experiments, it was asked them to think aloud to get their thoughts verbally, but during the mobile experiment, they were not

reminded too much in order not to affect results. Participants do not easily talk about their thoughts when the tasks are a little bit complex and it is required to use eye tracking method to understand participants' actions and usability problems in detail [12]. Moreover, mobile device usage is independent of time and place and mobile device was designed to make operations quick and efficient. For this reason, for mobile experiment, retrospective think aloud method could be more efficient.

- **Heuristics**

In this study, usability experts examined the webpages in detail and went over the pages related to the tasks of usability testing. Using scenarios during not only user testing but also expert-based evaluation gives more detailed results [4]. In the literature, there are some heuristics which are specified to mobile websites, but their validity has not been proven yet. Therefore, experts used the same Nielsen's heuristics for both mobile and desktop websites. Experts considered heuristics, but all the problems they found are not related with heuristics. Similar problems were found in expert-based and user-based study but on the basis of mobile experiment, experts found more mobile-specific usability problems. The reason is that participants were more task-focused, but experts spent enough time to understand the deficiencies of mobile design. Because websites of the universities are not mostly mobile-friendly, experts' evaluation had to remain at the level of few mobile-friendly website' evaluation. Besides that, experts tend to relate heuristics with usability problems easily on desktop websites because they have comprehensive knowledge of websites on desktop.

5.2 CONCLUSION

In this study, different usability evaluation methods were used for both mobile and desktop websites. Results were obtained on the basis of user-based and expert-based study. This study shows the usability issues of entrepreneurial and innovative universities. It was found that mobile websites have more usability problems and also users' satisfaction of desktop experiment was higher than mobile experiment. Today's technology makes the usage of mobile devices necessary. Therefore, designing mobile-friendly websites is no longer a choice but an obligation. This study shows that webpages of METU and KU are not mostly mobile-friendly. Main page and some subpages of those universities are mobile-friendly, but while using mobile websites, webpages which are not designed for mobile open in desktop sizes. This is a critical problem, so those websites should design mobile-friendly. Webpages of SU are mostly mobile-friendly, but mobile webpages have design problems. Besides that, it has been shown that despite critical problems, using a webpage which is not mobile-friendly on mobile devices affects users' satisfaction.

This study shows methodological differences of usability evaluation methods for mobile and desktop experiments. It is revealed that concurrent think aloud method is not appropriate for mobile experiments. For mobile experiments, in retrospective think aloud method, experiment is recorded and participants talk about their actions after the experiment by watching the video. Retrospective think aloud method will cause the experiments to be completed in a longer time, but more usability problems will be gathered from user testing.

To make usability evaluation for mobile websites, getting thoughts of users and recording the experiment will be enough to find out critical usability problems. Mobile eye tracker makes

participants uncomfortable and mobile devices are not used in an appropriate setting. Therefore, if the reason of a study is to learn the usability problems that participants encounter, video recording will be enough. However, to get results from eye tracker such as fixation durations, heat maps and gaze plots, mobile eye tracker should be used. Getting data from Iphone 6 was not easy because of the screen size. By improving mobile eye tracker technology, tablets could be used on mobile eye tracker because the bigger size the mobile device has, the better results the study reveals.

Experts' evaluation provided general usability problems and those mostly cover usability problems found in user testing. Therefore, before finishing the webpage, expert based study could be conducted in order to get general usability problems and then user testing could be used. In this way, findings of experts will improve the website considering the usability principles and then user-testing might give real-life usability problems which users encounter.

5.3 LIMITATIONS

During the study, several limitations were observed. Eye tracking experiment first starts with eye calibration, which helps participants learn the system, eye characteristics, speed and size. During the mobile experiment in Study 1, it took some time to calibrate some of the participants' eyes. Mobile eye tracker was not as good as desktop eye tracker technically. Eye calibration might change when the participants' head position changes slightly. For this reason, participants tried not to act too much and this was a little uncomfortable. Moreover, changing head position caused losing some of the data during the experiments.

WAMMI questionnaire was used in Study 1 as a post-task questionnaire to get satisfaction of the users from the user experiences after experiments. However, 20 participants evaluate their experiences and even if the number of participants is sufficient for eye tracking experiments, the study requires more people for the questionnaire.

Tasks were prepared to make participants pretend to perform like in their real-life. For Task 3, participants pretended that they were accepted to the Industrial Engineering program and they wanted to learn when the classes begin in 2014-2015 Spring Semester. Considering the universities that were evaluated during the experiment, academic calendar was faculty-independent, so they reached academic calendar including all faculties and dates. However, the universities that some of the participants graduated from have a specific academic calendar to the faculty. Therefore, participants tried to find academic calendar under the faculty webpage for a long time. Before the study, possible tasks might be reconsidered , to prevent usage habit from affecting results. Think aloud method provided significant feedback, but different from the desktop experiment, thinking aloud during the mobile experiment causes participants to stop for a while. Participants show a tendency to use mobile devices faster than desktop, so the researcher did not encourage participants too much to tell their thoughts.

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APPENDIX A

WEB SITESI MEMNUNIYET ANKETI (IN TURKISH)

WEB SİTESİ MEMNUNİYET ANKETİ

Genel Sorular	
Adınız Soyadınız:	**Tarih:**
Değerlendireceğiniz Web Sitesi: KOÇ	

	😀	🙂	😐	☹	😫
Katılımınız için teşekkür ederiz.	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Kesinlikle Katılmıyorum
Eğitim İçeriğinin ve Programının Değerlendirilmesi	**5**	**4**	**3**	**2**	**1**
1. Bu web sitesi ilgi alanıma girmektedir.					
2. Bu web sitesinde sayfalar arasında gezinmek zordur.					
3. Bu web sitesinde istediğim bilgiye kolaylıkla ulaşabiliyorum.					
4. Bu web sitesi bana mantıklı görünüyor.					
5. Bu web sitesinin daha fazla tanıtıcı açıklamaya ihtiyacı var.					
6. Bu web sitesindeki sayfalar çok ilgi çekicidir.					
7. Bu web sitesini kullanırken kontrolün bende olduğunu hissediyorum.					
8. Bu web sitesi çok yavaştır.					
9. Bu web sitesi aradığım bilgiyi bulmama yardımcı oluyor.					
10. Bu sitede dolanırken gitmem gereken yönü keşfetmek bir problemdir.					
11. Bu web sitesini kullanmaktan hoşlanmıyorum.					
12. Bu web sitesiyle ilgili isteklerim hakkında ilgili kişilerle kolaylıkla iletişim kurabiliyorum.					
13. Bu web sitesini kullanırken kendimi yeterli hissediyorum.					
14. Bu web sitesinin benim ihtiyacım olan şeylere sahip olup olmadığını söylemek oldukça güç.					
15. Bu web sitesini ilk kez kullanırken hiç zorlanmadım.					
16. Bu web sitesi kullanıcıyı rahatsız edecek bazı özelliklere sahip.					
17. Bu web sitesini kullanırken nerede olduğunuzu hatırlamak güçtür.					
18. Bu web sitesini kullanmak zaman kaybıdır.					
19. Bu web sayfasında bir şeye tıklayınca ihtiyacım olan şeye ulaşabiliyorum.					
20. Bu web sitesindeki her şeyi anlaması kolaydır.					

APPENDIX B

KATILIMCI BELIRLEME ANKETI (IN TURKISH)

1. **İnternete genellikle nereden bağlanırsınız (Masaüstü bilgisayar, akıllı telefon, ipad vb.)?**
   ❑ Bilgisayar ❑ Akıllı telefon ❑ Ipad ❑ Diğer: _____

2. **Günde ortalama kaç saat internet kullanıyorsunuz?**

   ❑ 1 saatten az ❑ 1-3 saat arası ❑ 3-5 saat arası ❑ 5 saat ve üzeri

3. **İnterneti genellikle hangi amaçlarla kullanırsınız (en fazla 3 madde seçiniz)?**

   ❑ Bilgiye ulaşma
   ❑ İletişim (e-posta)
   ❑ Sosyalleşme
   ❑ Alışveriş
   ❑ Eğitim amaçlı araştırma
   ❑ Bankacılık işlemleri
   ❑ Haber alma
   ❑ Oyun/Eğlence
   ❑ Diger: _____

4. **İnternete mobil cihaz üzerinden bağlandığınızda yaptığınız işlemleri sıklığına göre sıralayınız.**

   _____ Bilgiye ulaşma
   _____ Haberleri okuma
   _____ E-posta gönderme/okuma
   _____ Sosyal medyayı kullanma
   _____ Oyun oynama
   _____ Bankacılık işlemleri
   _____ Diğer: _____

5. **Akıllı telefonunuzun markası nedir?**

   ❑ Apple ❑ Samsung ❑ HTC ❑ LG ❑ Diğer:_____

6. **Akıllı telefonunuzu ne kadar süredir kullanıyorsunuz?**

   ❑ 0-6 ay ❑ 6 ay - 1 yıl ❑ 1 - 3 yıl ❑ 3 yıldan fazla

7. **Akıllı telefonunuz aracılığıyla günde ortalama kaç saat internet kullanıyorsunuz?**

   ❑ 1 saatten az ❑ 1-3 saat arası ❑ 3-5 saat arası ❑ 5 saat ve üzeri

8. **Akıllı telefonunuzda yer alan tarayıcıdan (Örn. Opera, Safari, Chrome vb.) herhangi bir internet sitesini kullandınız mı?**

   ❑ Evet ❑ Hayır

9. **Tabletiniz var mı? (Cevabınız Evet ise sonraki soruları cevaplayınız.)**

   ❑ Evet ❑ Hayır

10. **Tabletinizin markası nedir?**

    ❑ Apple ❑ Samsung ❑ Asus ❑ LG ❑ Diğer:_____

11. **Tabletinizi ne kadar süredir kullanıyorsunuz?**

    ❑ 0-6 ay ❑ 6 ay - 1 yıl ❑ 1 - 3 yıl ❑ 3 yıldan fazla

12. **Tabletiniz aracılığıyla günde ortalama kaç saat internet kullanıyorsunuz?**

    ❑ 1 saatten az ❑ 1-3 saat arası ❑ 3-5 saat arası ❑ 5 saat ve üzeri

13. **Tabletinizde yer alan tarayıcıdan (Örn. Opera, Safari, Chrome vb.) herhangi bir internet sitesini kullandınız mı?**

    ❑ Evet ❑ Hayır

APPENDIX C

GÖREVLER (IN TURKISH)

Çalışma kapsamında Orta Doğu Teknik Üniversitesi, Sabancı Üniversitesi ve Koç Üniversitesi web sitelerinin masaüstü ve mobil versiyonları kullanılacaktır. İlgili üniversitelerin web siteleri incelenmiş ve kullanıcıların gerçekleştirebileceği ortak görevler bulunmaya çalışılmıştır. Oluşturulan görevler, kullanılabilirlik uzmanları ile gözden geçirilmiş ve uzmanların geribildirimleri göz önünde bulundurularak yeni görevler oluşturulmuştur. Görev sayısı geribildirimler dahilinde azaltılabilir.

Oluşturulan yeni görevler üniversite mezunu kullanıcı grubu için hazırlanmıştır.

Görev 1

Hiçbir işlem yapmadan üniversitenin ana sayfasını inceleyiniz ve genel bir izlenim elde etmeye çalışınız. Genel bir izlenime sahip olduğunu düşündüğünüzde aşağıdaki sorulara cevap veriniz (sorular araştırmacı tarafından sorulacaktır ve cevaplar kayıt altına alınacaktır).

- Üniversitenin masaüstü/mobil web sitesine yönelik ilk izleniminiz nedir?
- Renkler, düzen, kullanılan resimleri göz önünde bulundurarak genel görünüm hakkında ne düşünüyorsunuz?
- Web sitesine yönelik izlenimlerini nelere bakarak oluşturdunuz?
- Sayfaya ilk baktığınızda dikkatinizi çeken şey ne oldu?
- Bu sayfayı kullanmak ister miydiniz?
- Eğer web sitesi üniversite hakkındaki ilk izlenimlerinizi oluşturacak olsaydı, bu üniversiteyi nasıl tanımlardınız?

Görev 2

Endüstri mühendisliği alanında yüksek lisans yapmaya karar verdiniz ve üniversitelerin bu alanda yüksek lisans programı olup olmadığını araştırıyorsunuz. ODTÜ/Sabancı/Koç Üniversitesi web sitesi aracılığıyla ilgili üniversitede Endüstri mühendisliği yüksek lisans programı olup olmadığını bulunuz.

Görev 30

Endüstri Mühendisliği yüksek lisans programına kabul edildiniz. 2014-2015 Bahar döneminde derslerinizi almaya başlayacaksınız. Derslerin hangi tarihte başlayacağını bulunuz.

Görev 4

Yüksek lisans programı kapsamında üniversite tarafından sağlanan burs imkanlarının neler olduğuna ve nasıl yararlanacağınıza yönelik bilgi almak istediniz. Arama alanını kullanarak ilgili bilgiyi bulunuz.

Görev 5

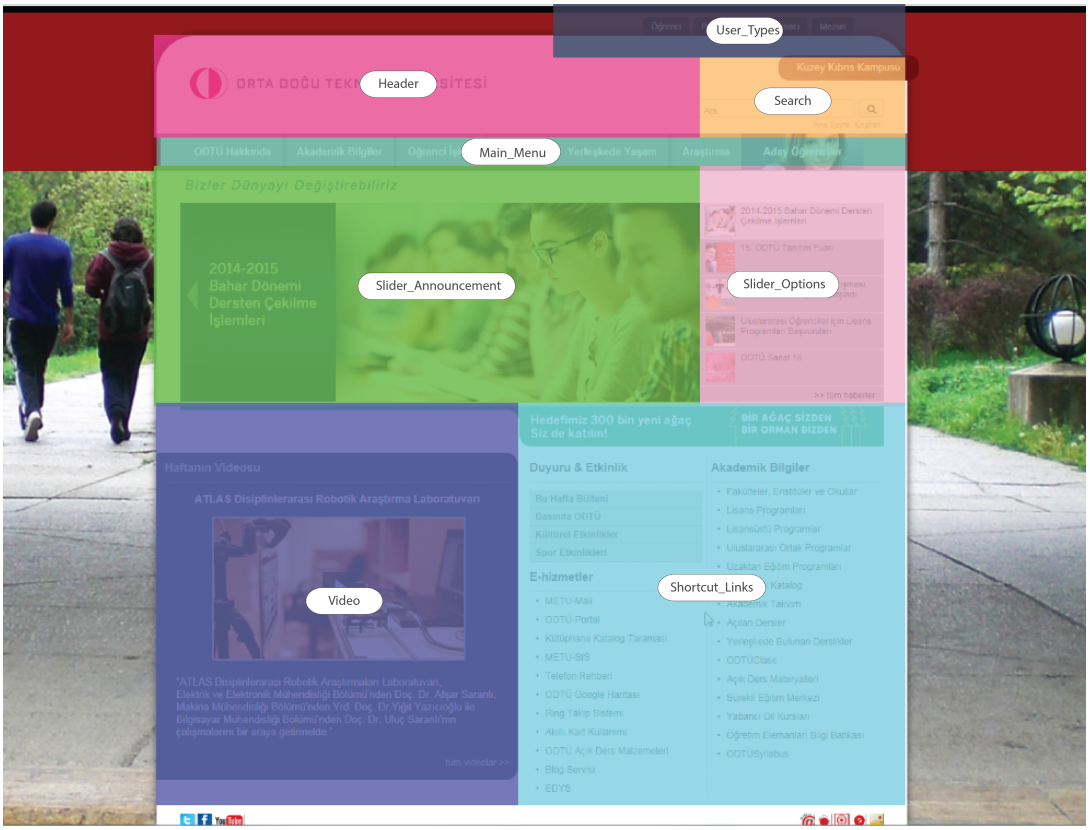
İşinizden dolayı yüksek lisans derslerinizden birisine bu haftalık giremeyeceğinizi fark ettiniz ve dersin hocasına bunu e-posta aracılığıyla bildirmek istediniz. Endüstri Mühendisliği,ndeki herhangi bir hocanın e-posta adresini bulunuz.

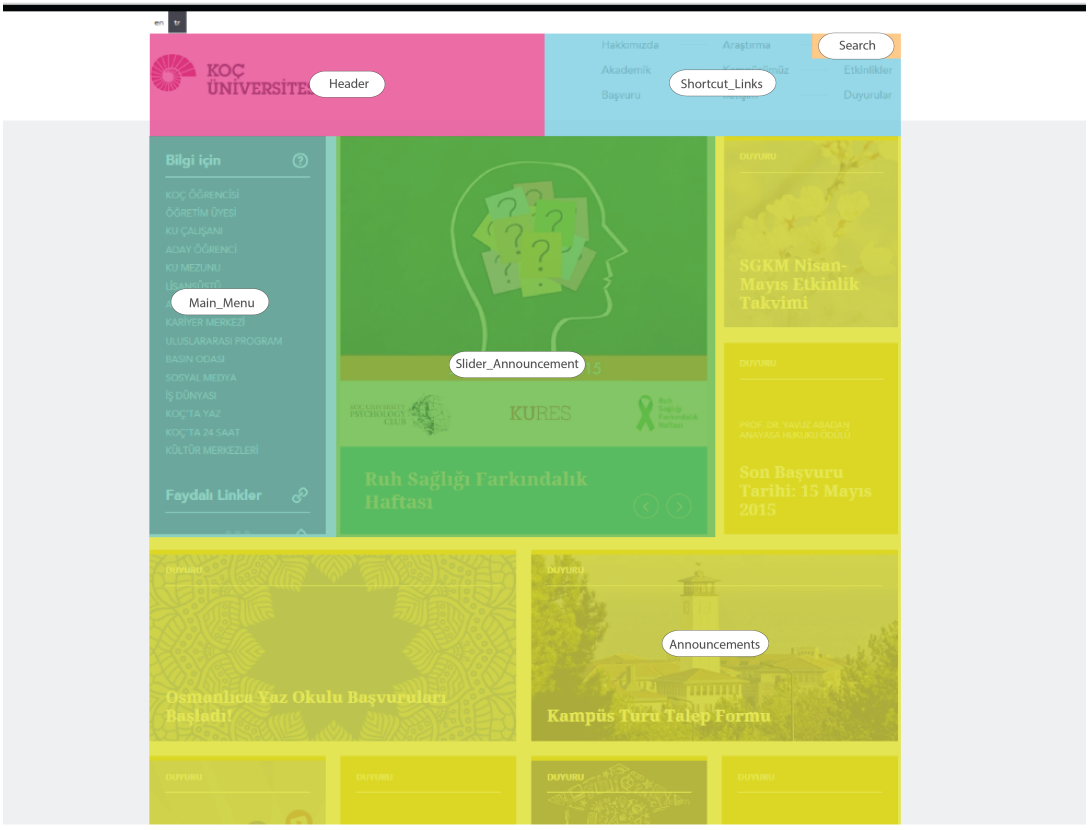
Görev 6

Yüksek lisans programına ait aldığınız dersler sonrasında kampüs içinde bir şeyler yapmak için zamanınızın kaldığını fark ettiniz. Kampüste yüzme havuzu var ise yüzmeye gidebileceğinizi düşündünüz. Üniversitenin kampüs içinde yüzme havuzu olup olmadığını bulunuz.

APPENDIX D

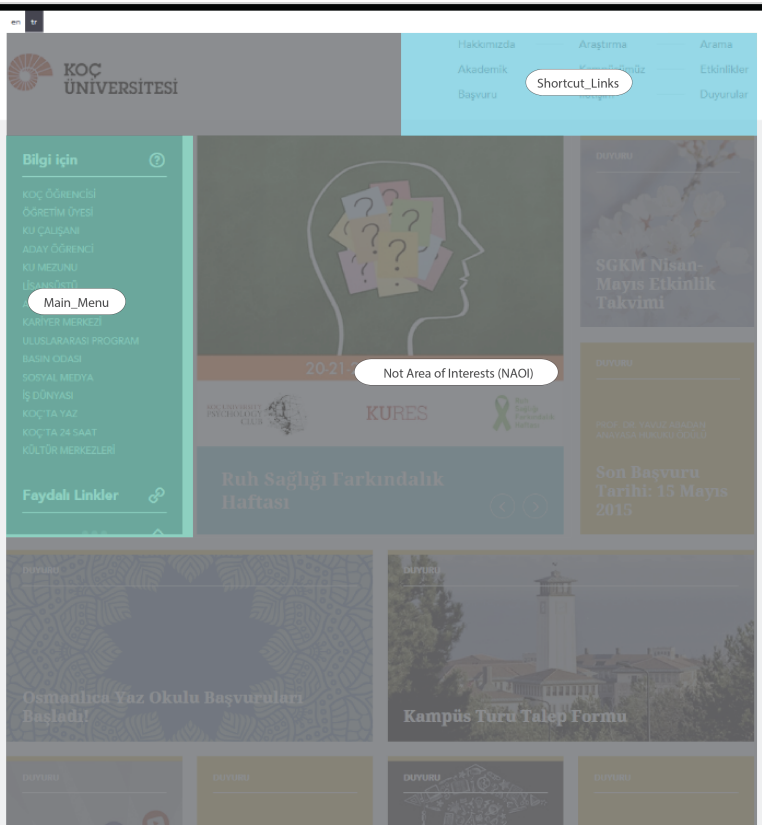
AREA OF INTERESTS FOR METU AND KU FOR TASK 1 ON DESKTOP EXPERIMENT


User_Types
Header
Search
Main_Menu
Slider_Announcement
Slider_Options
Video
Shortcut_Links


Header
Search
Shortcut_Links
Main_Menu
Slider_Announcement
Announcements

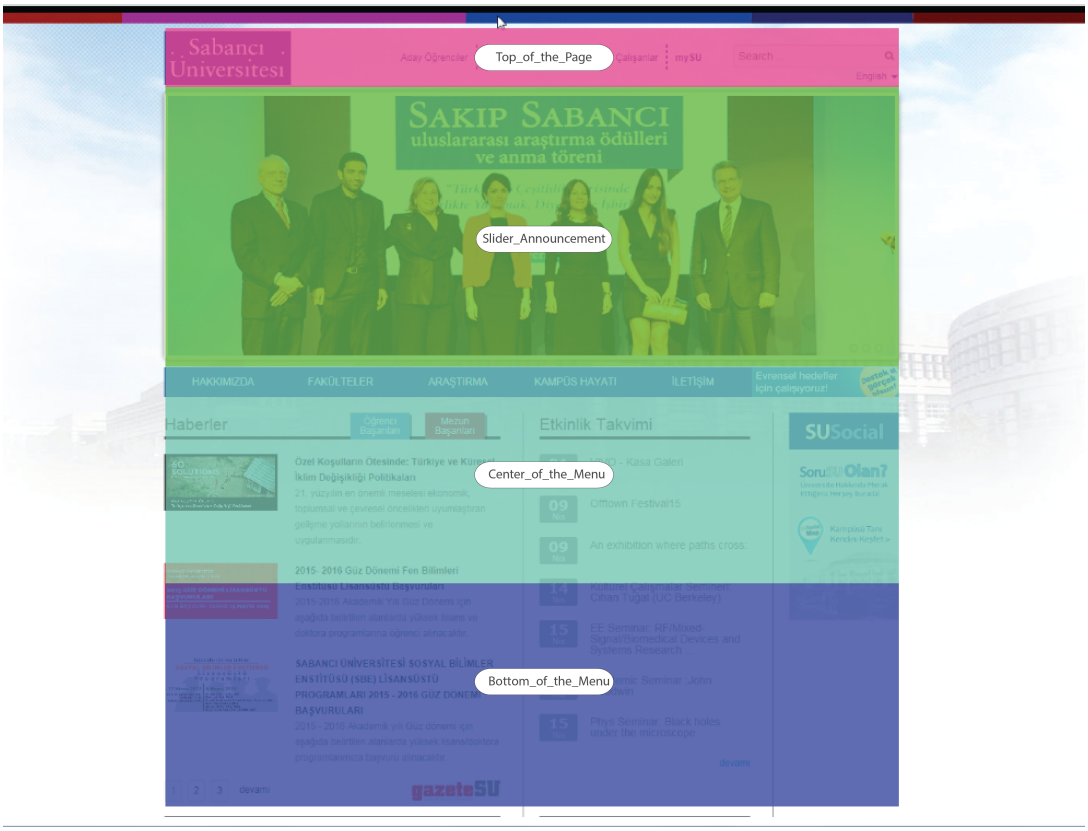
APPENDIX E

AREA OF INTERESTS FOR KU MAIN PAGE FOR TASK 3 ON DESKTOP EXPERIMENT



APPENDIX F

AREA OF INTERESTS FOR SU MAIN PAGE FOR TASK 3 ON DESKTOP EXPERIMENT



TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : .....
Adı : .....
Bölümü : .....

TEZİN ADI (İngilizce) : .....
.....
.....
.....
.....

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ☐
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

Yazarın imzası ..... Tarih .....