A USABILITY STUDY ON ELECTRONIC DOCUMENT MANAGEMENT SYSTEM IN MIDDLE EAST TECHNICAL UNIVERSITY

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ABSTRACT

A USABILITY STUDY ON ELECTRONIC DOCUMENT MANAGEMENT SYSTEM IN MIDDLE EAST TECHNICAL UNIVERSITY

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The development of information technologies (IT) in recent years has started to affect the daily routines of the people. These technologies have changed the way that the things are done. One of these technologies is Electronic Document Management System. Considering the increasing amount of documents needed for the institutions, it could be said that there was a need for a system to manage this complexity. However, usability of such technologies depend on the people who would use the system. Usability problems of such systems and websites have been an important topic for Human Computer Interaction. In this study, usability tests were conducted about Middle East Technical University's Electronic Document Management System. The main purpose of this study is to conduct three-step usability tests using eye tracker device and questionnaires and offer recommendations that would refine the problematic issues by analyzing the obtained data. Several usability issues were identified with the results of the study. Recommendations for further development were offered based on the findings of the study. There were two main usability issues identified. These issues were complexity and inconsistency of the system. For the solution of these problems it is recommended that the home page of the system should be simplified and the actions to be taken on a document should show consistency.

Keywords: Electronic Document Management System, Usability, Eye Tracking, Human Computer Interaction

ÖZ

ORTA DOĞU TEKNİK ÜNİVERSİTESİ ELEKTRONİK DOKÜMAN YÖNETİM SİSTEMİ ÜZERİNE BİR KULLANILABİLİRLİK ÇALIŞMASI

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Son yıllarda bilgi teknolojilerinin (BT) gelişmesi insanların günlük rutinlerini etkilemeye başladı. Bu teknolojiler işlerin yapılış şeklini değiştirdi. Bu teknolojilerden biri de Elektronik Doküman Yönetim Sistemi'dir. Kurumlar için gerekli belgelerin miktarındaki artışı göz önünde bulundursak bu karmaşıklığı yönetecek bir sisteme ihtiyaç duyulduğu söylenebilir. Fakat bu tarz teknolojilerin kullanılabilirliği sistemi kullanan insanlara bağlı olmaktadır. Bu tarz sistemlerin ve internet sitelerinin kullanılabilirlik problemleri İnsan Bilgisayar Etkileşimi (İBE) için önemli bir konu olmuştur. Bu çalışmada, Orta Doğu Teknik Üniversitesi Elektronik Doküman Yönetim Sistemi üzerine kullanılabilirlik çalışmaları yürütülmüştür. Bu çalışmanın ana amacı EDYS için göz hareketlerini izleme cihazı ve anketler kullanarak üç aşamalı kullanılabilirlik testleri uygulamak ve elde edilen verileri inceleyerek problemli konuları düzeltmeye yarayacak tavsiyeler önermektir. Çalışmanın sonuçları ile çeşitli kullanılabilirlik sorunları tespit edilmiştir. Çalışmanın bulguları temel alınarak gelecekteki gelişmeler için tavsiyelerde bulunulmuştur. Belirlenen iki temel kullanılabilirlik sorunu vardır. Bu sorunlar sistemin karmaşıklığı ve tutarsızlığıdır. Bu

sorunların çözümü için sistemin ana sayfasının basitleştirilmesi ve bir evrak üzerinde yapılacak işlemlerin tutarlı olması önerilmiştir.

Anahtar Kelimeler: Elektronik Doküman Yönetim Sistemi, Kullanılabilirlik, Göz İzleme, İnsan Bilgisayar Etkileşimi

This thesis is dedicated to

My family

&

My beautiful fiancée

Ceren Leymun.

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CHAPTER 1

1 INTRODUCTION

1.1 Introduction

The development of information technology (IT) in recent years has started to affect the daily routines of the people. These technologies have changed the way that the things are done. One of these technologies is electronic document management systems (EDMS). Applying new technologies like EDMS to make the life easier for people is important. However, the effectiveness and usefulness of such technologies depend on the people who would use the system. Moreover, usability problems of such systems and websites have been an important topic for Human Computer Interaction (HCI).

1.2 Background of the Problem

International Organization for Standardization (ISO) defines usability as "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" (ISO 9241-11). As it can be understood from this definition effectiveness, efficiency and satisfaction are important terms for usability context. In addition to these terms, simplicity, ease of use and predictability are some other important concepts for usability as Nielsen (2000) offered. All of these terms are taken into account during usability tests. When a formal usability test is applied, the users who test the system are observed while trying to achieve the given tasks (Battleson, Booth & Weintrop, 2001).

Different methods of usability tests show the importance of integration for usability concept in the institutions. People who have management and administrative duties in these institutions can support the system used but they might not have the chance to decide about the design of the system (Gulliksen, Boivie & Goransson, 2006). Even if Nielsen's 10 usability heuristics (Nielsen, 1994) is helpful to evaluate the systems which work on web, usability tests about the design of the website with the real users provide important findings.

Usability of a system together with the aesthetics issues affects users' preferences (Lee & Koubek, 2010). Therefore, usability should be assessed carefully while considering the system design process (Kay, 2009). Another aspect of the usability concept could be the type of the users. Being a novice or expert user affects the evaluation of the system but in our context it is difficult to categorize the system user based on their system knowledge because there are potential thousands of users in the campus and most of them have been using the system more than a year.

The effectiveness and usefulness of such technologies depend on the people who would use the system. Therefore, the users play an important role for the system. Considering the users for such a system working online like EDMS, it could be said that providing feedback to the users is an important issue (Dutta, Jarvenpaa & Tomak, 2003). Error messages can be perceived as one way of giving feedback to the users. Therefore, these error messages are supposed to be correct and appropriate for the related situation. Moreover, the error messages should guide the user so that the user should be able to solve the problem. Furthermore, consistency of an electronic document management system is an important feature. The system should be consistent through all the pages it has (Nielsen, 1992). If the system is not consistent within itself, it would make the users confused and they would not feel comfortable with the system. The users should be informed about where they are in the system as it was stated in one of the Nielsen's Heuristics (Nielsen, 1994). Considering the points stated above, the thesis aims to show the general usability picture of EDMS through the usability tests which have three stages and draw conclusions using the analyzed data via eye tracker records and questionnaires.

1.3 Statement of the Problem

Different kinds of technologies have been developed and applied in recent years. Middle East Technical University (METU) has introduced a new technology recently, electronic document management system (EDMS), for the academic and administrative to reduce the costs and the risk associated with the paper records management. The attitude and the resistance of the end users toward new technologies have been the subject to many studies. New approaches need to be found for the users to make them contribute more to the system. Moreover, the benefits of EDMS would develop when the users know and learn how to use the new technology. Therefore, there is a need to conduct usability tests for EDMS used in METU so as to understand the usability problems of the system and make the necessary changes to the system based on the data collected by the tests and users' questionnaires.

1.4 Purpose of the Study

New technologies are being applied in universities in order to facilitate the daily routines. The main purpose of this study is to conduct a three-step usability tests using eye tracker and questionnaires for the EDMS and analyze the obtained data in order to offer recommendations and refine the problematic issues.

1.5 Significance of the Study

There have been several studies attempting to identify the usability problems of the websites and systems like EDMS for new technologies. However, one important reason for this study is that examining and testing the EDMS will help METU understand the problematic usability issues with the current system. Moreover, this study will help to revise these problematic points by the administrators and designers of the EDMS. Furthermore, the administrators of EDMS in METU will be able to find valuable information about what kinds of factors related with the design of the system or components prevent the users from using the system more effectively.

1.6 Assumptions

For this study, following assumptions are made:

1. The participants will answer correctly to all measures which will be used in the study.
2. Reliability and validity of all measures of the study are accurate to let accurate assumptions be measured.
3. The data which will be collected during the study will be accurately analyzed.

1.7 Definitions of the Terms

Electronic document management (EDM): Sprague (1995) defines EDM as ‗the application of technology to save paper, speed up communications, and increase the productivity of business processes.

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.

Information technology (IT): The development, installation, and implementation of computer systems and applications.

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

1.8 Summary

1.8.1 Organization of the study

Chapter 1 of the study includes the introduction, the background of the study, the statement of the problem, the purpose of the study, the significance of the study, the definitions of terms, the assumptions, limitations and organization of the study.
Chapter 2 contains the review of the literature related with the human computer interaction (HCI). The literature review in this chapter is explained considering the historical progress of HCI. Then, it continues with the definitions of fundamental terms in association with the HCI and usability. Moreover, this chapter includes the stages of usability evaluation, the information about the usability techniques that will be used for the usability tests and a review of similar studies applied to different kinds of systems.
Chapter 3 contains information about the research questions, design of the study, instruments of the study, procedures of the study, participants and sampling, and analysis of data. The results of the data obtained are presented in Chapter 4. Chapter 5 contains the discussion of the results and the conclusion parts together with the recommendations for further improvement.

CHAPTER 2

2 LITERATURE REVIEW

Baker, Greenberg, and Gutwin, (2002) define Human–Computer Interaction (HCI) as the study, planning, as well as design of the interaction existing between individuals and computers. In a number of cases, it is considered as the connection of behavioral science, computer science, design and other study fields (Diaper & Sanger, 2006). Dix, Finlay, Abowd and Beale (1993), on the other hand, refer to human computer interaction as a discipline that deals with designing, assessing and implementing interactive computer systems for the use of humans.

From the perspective of computer scientists, the emphasis is on the interaction between humans, as well as computational machines. Since human–computer interaction involves the study of the combination of human beings and machines, the knowledge that supports it is drawn on the side of humans, as well as machines. On the side of machines, some of the techniques that are involved include operating systems, computer graphics, programming languages and development environments (Dey, 2001). Additionally, on the side of the humans some of the areas that are relevant include linguistics, communication theory, cognitive psychology, industrial design and human factors like computer user satisfaction. In addition, design methods and engineering designs are also very relevant in this field of study. Karam and Schraefel (2005) state that HCI is multidisciplinary in nature. Therefore individuals with diverse backgrounds are able of contributing to its success. In some cases, HCI is called as computer-human interaction (CHI) or man–machine interaction (MMI).

2.1 Human Computer Interaction Concepts

2.1.1 User Interface

Shneiderman and Ben (2003) define user interface as the point where the interaction between the computer and the human takes place. It is aimed that there is effective control and operation of the computer by the end user and effective feedback from the computer is provided. This will significantly help the operator when operational decisions are being made. The design considerations that can be applied in the creation of user interfaces are linked to disciplines such as psychology and ergonomics.

Strijbos, Martens, Prins and Jochems, (2006) on the other hand, define the user interface as the system through which individuals (users) interact with computers. The user interface entails software, and hardware elements. Additionally, various systems use the user interfaces. They offer means of inputting that makes the use be able to influence the system and outputting that enables the system to illustrate the effects of manipulation by the user.

The aim of human-machine interaction engineering is to create a user interface that makes it efficient, enjoyable and easy in order to interact with the computer. Moreover, the desired results should be achieved with the help of this interaction. This generally implies that there is a need for the user to offer minimal input in order to attain the output that is desired. The machine should also minimize the possible outputs that are not desired (Wald, 2005).

Savidis and Stephanidis (2006) define human–computer interface as the communication point between the computer and the human user. Information flow between the computer and the human is referred to as interaction loop. There are several aspects of the loop of interaction. These include;

i. The *task environment*, which entails goals and conditions that are set on the user.
ii. *Machine environment*, which refers to the environment to which the computer is connected
iii. *Interface area:* areas that are not overlapping. It involves the processes of the computer and the human that does not pertain to their relation.
iv. *Input flow:* refers to the information flow that commences within the task environment, where the user completes tasks.
v. *Output:* refers to information flow originating within the machine environment.
vi. *Feedback:* refers to the loops within the interface. It includes evaluating, moderating, and confirming processes when they flow from the human via the interface up to the computer and back (Daniels, 1992; Raskin, 2000).

2.1.2 Usability

Faconti (1996) considers user interfaces as the prime element of computer user satisfaction. The user interface influences the effort needed by the user in order to provide input to the system. Besides, it influences the efforts needed for the interpretation of the output provided by the system. Additionally, it affects the efforts needed to comprehend how this is done.

Wild and Johnson (2004) define usability as the extent to which the user interface design takes the human psychology and physiology into consideration. Baker, Greenberg, and Gutwin (2002) define it as the degree to which the user interface makes it effective, efficient and satisfying to use the system's process.

Usability is majorly a feature of the user interface; however, it is also linked to the functionalities of the process and the product to design it. Additionally, usability describes how sound a given product may be applied for its projected purpose by its ultimate users with effectiveness, efficiency, as well as satisfaction (Baker, Greenberg & Gutwin, 2002).

Diaper and Sanger (2006) state that usability involves techniques with which usability can be measured such as need analysis. It also entails studying the principles behind the elegance or efficiency of the human computer interaction. In computer science, as well as human-computer interaction, usability studies the clarity and elegance with which the relation with a computer program is designed (Dix et al., 1993). Usability is different from the satisfaction of the user, as well as the experience of the user since usability also takes usefulness into consideration.

There are a number of principles of usability design. The three major ones include learnability which refers to the ease with which HCI can be learnt, flexibility which refers to the several ways through which the HCI can be interacted with and the third major principle

of human computer interaction is robustness which refers to the level of support for the handling of errors.

2.1.3 Learnability

Learnability entails the following concepts:

Predictability: the application ought to produce results, which are in line with the pervious commands, as well as states. Predictability entails being aware of the present state or every previous orders and states only. Predictability makes it very easy for users to know whether they are able to predicate the system's result from the history of the system (Karam & Schraefel, 2005).

Synthesizability: it entails exploring whether the user of the product is capable of constructing the right model for the system. Besides, it explores whether the system displays the right signs for the construction of proper models (Kligyte, 2001).

Familiarity: it entails exploring whether new users are capable of getting good clues in order to use the system properly. Because of the creative use of WIMPI, as well as metaphors, users who are native are always capable of using the applications without having to study (Lindgaard et al., 2006).

Generalizability: it entails exploring whether the user is capable of guessing the working of new commands.

Consistency on the other hand, entails exploring whether the operation performs alike for similar inputs.

2.1.4 Flexibility

Flexibility on the contrary entails the following:

Dialog initiative: This entails assessing whether the dialog boxes are capable of holding the users as prisoners. The old dialogue boxes, which were modal, barred the users from interrelating with other system's parts referred to as system pre-emptive. On the other hand, modern dialog boxes are generally user pre-emptive.

Multi-threading: it entails establishing whether the user is capable of performing simultaneous tasks. The tasks in question symbolize threads, whereas multi-threading allows the user to execute simultaneous tasks (Macleod, 1994).

Task migratability entails establishing whether the user is capable of performing the given task. It also entails establishing whether the user is capable of controlling the tasks that are automated by the computer.

Subsitutivity: it entails establishing whether a command's output can be embodied differently.

Customizability entails establishing whether the user is capable of modifying the interface to enhance efficiency. It also entails establishing whether the customizing features can easily be accessed.

2.1.5 Robustness

Robustness contains the following concepts:

Observability entails exploring whether the user is capable of evaluating the application's state.

Recoverability: involves exploring whether the occurrence of mistakes that are made by the user can be corrected. It also entails assessing whether mistakes made by the application failure can make the user recover the task.

Responsiveness on the other hand, entails exploring whether the system always responds at the right time.

Task conformance entails exploring whether the system carries out every tasks needed by the user. The application ought to cover every domain tasks (Cory & Hessler, 1994).

2.1.6 Usability Testing

A significant element of design processes that is user centered is the integration of usability testing when the system is being designed and evaluated or when the interface is being developed. Lipponen (2002) defines usability as the simplicity of information technology. Useful information technologies have to be helpful, functional, and can easily be learnt by humans.
Maxwell (2001) states that there are various need for usability testing. For instance, it demonstrates the weakness and strengths of the design process. Usability testing entails collection of data, which may be applied in order to redesign and enhance the interface. As Myers (1998) on the other side notes, it is vital since it helps in the evaluation of the design, as well as the specific features of the system. For instance, HCI workers might test whether users like a menu interface or command line.

Nemirovsky (2003) states that usability is very important in order to assess the functionality of a system for a specific group of users. Additionally, it is beneficial in validating the efficiency, as well as the effectiveness of the system, together with probable productivity gains. On the same note, usability testing provides the designers of the system with the outcome on user satisfaction. Likewise, errors, as well as mistakes can easily be identified within the systems design (Brewster, 2002; Eastwood, 1993).

Usability workers iteratively and systematically test every element of the system in order to enhance the design of the systems. Usability testing is a significant part of iterative design method. In a number of cases, systems are tested in order to check whether they meet the goals of the users and to communicate the results to the user concerning the actions they have taken (Nielsen, 1994). A number of the accidents that takes place within the industry occur because information technologies are poorly designed. It is aimed that usability testing

identifies the problems that the users of the system may encounter while using it. Besides, it ensures that users provide beneficial feedback to the designers of the system. The system's performance is evaluated with the help of the usability tests' data (Oulasvirta & Tamminen, 2004).

2.1.7 Summative and Formative Evaluation

Preece, Rogers, Benyon, Holland and Carey (1994) state that usability testing may take place at any time of the design process, whereas user testing ought to be conducted early enough and in a number of cases with the real users of the systems. There are numerous terms and approaches that relate to user testing. Formative evaluation is the first one. It takes place in order to help the designers of IT in refining and forming their designs. During the design processes, specific problems may be identified. The stage of formative evaluation may entail a session where users are allowed to verbalize their questions, thoughts, as well as choices to the assessor. In a number of cases, evaluation is highly likely to be conducted individually with straight observation. On the same note, audio or video recording of the interactions of the user may be conducted (Preece, et al, 1994).

Summative evaluation on the other hand, is applied after usability testing. The complete impact and effectiveness of the given system are reviewed. This might entail a test between a numbers of alternatives. Additionally, statistical differences between the features might be compared and summarized, and evaluation may be done remotely (Savidis & Stephanidis, 2006).

Alpha Testing is in a number of cases an internal testing. The prototype that is developed is assessed by the internal users. Beta Testing on the other hand, is often available for the external users, besides the model is assessed by the external users (Shneiderman, 1998).

2.1.8 Usability Testing Tasks

Strijbos et al., (2006) states that usability testing tasks entails the analysis of the interaction that exists between the user and the system, for instance, the interaction of the user and keystrokes movements of the eye, history , as well as user patterns.

Another usability-testing task is measuring the time taken by users for every given task, their rates of error, as well as their satisfaction levels with the system. Additionally, it entails recording the interactions of the user with the system through audio taping, paper forms, or through videotaping in order to assess the errors, problems, as well as interaction effectiveness of the user. Besides, the other task involves surveying the users using an interview, questionnaire concerning their levels of satisfaction with the given system (Wald, 2005; Medlock, Wixon, Terrano, Romero & Fulton, 2002).

Usability testing entails ethical concerns of showing respect to the user's physical and mental well-being, as well as privacy. The assessing workers have to get the volunteer participant' consents before commencing usability testing. Additionally, usability workers should never be biased during the process (Wild & Johnson, 2004).

2.2 Usability Evaluation Phases

Usability evaluation is a process entailing a number of activities detailed below. Usability evaluation requires some stages to be followed (Kushniruk & Patel, 2004). This section provides information about these stages.

2.2.1 Phase 1: Identification of Evaluation Objectives

This phase entails the definition of the purpose, goals, as well as the aims of the user evaluation. It is undoubtedly one of the highly significant steps within the whole process. It states why, what, and how an individual intends to apply the usability study in order to attain the goals. It is very significant, as it makes sure that the intended questions are addressed. Besides, it makes it very easy for additional insights to be gained (Bratthall & Jorgensen, 2002).

Usability evaluation is relevant at every stage of the user interface life cycle (like design, redesign or implementation). In this stage, user interface requirements are detailed. Besides, the design alternatives are evaluated. The specific usability problems are also detailed. The evaluator has to specify the usability evaluation goals at the beginning of the study clearly (Brewster, 2002).

2.2.2 Phase 2: Sample Selection and Study Design

Technicians ought to be selected in order to offer enough sample of the given group, which will be applying the manual. The background of the technicians ought to be described. It should have pertinent information like levels of experience, education job functions, as well as skills. The vital differences between technicians ought to be established before selecting the participants to be tested (Abowd et al., 1999).

Participants ought to be selected carefully in order to reflect the wide array of characteristics that were determined during the evaluation of the target audience. Additionally, the kinds of the characteristics of the technician needed will depend on the kind of task to be assessed (Dey, 2001; Crockett, 1993).

2.2.3 Phase 3: Selection of Representative Experimental Tasks and Context

After the completion of the previously stages, there is need for the evaluator to design experiments aimed at gathering usability data. Specifically, there is need for the evaluator to choose participant's number (users and evaluators), the procedure for evaluation, as well as the system and environment setup. The kinds of experiments are dependent on the method of evaluation. Experiments might entail the accomplishment of tasks in a controlled way, providing response to specified questions, as well as comparing optional designs. In this phase, the evaluator should carry out pilot runs (Dix, Finlay, Abowd & Beale, 2003). The application of experiments in order to establish usability is beneficial. Experimenters should study users from the target audience whereas the users should conduct representative tasks through the use of prototype or a product.

Every objective of usability test ought to be elucidated prior to the actual testing. When there are very clear objectives, the developers of the product will be able to select the test

methods, test participants, as well as user tasks, which are highly suited to look into the questions or objectives of interest.

2.2.4 Phase 4: Selection of Background Questionnaires

The questionnaires should be designed in order to detail some if the desired outcomes of the evaluation. It contains the various questions that will be administered to the respondents in order to obtain information that concerns the evaluation. It is also very significant, as it makes sure that the intended questions are addressed. Besides, it makes it very easy for additional insights to be gained (Goodman, Brewster & Gray, 2004).

Additionally, the background questionnaires are designed in order to evaluate prior knowledge of the participants concerning the product prior to the test, the backgrounds, as well as their initial impressions with the given product.
Background questionnaire offers historical information concerning the participants. It helps in making individuals to comprehend the behavior as well as the performance of the participants during the test. It is made up of questions, which disclose the attitudes, experience and preferences of the participants in the areas which may influence their performance. For instance, when an individual is testing a DBMS, it will be beneficial to know whether the pa DBMS has been used by the participants before, and, if they have used it, which DBMS and the length of time they have used it. Whereas individuals might not know whether that experience will influence their performance positively or negatively, they almost surely know that it is capable of influencing their performance in a different way than an individual without the experience of a DBMS.
The background questionnaire is usually filled out before the test. In some cases, majorly when it is very long, it may be sent to participants via e-mail before the usability test is conducted.

2.2.5 Phase 5: Selection of Evaluation Environment

The selection of the evaluation environment is also a very crucial phase of the evaluation process. A given interface might be planned for a bigger user community; however, it is significant to determine user characteristics that are highly applicable for the evaluation and for the user interface aspects (Kjeldskov, Skov, Als & Hoegh, 2004). Together with the user, as well as task analysis, there is the need for third analysis like proper comprehension of the environments of the user such as the social, physical, cultural and technological environments.

The evaluation environment ought to represent the bigger user community. A given interface might be proposed for the bigger user community; however, it is significant to establish the user characteristics that are highly applicable for the given study, as well as for the user interface aspects in specific. When users are entailed in the study, they should represent the bigger user community (Kjeldskov et al., 2005).

2.2.6 Phase 6: Data Collection, Video Recording and Recording of Thought Process

Data collection is done using various methods like video recording, as well as recording of data during the thought process. The collected data can then be evaluated and analyzed at later stages (Kim, Kim, Lee, Chae & Choi, 2002).

Equipment like audio and video recorders, cameras, and video feeds may be applied in monitoring the comments and actions of participants when testing the usability. Cameras may be used in order to record participants' actions.

Equipment for videotaping without camera may be applied in monitoring the tasks that are performed on computer.

Test monitors may see all interactions of the user; they can observe onscreen events.
Through cameraless videotaping, onscreen information can be captured. However, it leaves the participants of the test out of the picture. This method is advantageous since participants of the test are usually less self-conscious or more comfortable when no camera is aimed at them. Besides, in comparison to camera recording, camera less videotaping is less expensive since it does not need cameras as well as camera operators.

Audio recorders assist the researcher during interviews in recording the comments of test participants during the usability test. Through audio recorders, test monitors are enabled to pay attention on several other observational tasks rather than noting down comments.

2.2.7 Phase7: Analysis of Process Data

The major aim of the analysis of usability data is to ensure that results are summarized. This summarization might involve statistical tools founded on the usability evaluation goals. It might also involve the creation of a list detailing the exact usability problems. Actual interpretation of the study's results forms a major element of the evaluation. It involves the use of the data in order to come up with conclusions as guided by the goals of evaluation. For instance, it might imply making the conclusion that a design is superior to another. It can also state whether usability needs are met (Kim et al., 2002).

Besides, it entails the identification of participation errors as well as the difficulties that the participants faced with. It also helps to analyze the origin of errors and difficulties. The origin could be related with the technical sources, procedural sources, grammatical sources and graphical sources. The identification of the corrective action to be taken on the difficulties, as well as the errors. Besides, the phase entails prioritization of problems through criticality. They can be prioritized as severe, unusable, moderate irritant among others. In addition, the phase involves the analysis of the differences that exist between the levels of experiences of the participants (Kim et al., 2002).

2.2.8 Phase 8: Interpretation of Findings

Communication and interpretation of findings fall among the last stages of the evaluation process. They also form part of the most important stages of the evaluation process. It entails communicating the results to the concerned stakeholders and interpreting the findings to them. The results may be presented by the evaluator through the use graphs, as well as providing the severity ratings for actions to be made (Kim et al., 2002).

Data analysis entails transforming raw quantitative and qualitative data into summative results which can be applied in to making recommendations that may be used to enhance the product's usability. Interpretation of findings makes it very easy for the stakeholders to understand the results of the entire process. Interpretation of data is done in order to

comprehend the findings, and to know the problems that the tested product may have. Researchers are able to interpret data by reporting the things that they established in the study.

2.2.9 Phase 9: Iterative Input into Design

This is the last phase of the process. It enables designers to note usability issues which may be experienced before the user interface is put into use. It is very difficult to design a faultless user interfaces in one single attempt. Therefore, this process is vital.

1. The archetypal iterative design phases in user interfaces include:
2. Completing the original interface design
3. Presenting the design to numerous test users
4. Noting the problems experienced by the test user
5. Refining the interface in order to account fix the noted problems
6. Repeating steps until all the problems are solved.

This phase is highly beneficial since it makes sure that the produced product is the best. When effectively conducted, it can make significantly save on costs. Several other benefits that are associated with this phase are as follows:

1. Misunderstandings are revealed in the early stages of the lifecycle when they can easily be responded to
2. It provides room for user feedback thereby making the users to bring out the real requirements of the system.
3. Continuous, iterative testing ensures that there is objective assessment of the status of the project.
4. Discrepancies among designs, requirements as well as implementations will be detected early.

2.3 Usability Evaluation Methods

2.3.1 Interviews

Interviews entail finding about the experiences, as well as the expectations of users through conducting of interviews. Through this method, questions are formulated, and they are asked to obtain the desired information. During the interviews, questions are read as the user responds verbally. The responses are then recorded by the interviewer. Two types of interviews may be used. These include structured interviewing and unstructured interviewing (Card, Moran, & Newell, 1983).

With unstructured interviewing, methods are applied during the initial phases of usability evaluation. At this stage, the investigator is aimed at gathering much information concerning the experience of the user. With unstructured interviewing, interviewers do not have fixed agendas. On the same note, the interviewer does not look at any specific element of the system. The major aim is to get information on the procedures that are adopted by the users, as well as information concerning what they expect from the system (Gould & Lewis, 1985). On the other hand, structured interviews have predetermined and specific agenda. Additionally, they have given set of questions aimed at guiding and directing the interview.

Structured interviews are more interrogations than the unstructured interviewing that is very close to a conversation (Kim et al., 2002).

There are advantages and disadvantages of using interviews. For instance, it is capable of enhancing the relations with the customers. Besides, it is very applicable when detailed information is being explored. On the same note, it entails very few participants. On the contrary, interviews cannot be carried out remotely. In addition, the usability issue of efficiency is not addressed (Tognazzini, 1992).

2.3.2 Task Analysis

Task analysis refers to learning more about the goals of users, as well as their manners of working. Through task analysis, individuals are able to establish the tasks that they are supposed to do to accomplish given goals. Additionally, it entails the steps that users have to take in order to accomplish the tasks.

Task analysis assesses the cognitive processes or the actions of users that are aimed at accomplishing a given task. A thorough task analysis is conducted in order to comprehend the present system and the flow of information within it. The flow of information is significant in the maintaining the existing system and it has to be integrated or substituted with new systems. With task analysis, it is very possible to allocate and design tasks properly in the new system. In addition, the function that is to be put within the system, as well as within the user interface may then be specified accurately. Tasks analysis is beneficial since it offers knowledge of the various tasks the user intends to perform. Therefore, through it, functions, as well as the features of the systems can be established.

2.3.3 Think Aloud Method

Through this method, the participants in through tests convey their opinion concerning the given application as they execute the set tasks. It also has its advantages, as well as its disadvantages. For instance, it is less expensive, and besides, the results are very near to what others experience. On the other hand, the surrounding may not be ordinary to the user (Lund, 1997).

The Think aloud protocol is a technique of collecting data, which is applied in psychology, as well as usability studies. It entails obtaining a user to express their thinking processes while performing a given task. In a number of cases, instructors are always present in order to encourage the user to be extra vocal in work. The technique is vital in indicating problems. Besides, it is comparatively simple to establish. Additionally, it is capable of providing insight into the attitude of the user (Medlock et al., 2002).

2.3.4 Eye Tracking Methodology

Eye tracking methodology is a tool whereby the eye movements of individuals are measured for the researcher to know where an individual is looking at a given time. Through it, the researcher is also capable of knowing the progression in which the eyes shift from a location to the other. When the eyes of individuals are tracked by HCI researchers, they will be able to comprehend visual, as well as information processing that are display-based. Besides,

through eye tracking, HCI researchers are able to understand the factors that are capable of influencing system interfaces' usability (Kuniavsky, 2003). Moreover, eye-movement recordings are capable of providing an idea source of data used in interface evaluation. The data is capable of informing the design of enhanced interfaces. Additionally, eye movements may be captured besides being applied as control signals to allow individuals to interact directly with interfaces without using keyboard input or mouse, which may be a big advantage for some groups of users like disabled individuals.

Several diverse techniques have been applied in tracking eye movements. Electro-oculographic techniques, for instance, depended on electrodes placed on the skin surrounding the eye, which was able to note differences in electric potential in order to notice eye movements. Some other historical techniques needed wearing of huge contact lenses, which enveloped the sclera and cornea with a metal coil entrenched around the lens' edges.

These techniques proved to be quite invasive, and several current eye tracking systems make use of eye's video images to establish where an individual is looking. A number of distinctive characteristics of the eye may be applied in order to deduce point-of-regard such as corneal reflections, the boundary of iris-sclera and the apparent pupil shape.

A number of commercial eye-tracking systems that are available nowadays measure the point-of-regard through the "pupil-centre/ corneal-reflection" technique. These types of trackers generally entail a uniform desktop computer having an infrared camera placed beneath or near display monitor having software for processing images to identify and locate the characteristics of the eye that is used for tracking. In action, infrared light coming from the LED that is entrenched within the infrared camera is initially guided into the eye in order to generate strong reflections in the features of the target eye in order to make them very easy to track. The light gets into the retina and a big percentage of it is echoed back, thereby making the pupil to appear like a bright and well defined disc. Corneal reflection is also produced by the infrared light that appears as a diminutive, yet sharp, glint.

2.4 Usability Studies about Online Systems in Turkey

Usability can be defined as the simplicity of use, as well as the learnability of the objects that are made by man. The objects are wide and include websites, software application, tools, book, process, machine, or any other thing with which human interacts. Usability studies are primarily carried out by usability analyst or as secondarily by the designers marketing personnel, and several others. It is majorly applied in communication, consumer electronics and knowledge transfer items (McKeown, 2007).

Usability has become popular and highly recognized in the recent decades. This situation has brought numerous benefits. Through researching and understanding the interaction between the user and the product, usability experts are capable of offering insights that are unachievable by conventional market research. For instance, after observing, as well as interviewing the users, usability experts are capable of identifying needed functionalities and design flaws that were not expected.

Several studies have been conducted in Turkey as well as the world. Mentes and Turan (2012) studied on usability of university websites. This is an empirical study on Namık Kemal University and it emphasizes the importance of fulfilling web site users' requirements

and anticipations. The purpose of the study is to recover and discover the usability of the web site of Namık Kemal University. Study employs WAMMAI which is an assessment tool for web sites and focuses on five elements attractiveness, controllability, efficiency, helpfulness and learnability. 339 questionnaires were responded by students, faculty members and the administrative staff. The research reveals that website usability is affirmatively related with its attractiveness, helpfulness, efficiency and learnability.

Another study on usability testing was conducted by Sengel and Oncu (2010). The study is about examining the website of the Uludag University and it aims to carry out a future work on usability of the website to enhance the site with the help of HCI guidelines. Data of this study were collected from 445 students which were enrolled from several faculties of Uludag University. Students answered a questionnaire which had 22 units and five-point likert type questions. Results showed that gender was an important aspect on sensation of web usability. Female students were more captivated with website then male students. The study revealed that information on the website should be updated frequently. Moreover, more than half of the students compared their websites with other universities' websites and they did not find their site pleaser or more practical.

Another usability study titled "An eye-tracking study of how color coding affects multimedia learning" questions the impacts of color schemas on usability and learning (Ozcelik, Karakus, Kursun & Cagiltay, 2009). According to the article, eye tracking methods give unique chances to understand the effects of color coding on learning process. The authors state that color-coded materials are more successful than conventional ones. They justify their arguments with the results of experiments including 52 students which show that students easily map, organize and understand the documents with the color-coded format. Participants easily found the related items in the documents and spent less time to achieve objectives. The study shows the importance of usability studies in education and gives clues about the possible improvements on education with the help of usability studies.

A recent usability study of a system widely used in Turkey which named as "e-okul" is the main topic of the article titled "Evaluation of Turkish "E-Okul" System in Terms of Usability" (Tufekci, 2013). 10 high school teachers, 95 students and their parents participated in the study. Nearly 15 million students use the system named "e-okul". Participants filled an attitude questionnaire. The data gathered from this questionnaire was examined based on effectiveness, efficiency and satisfaction criteria. As a result of the study, some design and navigation problems were identified especially related with the pages having access to student information.

A recent usability titled "A Case Study for the Usability of Public Institutions: Turkish State Meteorological Service web site" investigates one of the e-government web sites (Tekin & Tufekci, 2013). The methods used to evaluate the usability are survey, observation and think-aloud. The study emphasizes importance of the usability studies on a critical issue, government services, and tries to explain how to make government services better. It is also implied in the study that such usability studies might increase the quality and penetration of the given e-government services.

2.5 Electronic Document Management System

Barry (1993) defines document management system as a computer system (several computer programs) applied in order to store and to track electronic documents. It is also capable of

doing history tracking. In a number of cases, document management systems offer versioning, storage, metadata, indexing retrieval, as well as security capabilities.

Electronic Document Management Systems (EDMS) refer to the software collections that are capable of digitizing documents. A number of the systems are capable of storing documents images though software solutions entailing optical character recognition that are capable of translating document scans to texts that can be edited. EDMS is also applied as a database of a kind that allows for sorting and searching of the numerous documents that are collected (Bearman, 1993; Du Rea & Pemberton, 1992).

Electronic document management is also defined as the systems for inputting, tracking, routing, and processing documents. The documents may have been electronically created through online forms or e-mail. Document management system is division of workflow systems, although they might also have different emphasis lacking the groupware taste of workflow (Bearman, 1993; Bearman, 1994).

Document management systems may be applied in the maintenance of huge archives like legal documents, libraries, credit card receipts and cancelled checks. It may be used as a system for processing forms (Bearman, 1993; Bearman, 1994).

EDMS organizes and stores several types of documents. It is a highly particular type of document management system, and besides, it is a highly general kind of storage system helping users to sort and to store digital documents or paper. EDMS refers more directly to a software system handling digital documents, instead of paper documents. However, in a number of instances, the system is also capable of handling digitally scanned forms of the original paper documents (Bearman, 1993). A number of the systems also have features that are capable of ensuring affective and efficient retrieval of documents (Bearman, 1994; Cox, 1992; Emmerson, 1993).

Electronic document management offers a means of centrally storing huge amounts of digital documents. A number of EDMS also entail features for efficient and effective retrieval of documents (Bearman, 1993; Bearman, 1994; Cox, 1994).

2.5.1 The Usage of Electronic Document Management Systems

There are numerous obvious applications of EDMS. However, the major use entails digitizing and storing paper document collections. Generally, this is a highly efficient way of information storage, and can significantly diminish the quantity of labor required in order to conduct very simple tasks. Additionally, it averts paper documents loss and makes sure that the entire historical document may be altered or modified without making copies. Besides, EDMS simplifies the document transmission. In addition, the EDMS enhances the security of the computer system (Bellyuk, 1993; Bruns, 1992; Campbell, 1994; Cory & Hessler, 1994; Davidson & Moscato, 1994).

A number of experts opine that electronic document management system is highly very similar to content management system (CMS). However, one big difference, between the two is that a number of CMS systems entail dealing with a wide array of web contents from a single site, whereas document management systems are primarily applied in archiving

(Bikson, 1994; Bikson & Frinking, 1994; Bikson & Law, 1993; Branger & Duisterhout, 1991; Brown, 1993).

For the provision of a good classification for digital documents, numerous EDMS depend on a highly detailed procedure for the storage of documents, including some elements referred to as metadata. Metadata around the document offers very easy access to major details capable of helping the individuals searching the archives to obtain the things that they require, whether through topic, chronology, keywords or through other strategies. EDMS is useful for businesses or organizations because of its capacity to store original documents (Brown, 1993).

EDMS can be used in human resources. Groenewald (2004) investigated the implementation of an EDMS in human resources. This study showed that if an organization implies EDMS without a groundwork, it would not secure the corporate memory. Another application field of EDMS could be public administration (Tiitinen, Lyytikainen, Paivarinta & Salminen, 2000). In their study which is a part of the research related to SGML standardization in the Finnish Parliament and ministries, there are two cases that studied EDMS. In the first case, they focused on the creation of state budget of Finland and second case concerns participation of Finnish in EU legislative work. Both of the cases address different aspects of electronic document management such as documents, information technology, and work with documents. After user need analysis, an efficient structured documents and electronic document management systems are implemented to solve many problems raised.

E-government services can take advantage of EDMS (Hung, Tang, Chang & Ke, 2009). This study has examined the factors influencing the acceptance of EDMS in e-Government project in Taiwan. Data are collected from 186 users of e-government's EDMS in Taiwan. Findings of this study indicated that "perceived usefulness, perceived ease of use, training, compatibility, external influence, interpersonal influence, self-efficacy, and facilitating conditions" are really important for users' intention to use EDMS.

CHAPTER 3

3 METHODOLOGY

Different methods have been applied in order to examine the usability of METU EDMS. A test system environment was formed in order not to affect the real records and the usability tests were conducted by using this environment. A pretest questionnaire was given to the participants in order to record and analyze demographic information. Task analysis was performed so as to decide the basic tasks and to illustrate how these tasks are accomplished step by step. Thereafter, the usability tests were performed with two groups of real system users at three steps. In the first step, the first group took usability test and this test was repeated after one year for the second step. Then, another usability study was conducted with the second group for the third step. An eye tracker device was used during the usability studies to record and monitor the eye movement and the gaze direction of the participants. The participants were chosen among METU's administrative personnel, workers and managers who had been working in the institution at least for a year. Test sessions conducted with the users were recorded to measure how much time each task took and to observe whether they focused on the relevant part of the screens or objects. Moreover, think aloud method was applied to encourage the participants to express their feelings and opinions during the usability studies. Participants' opinion, explanations and advices were acquired with the help of this method. Finally, a post-test questionnaire was conducted with the participants so as to evaluate the system, METU EDMS. The following sections of this chapter provide detailed information about the research questions, design of the study, materials, instruments and software used, EDMS, questionnaires and the procedure of the study.

3.1 Research Questions

This study mainly will attempt to answer the following questions:

RQ1: What are the most significant tasks performed by managers and personnel on METU EDMS?

RQ2: Which usability issues are present on the current METU EDMS interface with respect to the significant tasks?

- **RQ2.1:** What are the task success rates of the users for each task?
- **RQ2.2:** Which tasks are the most difficult for the users to accomplish? What kinds of errors/problems do they experience when they were not able to accomplish a task?

RQ2.3: Is there a positive change in terms of using the system effectively for the users of first and second stages who took the system test one year ago?

RQ2.4: How long does it take for the users to complete each task?

RQ2.5: How many mouse clicks do the users execute to finalize each task?

RQ2.6: How long do the users stare at the task-related and non-task-related areas?

RQ2.7: How do the users evaluate the perceived usefulness of METU EDMS?

RQ2.8: What kind of interpretations do the users make about the interface of METU EDMS?

RQ3: How can METU EDMS interface be developed in the light of usability issues?

3.2 Design of the Study

This study contains certain phases. The first phase is the selection of the Electronic Document Management System (EDMS) for usability testing. One of the basic reasons why EDMS is chosen for this study is that it will be a mandatory system for the affairs of state in the near future and there is not too many studies about the usability of EDMS. After this phase, it was important to determine the tasks that would be given to the users. Two different task lists were prepared based on the user's administrative duty with the help of task analysis. Detailed information about the tasks is stated in the procedure section. Selection of the users who would test the system was another phase. Users were chosen based on their administrative duties in order to fit the predefined tasks. Then, usability tests were conducted with the chosen users in METU HCI Lab. The procedure followed for the usability tests is that the EDMS was tested with ten users firstly. After that, the results were analyzed and applied to the system. Then, the system was tested with the same ten users again so as to see the effect of the changes made and compare the results. Moreover, one more usability test was conducted with another group of ten users who had not participated in the first two usability tests. The aim for this was to see and compare the results with the first group. All of these phases are explained in the following sections.

3.3 Materials, Instruments and Software

EDMS was chosen for this study because it is commonly used in METU and this system will be mandatory in the near future. Users, chosen based on the characteristic, were invited to the METU HCI lab for the usability study. A pretest questionnaire was given to the users in order to identify the demographic information (see Appendix A). Then, the usability study was conducted with the users. After the usability study, users took a post-test questionnaire and filled it in. The questionnaire mainly included likert type and open-ended questions (see Appendix B). Now, detailed information about the materials will be provided in this section.

3.3.1 Eye Tracking System

Eye tracker is a device that collects the gaze direction or eye movements and it allows researchers to track and monitor this data. Hence, researchers are able to analyze where the

subjects mainly focus on the screen with the help of this data. Moreover, the data acquired with this device provides some statistical information such as mouse click count, click proportion of the objects and heat maps. The model of the eye tracker device used for this study is TOBII T120. The picture of this device can be seen below in Figure 3.1. The data rate of this instrument is 120 Hz. In other words, this device gathers the eye-gaze data of the test subjects with a rate of 120 Hz.

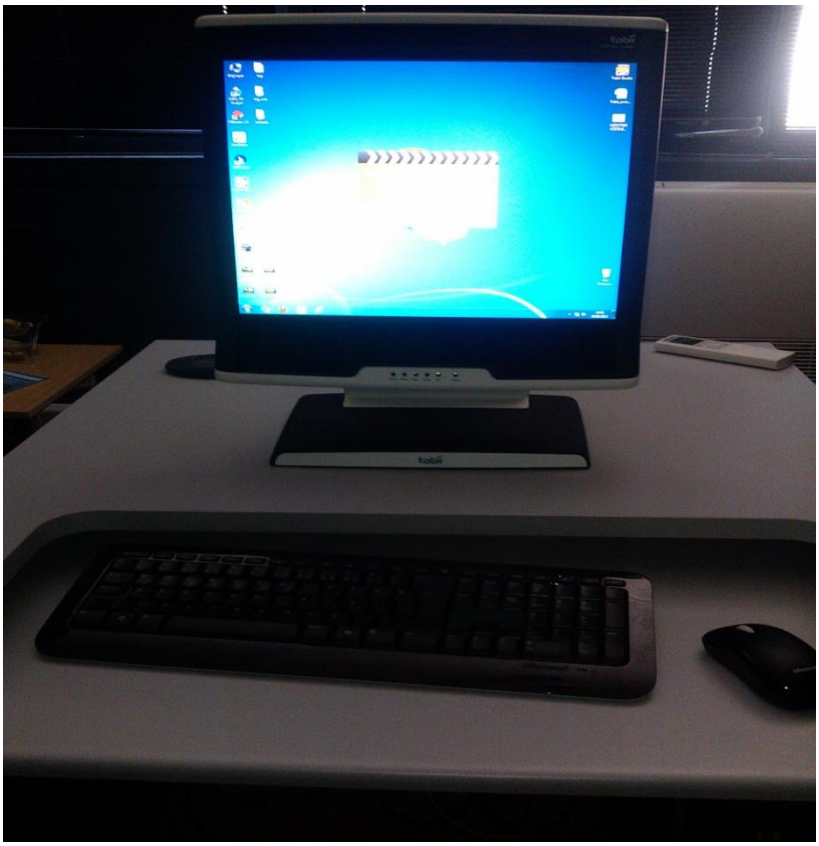

Figure 3.1: TOBII T120 Device in METU HCI Lab

3.3.2 Tobii Studio Software

The software that was used to analyze the data gathered from the eye tracker is Tobii Studio. The version of the software is 3.0.3. The software provides many benefits to researchers. One of these benefits is that the software allows researchers for the analysis of the raw data gathered during the usability tests. Moreover, the software enables evaluators to examine the raw data with different options. One of these options is the replay property. Researchers can watch every second of the recorded session again with the help of Tobii Studio. Another option is the event logs. Researchers can use the event logs provided by the software to calculate the mouse click count, starting and ending point of a task and to see the gaze path video. Evaluators can listen the environment's and participant's sound with the help of replay property and analyze the participant's behavior with think aloud method. Another benefit of this software is the visualization feature. This feature enables researchers to create gaze plot, heat map or clusters. Gaze plot reflects the order and the location of fixations for the related record. Heat map indicates the number of fixations made by the participant in a

definite area of the screen with the help of different colors. The last visualization type is cluster and cluster shows the areas of raw gaze data spots that are highly concentrated by the participant. These three visualization types are used to reflect the raw gaze data of the participants and show the areas of interest. Another beneficial specialty of the software is the statistics. The software provides some statistical information to the researchers such as time to first fixation, fixation count and fixation time. Furthermore, the software allows evaluators to export the raw gaze data to a Microsoft Excel file. In this way, evaluators can examine the data in a more detailed way.

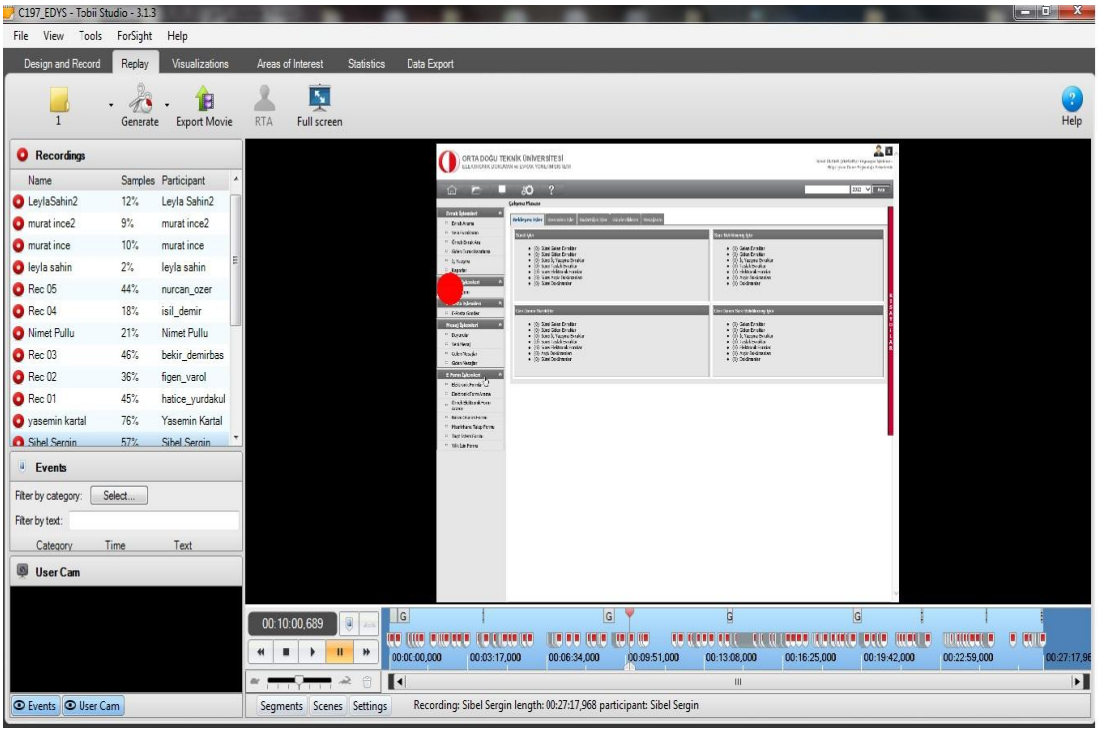

Figure 3.2: TOBII Studio Software (Version 3.1.3) Interface

3.3.3 Electronic Document Management System (EDMS)

New technologies have arisen together with the advancement of science. One of these technologies is EDMS which organizes and manages electronic documents. Considering the increasing amount of document needed for the institutions, it could be said that there was a need for a system to manage this complexity. Moreover, the time spent to distribute and share the documents in short time periods is important in our global world. Furthermore, knowledge and sharing this knowledge within an institution have vital importance. It has to be a private asset and it should not be kept in office desks or on personal computers for the sake of institutions. Therefore, these kinds of issues lead us to take advantage of the internet by transferring the documents to an electronic form (Volarevic, Strasberger & Pacelat, 2000).

Other aims that drive institutions to use electronic format for the documents are to save time and secure the data. Even if the reliability of such systems depends on the developer, they provide more flexibility than paper work. However, the structure of the network for the

system, the amount of the documents that need to be collected and the maintenance of those documents and the system are not easy (Zhao, et al., 2010).

There are various technologies for document generation and management. However, as Gilani, Ahmed and Abbas (2009) offered that there should be a single software unit running to ease the necessary processes for creating and sharing the document. This kind of software would facilitate the regulation of the documents and it would make the documents to manage easily for the institution.

The EDMS in METU has been used more than three years. The administrative staff has been using the system since the beginning of the project. However, the academic staff has started to use the system almost a year ago. The system enables the users manage different types of operations such as:

- filling a form and tracking it
- searching and previewing document/form
- assigning deputation and cancelling it
- learning the result and the stage of a document
- dispatching a document to the next level
- editing and cancelling document
- archiving documents
- issuing reports
- sending message
- scanning document and transmitting it into the system
- sharing documents with other users
- creating private folders
- checking the documents previously created by the related department
- approving and signing documents

In addition to these main functions, EDMS is also capable of providing special reports to the managers and heads of the departments based on their needs. Moreover, the performance of the workers can be evaluated with the help of the EDMS since the system shows when a document is sent to the related worker and when the worker sends the document to other people or departments.

3.3.4 Questionnaires

Two questionnaires were conducted with the users: pretest questionnaire and post-test questionnaire. Pretest questionnaire was given to the users before the usability test. This questionnaire mainly includes information concerning demographics (age, gender, education level) and computer usage. This questionnaire can be seen in Appendix A. After the usability study, subjects took post-test questionnaire. This questionnaire is more detailed than the pretest questionnaire. Post-test questionnaire was prepared with the help of a questionnaire tool called QUIS (Questionnaire for User Interaction Satisfaction). This questionnaire tool was developed by a team of researchers in the Human Computer Interaction Lab (HCIL) at the University of Maryland. The license of this tool was bought for academic purposes. Post-test questionnaire is consisted of five sections. These sections are system experience, common user reactions, the appearance of EDMS's pages, terms used in EDMS pages and learning the system usage. 9 point likert scale was used in this questionnaire except the

system experience section. Moreover, there is one open-ended question after the third, fourth and fifth sections of the questionnaire. This questionnaire can be seen in Appendix B.

3.4 Procedure

3.4.1 Designing Test Environment

The system tested is Electronic Document Management System (EDMS). University personnel can reach the system on web with the following address: **https://edys.metu.edu.tr**. Users can only reach the test system inside the campus. For this usability test, a test environment which was the same with the real system had been developed in order not to affect the real records. Participants' behaviors were observed and their eye movements were recorded in the HCI lab with the help of an eye tracker device.

Before applying the test with the participants, a pilot study was conducted in order to measure how much time it would take to complete the test and see the possible difficulties that may be faced during the test. The trial system test took about half an hour and filling the questionnaires took around 15 minutes.

3.4.2 Task Analysis

Before the usability tests, a brief information was given to the participants. Participants were told that they could leave the experiment any moment they want because of a health or personal problem. Besides, they were informed that the tests would be performed in a test environment which is the same of the real system and they should not be afraid of making mistakes since it would not affect the real system records. Then, the participants sit in front of the computer having eye tracker. After that, eye calibration of the participants was adjusted with the help of the Tobii Studio software. Before starting the experiment, participants need to know some button combinations in order to start and end the tasks. They were told that they should press space bar so as to start the related task after reading the text on the screen. Moreover, they should press F10 button after completing the task or when they think that they completed the task. A task list was also provided in case the participants forget the task that they try to accomplish. Task analysis method was implemented to identify the most frequently used tasks and see the flow while accomplishing these tasks. This method is beneficial so as to understand how the related task is accomplished and see in how many steps the related task can be accomplished. As the result of the system tests conducted by the administrators of METU EDMS, 5 tasks for managers and 7 tasks for personnel / workers were identified for the task analysis by the administrators of METU EDMS. Moreover, the ideal cases for the completion time and mouse clicks were revealed with the help of task analysis. The ideal cases are important since the divergence from the ideal cases can be visualized via graphs. The tasks chosen for the task analysis are clarified in the next two sections for managers and personnel respectively together with the scenario presented to the participants during the test sessions.

3.4.2.1 Tasks for Managers

3.4.2.1.1 Task 1: You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works on behalf of you. For this reason, assign delegation the worker that will perform your works by filling the related date and time information. After assigning your delegation, assume that your annual leave has ended and cancel your delegation.

There are 2 ways to achieve this task and these are explained below.

3.4.2.1.1.1 Using System Settings Menu

When participants login METU EDMS with their username and password, they are directed to the home page. The home page that they see can be seen below in Figure 3.3. System settings menu, the fourth icon located on the top left of the screen, should be chosen. After entering the system settings menu, the participants would see four menus on the left side of the screen and these menus are help, archieve management, records management and customization. My positions submenu under the customization menu should be clicked in order to see delegation option. Assigning delegation option appears on the right side of the screen in this submenu. When assign delegation icon is clicked, users face with a screen that they need to fill some fields so as to assign delegation. These fields are user to be delegation, delegation type, start date, end date and description. User to be delegation and delegation type are obligatory fields and delegation cannot be assigned without filling these two fields. The other three fields are optional and delegation can be assigned even if they are not filled. After filling the necessary fields, participants should click save button to assign delegation. When a delegation assigned, the users cannot use the system unless they cancel the delegation. Therefore, when they are back from the annual leave, they should cancel the delegation. Cancelling delegation can be achieved from the same page of assigning delegation. When the users click the assign delegation icon or when they login the system after assigning delegation, they would see a cancel icon, red cross sign. They are also cancel the delegation by clicking this red cross sign. The flow chart of this method is presented in Appendix C.

Figure 3.3: Home Page of METU EDMS

3.4.2.1.1.2 Clicking on My Positions Information

Another way of assigning delegation is clicking on my positions information located at the top right of the home page screen. When users login to the system, they see their name, title and department information at the top right-hand corner. This text area is called as my positions and it is clickable. When the participants click on the text, they are directed to my positions submenu under the customization menu. Therefore, this way is a shortcut of assigning delegation. Assigning delegation option appears on the right side of the screen in this screen. The rest process of this method is the same with the first one. The flow of this method can be seen in a detailed way in Appendix C.

3.4.2.1.2 Task 2: You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information. After previewing the document, learn where and on which phase this document is.

METU EDMS provides different search options to the users. One of them is electronic form search. Users should click desktop menu after logging in the system. Then, they would see menus on the left side of the screen. They should click E-Form Processes menu in order to see the Electronic Form Search submenu. After clicking the submenu, they are required to select the type of electronic form that they will search. They should click Bakım Onarım Formu (Maintenance and Repair Form) for this task. When they choose the related form, they would see the search criteria such as reference number, subject, ID, registered by (unit) and registered by (user). The system offers different criteria to search for the desirable form. Participants are required to fill the subject criterion as "Eğitim Deneme Formu" (Education Test Form) and click the search button. The system would provide the matching form(s) after

this process. Participants should preview the document by clicking processes box and selecting the preview option. They need to be sure that they find the required form and this is achieved with preview option. Then, they should close the preview screen and click the processes box again so as to select dispatch history. Dispatch history gives information about where and on which phase this document is. The flow chart of this task can be found in Appendix C.

3.4.2.1.3 Task 3: Preview the maintenance and repair form whose subject is "Eğitim Deneme" (Education Test) sent by the related personnel and make the essential changes by using Edit Text option. Send the document to the related personnel after you make the desired changes.

The user should click on the pending tasks at the home page after logging in the system. Then, the system would direct the user to the desktop menu where all the pending tasks can be seen. There are five different task tabs at the desktop menu. These are pending tasks, my tasks, my started tasks, my sent and my messages. The user should click on the related tab and find the maintenance and repair form whose subject is "Eğitim Deneme" (Education Test). The participant should click on the processes box and select preview option in order to control the document. When the user previews the document, the system provides different options for the document. These options are edit text, document information, dispatch, dispatch history, dispatch back and note / comment. The user should click edit text button in order to make essential changes. The participant is required to refine the document and make the related changes. After that, save button should be clicked to send the document back to the related personnel. The flow of this task is visualized in Appendix C.

3.4.2.1.4 Task 4: Review the maintenance and repair form, which was filled and sent to you, related with central heating problem of a department and process it to the next phase (Sending it to the next department / manager or archiving).

The user should click on the pending tasks at the home page after logging in the system. Then, the user would be directed to the desktop menu where all the pending tasks can be seen. The user needs to click processes box and select preview option in order to check the document. If there is more than one document, the user should preview the documents to find the related one. After finding the document, the user should check whether the document was filled correctly. The user should click dispatch button after controlling the document so as to send it to the next department / manager or archieve the document. Thereafter, the user would see a list of departments and people that the document can be sent to. Moreover, the user would see archieve button on the same screen, too. If the user decides to send the document to a department or a person, the related department or person should be selected. After selecting to where the document would be sent, the user should click dispatch button. If the user wants to archieve the document, archieve button should be clicked. After that, file code should be chosen and added at this page in order to specify under which file the document will be archieved. Finally, the user should click archieve button. The flow chart of this task can be seen in Appendix C.

3.4.2.1.5 Task 5: You want to make some changes on a repair and maintenance form's text. However, you do not know how to make these changes and

direct it to the related personnel. Find the help menus inside the system so as to get help and get information about the related situation from these menus.

There are 2 ways to reach help menus in the system. These ways are clarified below.

3.4.2.1.5.1 Clicking Help Menu Icon

The user should click on the help menu icon at the home page after logging in the system. Help menu icon is represented with a question mark. Moreover, five main menus seen at the home page of the system are constant. In other words, the users are able to see these main menus in any page of the system. Therefore, they can click the help menu icon at any moment. The visualization of this task can be found in Appendix C.

3.4.2.1.5.2 Using System Settings Menu

The user should click on the system settings menu icon at the home page after logging in the system. Then, the user would see four menus at the left side of the screen. These menus are help, archieve management, record management and customization. The user should click help menu and select the application manuals submenu. Thereafter, the user would see the related topics and should click on the related title that s/he wants to receive support. The flow of this task is visualized in Appendix C.

3.4.2.2 Tasks for Personnel / Workers

3.4.2.2.1 Task 1: You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works on behalf of you. For this reason, give your procuration to the worker that will perform your works by filling the related date and time information. After giving procuration, assume that your annual leave has ended and cancel your procuration.

There are 2 ways to achieve this task and the ways of assigning delegation for personnel or workers is exactly the same with the managers'. Therefore, the flow charts of the ways of achieving this task and the explanation are the same with 3.4.2.1.1.

3.4.2.2.2 Task 2: You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information.

This task for personnel is partially similar with 3.4.2.1.2. Users should click desktop menu after logging in the system. Then, they should click E-Form Processes menu in order to see

the Electronic Form Search submenu. After clicking the submenu, they are required to select the type of electronic form that they will search. They should click Bakım Onarım Formu (Maintenance and Repair Form) for this task. When they choose the related form, they would see the search criteria. Participants are required to fill the subject criterion as "Eğitim Deneme Formu" (Education Test Form) and click the search button. The system would provide the matching form(s) after this process. Participants should preview the document by clicking processes box and selecting the preview option so as to get the essential information. The flow chart of this task can be found in Appendix C.

3.4.2.2.3 Task 3: Since you had another work to do, you left a repair and maintenance form that you were filling incomplete. You want to continue filling your form after you completed the other work. Hence, find the shortcomings of the document whose subject is "Eksik Bilgileri Giriniz" (Enter Incomplete Information) in My New Records and send it to the related personnel by completing it.

The user should click desktop menu after logging in the system. Then, record processes menu should be clicked and my new records submenu should be selected. When the user selects my new records submenu, a categorization appears at the top of this screen. These categories are unsent records, draft records and electronic forms. Draft records are listed on this screen by default. Therefore, electronic forms check box should be clicked so as to see incomplete electronic forms. Then, the document whose subject is "Eksik Bilgileri Giriniz" (Enter Incomplete Information) would appear. The user should click processes box and select the preview option after finding the document. The document should be controlled and the missing information should be found on the preview screen. Edit text button should be clicked to make the necessary changes. Thereafter, save button should be clicked to save the changes and dispatch button should be clicked to send the document to the related personnel. The user would see a list of departments and people that the document can be sent to. The related department or person should be selected from this list. After selecting to where the document would be sent, the user should click dispatch button. The flow of this method can be seen in a detailed way in Appendix C.

3.4.2.2.4 Task 4: A malfunction has occurred for a room's heating system in your department or agency. Your head of department or manager demanded you to fill a repair and maintenance form related with this situation. Complete the repair and maintenance form by filling the essential information and dispatch it to the appropriate personnel.

The user should click desktop menu after logging in the system. Then, e-form processes menu should be clicked and Bakım Onarım Formu (Maintenance and Repair form) should be selected. Then, the user would see the related form. There are different fields in this form but four of them are obligatory. The obligatory fields are telephone number, request type, request order and detail. The document cannot be sent unless these obligatory fields are filled. The user should fill the essential fields in addition to the obligatory fields. After filling the necessary fields, the document should be saved and dispatch button should be clicked. Thereafter, the user would see a list of departments and people that the document can be sent to. The related department or person should be selected from this list. After selecting to

where the document would be sent, the user should click dispatch button. The flow chart of this task is shown in Appendix C.

3.4.2.2.5 Task 5: Your head of department or manager wanted information about where and on which phase the repair and maintenance form that you had dispatched is after some time. For this reason, learn where and on which phase the repair and maintenance form that you had dispatched is by finding your document.

Users should click desktop menu after logging in the system. Then, they should click E-Form Processes menu and select Electronic Form Search submenu. After clicking the submenu, they are required to select the type of electronic form that they will search. They should click Bakım Onarım Formu (Maintenance and Repair Form) for this task. When they choose the related form, they would see the search criteria. The users should enter the necessary information about the document that they had prepared during the previous task and click the search button. The system would provide the matching form(s) after this process. Participants should click processes box and select dispatch history option so as to learn where and on which phase the repair and maintenance form that they had dispatched is. The flow chart of this task is visualized in Appendix C.

3.4.2.2.6 Task 6: You realized that you had sent the Repair and Maintenance form that you had filled based on your head of department or manager demand to a wrong personnel. Take your document back before the personnel that you had sent wrongly makes a change on your document.

Users should click desktop menu after logging in the system. They would see five different task tabs at the desktop menu and they should click my sent tab. After that, they would see two different categories which are time-bound tasks and transitory tasks. They should click on the appropriate category that the document belongs to. The system would provide the related forms that match this category. Then, the users should click the processes box and select take back option. The system would ask the users whether they are sure to cancel the dispatch with a dialog box. The users should click yes / ok option in order to take the document back.

3.4.2.2.7 Task 7: You could not guess what to write to some text fields that exist in Maintenance and Repair Form and you have difficulty in filling the form. Find the help menus inside the system so as to get help and get information about the related situation from these menus.

There are 2 ways to reach help menus in the system and the way of achieving these tasks are the same with 3.4.2.1.5. Therefore, the flow charts of this task are also the same with 3.4.2.1.5.

3.4.3 Eye Tracking Study

3.4.3.1 Subjects

There have been 20 participants who took the system test in HCI lab in METU Computer Center. These participants were divided into two groups and each group consists of ten participants. The first group tested the system twice. Firstly, a usability study was conducted with the first group. The necessary changes based on the results of this test were implemented to the system. After the implementation of the first test findings, another usability study was conducted with the first group in order to see the effect of the implementation. Moreover, one more usability study was conducted with the second group so as to compare the results with the first group. Participants were chosen randomly among the system users. They were chosen based on the general characteristics and duties of the system users.

Subjects were informed about the aims of this test and what they were supposed to do during the test before they started the test. Participants took the system test based on the tasks that were identified beforehand. The lists of these tasks based on the duty of the worker are provided in Appendix D and Appendix E. These tasks were identified by considering the current version and usage of the system. These tasks were appropriate for the users with the current version. Some of the tasks require some operations on documents. These documents had been created for the test users' accounts before the test. When the users log in the test environment with their username and password, they were able to see these documents.

People who have academic duties are ignored for this test because what they do with the current version of the system is only to preview the documents and send them to necessary person. Therefore, the tasks which will be tested are not appropriate for the role that they have in the system for now.

3.4.3.2 Think Aloud Method

Think aloud method was applied during the usability test sessions. The participants were encouraged to speak and express their feelings and ideas verbally. Applying this method helps to understand the feelings of the participants while performing the tasks. Their comments give clues about at which tasks they face with difficulties, what they think about the design and functionality of the system and how they react to the errors or feedbacks of the system. Moreover, when the users talk loudly during the usability study, they are unaware that they offer beneficial solutions for a problematic component or item. Therefore, this method assists to find different and user friendly solutions.

Sound records of the participants were monitored and investigated after the test sessions. The statements and expression of the participants were identified by watching the video records and listening to the sound records again. After the identification of the related expressions, these expressions were classified into 11 categories. These categories help to identify potential problems for user interface or the design of the system (Kushniruk & Patel, 2004). 11 categories that were used for the expression classification are explained below:

Navigation: Coded when participant makes a comment about navigation or states can't act through interface.
Graphics: Coded if participant refers to the graphics of the system.

Layout / Screen Organization: Coded if participant expresses a feeling about the layout or screen organization.
Color: Coded if participant refers to the usage of color.
Resolution: Coded if participant makes a comment about the resolution of the information
Meaning of Labels: Coded if participant comments on the elements of the interface.
Understanding of System Instructions / Error Messages: Coded if participant mentions understanding of instructions or errors.
Consistency of Operations: Coded if participant makes an interpretation about the consistency of operations.
Overall Ease of Use: Coded if participant states an opinion about the overall ease of use for the system.
Response Time: Coded if participant make a comment about the response time of the system.
Visibility of System Status: Coded if participant mentions about visibility of the system status.

CHAPTER 4

4 Results

4.1 Demographics

Participants' demographic information was collected with pretest questionnaire. This information is presented in this section. The average age of the participants for the first stage is 40, 5 years (S.D. = 7,59 and range between 30 and 52). The participants of the first stage and the second stage are the same. However, two of the participants were not able attend the second stage. Therefore, the age distribution of the second stage is different than the first stage. The average age of the participants for the first stage is 41,875 years (S.D. = 7,88 and range between 30 and 52). The third stage of the study was conducted with 10 participants. The average age of the participants for this stage is 37,6 years (S.D.=8,69 and range between 25 and 50). The age distribution of the study for each stage is shown in Figure 4.1.

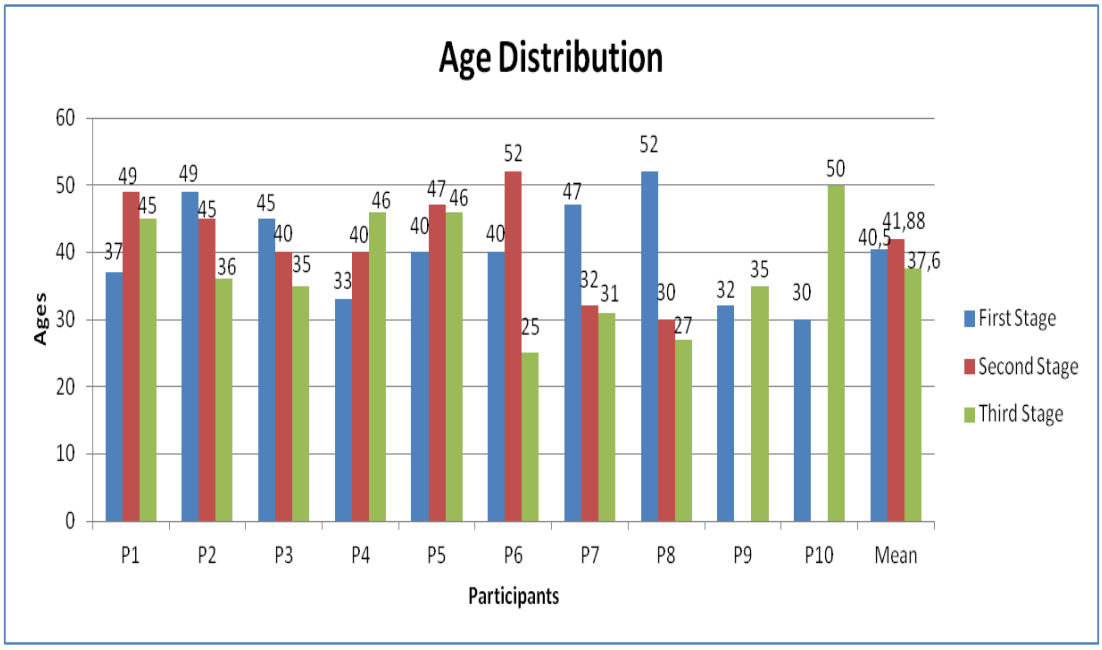

Figure 4.1: Age Distribution of Participants for Each Stage

The first stage of the study was performed with 6 female and 4 male participants. Therefore, majority of the participants were female (6 participants, % 60) for the first stage. Two participants of the first stage did not attend the second stage since one of them had retired and the other one was on annual leave. Both of these participants were female. Therefore, the second stage of the study was performed with 8 participants, 4 male and 4 female. The last stage of the study was conducted with 10 participants. 5 of these participants were female and 5 of them were male. The gender distribution for each stage is demonstrated in Figure 4.2.

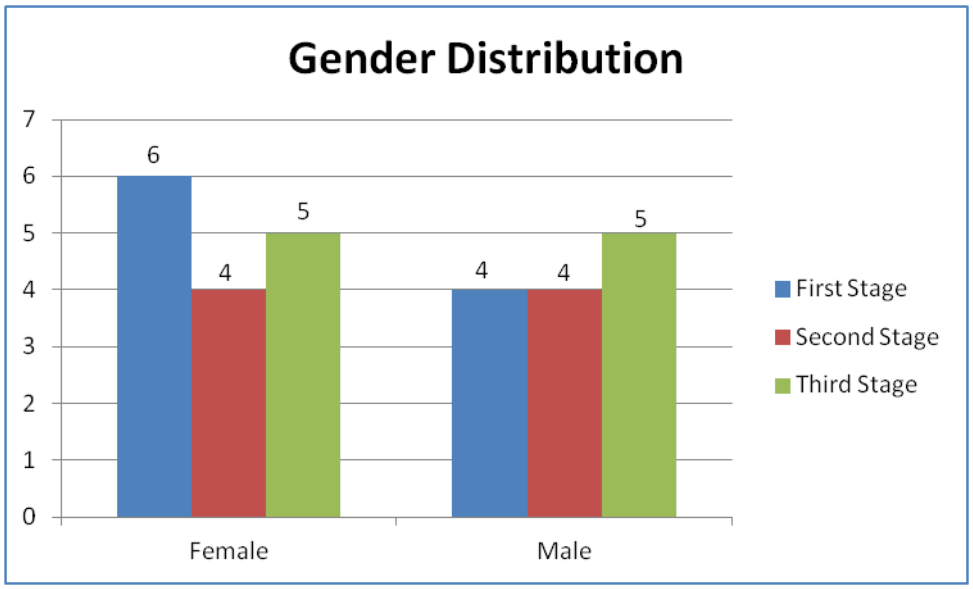

Figure 4.2: Gender Distribution of Participants for Each Stage

In addition to the age and gender information, educational level of the participants was analyzed for each stage. The educational level of the participants for the first stage varies from high school to Master of Science. 3 of the participants have graduated from high school. 4 of them have graduated from vocational school of higher education and have an associate degree. 3 of them have graduated from university and they have Bachelor of Science (B.S.) degree. There were 8 participants for the second stage. 3 of these participants have graduated from high school. 3 of them have graduated from vocational school of higher education and have an associate degree. Finally, 2 of them have graduated from university and they have B.S. degree. The final part of the study was conducted with 10 participants. 3 of these participants have graduated from high school. 2 of them have graduated from vocational school of higher education. 3 of them have graduated from university and have B.S. degree. Finally, 2 of them have Master of Science (M.Sc.) degree. The educational status of the participants is represented in Figure 4.3.

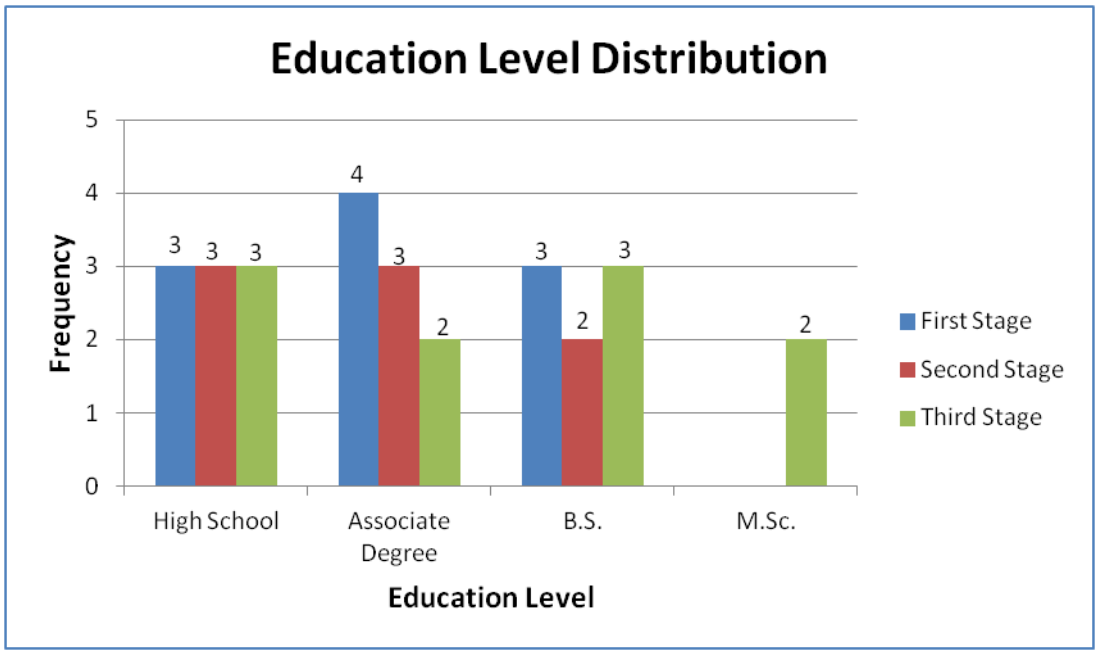

Figure 4.3: Education Level Distribution of Participants for Each Stage

Manager and workers from different departments and duties were chosen for this study. Academic staff was ignored since they use the system for only one form to apply publication award. Therefore, the participants were chosen among personnel having administrative duties. 1 secretary and 1 faculty secretary were not able to attend the second stage. The last stage of the study was conducted with 4 secretaries, 2 managers, 2 officers, 1 property officer and 1 chief. The administrative duties of the participants are represented in Figure 4.4.

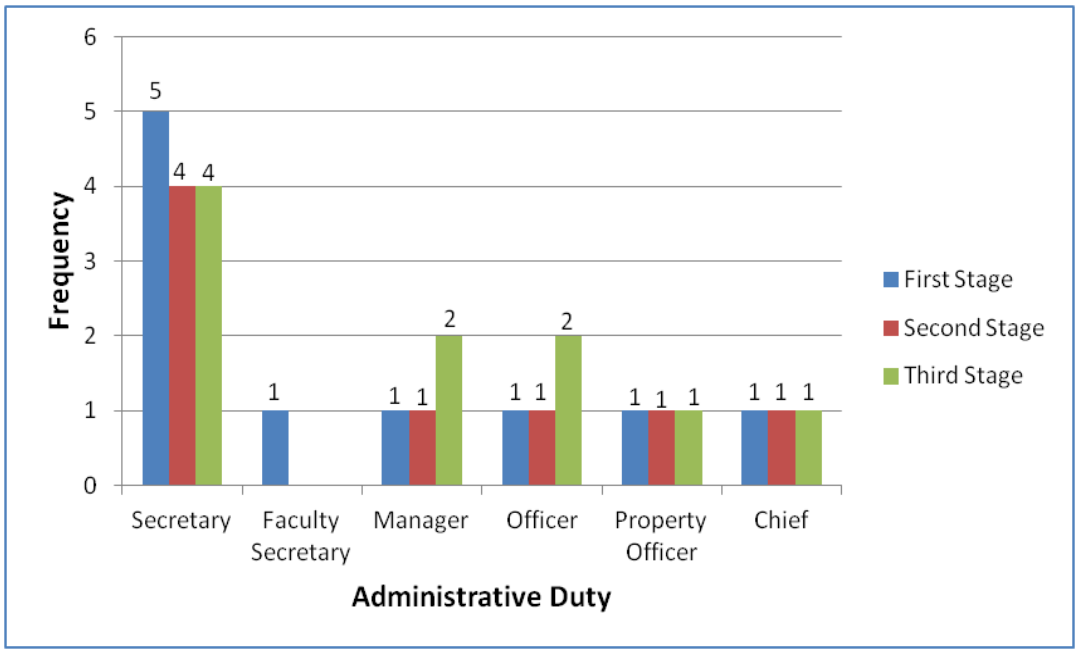

Figure 4.4: Administrative Duties of Participants for Each Stage

4.2 Pretest Questionnaire Results

A short questionnaire was given to the participants before the usability test (See Appendix A). This questionnaire includes questions about the demographics of the participants and their computer usage. The first three questions are related with the demographics and the answers of these questions were used in section 4.1 above in order to present participants demographics. The answers for the rest four questions are given in this section.

There were totally 3 stages and 20 participants for the usability tests. Therefore, the answers are evaluated by considering 20 participants' answers. Large majority of the participants have their own computer at home (18 participants, 90%). Most of the participants stated that they use computer for more than five years (18 participants, 90%). One of them use computer for between 3-4 years and another one for less than a year.

More than half of the participants use computer mostly at their work place (12 participants, 60%). There are some participants that use computer mostly both at home and workplace (8 participants, 40%). 8 of the participants use computer at home more than their work place. Majority of the participants stated that they use computer more than 8 hours in a day (13 participants, 65%). 4 of participants (20%) use computer 6 to 8 hours, 2 of them (10%) answered as 4 to 6 hours and 1 of them (5%) responded as 2 to 4 hours.

4.3 Posttest Questionnaire Results

A posttest questionnaire was given to the users after the system test (see Appendix B). This questionnaire contains 5 main parts and 39 questions. These questions have a scale from 1 to 9 for the evaluation of the users. Five main parts of the questionnaire are the system experience, general user reaction, appearance of the METU EDMS pages, terms used in METU EDMS pages and learning the system usage. Participants' scores for the related tasks were analyzed and the mean of these scores were calculated. The results of the questionnaire are provided in the following sections in a detailed manner for each section.

4.3.1 System Experience (1 question)

The frequency of the users' visit to the system was asked in this part. The participants of the first and second stages were the same. Their answers to this question are represented in the figure below.

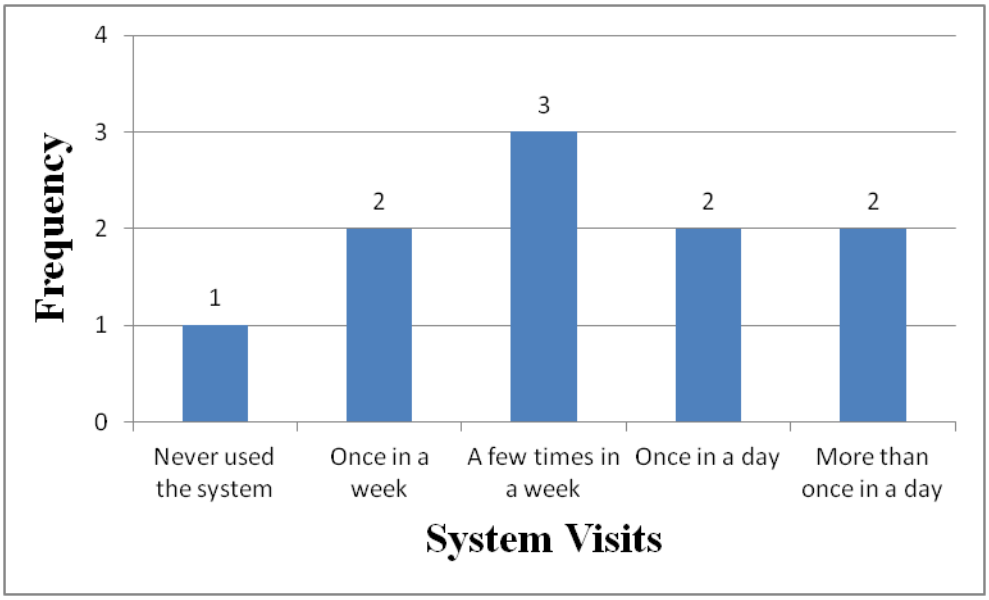

Figure 4.5: Frequency of System Visits of Participants for First and Second Stages

8 participants from the first and second stages are the same. Moreover, their answers' to this question are the same, too. Two of the participants from the first stage did not attend the second stage. Their answers to this question were never used the system and once in a day. There were totally 10 participants for the third stage. Their answers to this question are shown in figure below.

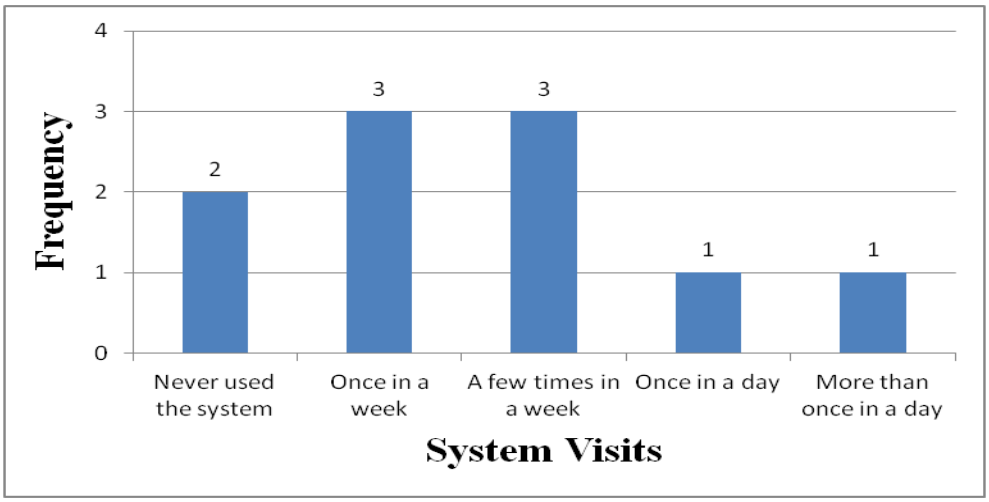

Figure 4.6: Frequency of System Visits of Participants for Third Stage

4.3.2 General User Reaction (6 questions)

It was demanded from the users to evaluate the system in more general terms for this part. The results of the general user reaction are presented below in the tables.

Table 4.1 : General User Reaction Results for First Stage

Subject	Personnel	Managers
Appearance of METU EDMS	5,41	6,06

Table 4.2: General User Reaction Results for Second Stage

Subject	Personnel	Managers
Appearance of METU EDMS	5,63	5

Table 4.3: General User Reaction Results for Third Stage

Subject	Personnel	Managers
Appearance of METU EDMS	4,69	5,89

4.3.3 Appearance of the METU EDMS Pages (15 questions)

The users evaluated the font and font size, order of the page, the links of the pages, the pictures and icons used at the pages, and the colors used for the design in this part. The results of these sections are given at the tables 4.4, 4.5 and 4.6 below.

Table 4.4: Appearance of the METU EDMS Pages Results for First Stage

Subject	Personnel	Managers
Font and Font Size	7,45	7,33
Page Order	5,61	6,78
Transition between Pages	5,13	6,75
Pictures and Icons	6,87	7,44
Design Colors	7,1	8

Table 4.5: Appearance of the METU EDMS Pages Results for Second Stage

Subject	Personnel	Managers
Font and Font Size	7,25	7
Page Order	5,92	5
Transition between Pages	5,44	3
Pictures and Icons	6,25	5
Design Colors	5	3

Table 4.6: Appearance of the METU EDMS Pages Results for Third Stage

Subject	Personnel	Managers
Font and Font Size	6,44	7
Page Order	4,78	6
Transition between Pages	4,67	5,83
Pictures and Icons	5,89	7,11
Design Colors	5,83	7,17

In addition to these questions, there was an open ended question at the end of this part. Some users filled this question and they complained about having too much text in some pages.

4.3.4 Terms Used in METU EDMS Pages (7 questions)

Evaluation of the terms used in EDMS, the messages appear on the screen and the feedback provided by the system were included in this part. The results of these sections are given at the tables 4.7,4.8 and 4.9 below.

Table 4.7: Terms Used in METU EDMS Pages Results for First Stage

Subject	Personnel	Managers
Terms used	5,86	7
Messages	6,57	6,67
Informing the User	5,29	7

Table 4.8: Terms Used in METU EDMS Pages Results for Second Stage

Subject	Personnel	Managers
Terms used	5,50	6
Messages	6,63	5
Informing the User	5,88	6

Table 4.9: Terms Used in METU EDMS Pages Results for Third Stage

Subject	Personnel	Managers
Terms used	6,06	6,44
Messages	4,83	6,67
Informing the User	4,08	5,67

4.3.5 Learning System Usage (10 questions)

This part contains questions about learning how to surf between pages, exploring the page properties, recalling and achieving the given task without losing time. The results of these sections are given at the tables 4.10, 4.11 and 4.12 below.

Table 4.10: Learning System Usage Results for First Stage

Subjects	Personnel	Managers
Surfing the Pages	6,17	7
Exploring Page Properties	6	6,33
Recalling	6	6,67
Achieving Given Task	5,83	7,67

Table 4.11: Learning System Usage Results for Second Stage

Subjects	Personnel	Managers
Surfing the Pages	4,75	7
Exploring Page Properties	5,58	7
Recalling	4,75	3
Achieving Given Task	6,08	3

Table 4.12: Learning System Usage Results for Third Stage

Subjects	Personnel	Managers
Surfing the Pages	4,94	5,22
Exploring Page Properties	5,06	5,22
Recalling	5,17	6,33
Achieving Given Task	5,50	5,78

4.4 Eye Tracking Results

An eye tracking study was conducted with totally 20 participants in three stages. The eye tracking study was performed in the human computer interaction laboratory in METU Computer Center. Participants were divided into two groups. These groups are managers and personnel. The managers executed 5 tasks and the personnel group performed 7 ordinary tasks in METU EDMS throughout the test. The eye tracking study results will be represented in this section. The users' data were analyzed for statistical estimations such as completion time, mouse clicks, areas of interests, fixation count and fixation duration. Moreover, the records of users were analyzed to identify the comments made during the test and these comments are indicated for each task. The data of the participants were analyzed with the help of a software called Tobii Studio (Version 3.1.3). 10 participants attended for the first stage of the study. The participants of the first stage were invited for the second stage after a year and 8 participants (1 manager was on annual leave and 1 personnel had retired) were available for the second stage of the study. Finally, the third stage of the study was performed with 10 participants. The related data are indicated at the following sections.

A task analysis was conducted as stated in section 3.4.2. The ideal completion time and mouse click count were identified. The ideal completion time and mouse click count information are important so as to see the divergence from the ideal cases. This information is presented below at the tables 4.13, 4.14, 4.15 and 4.16 for managers and personnel. The information presented at these tables is used for the graphs that demonstrate the eye tracking results.

Table 4.13: Ideal Completion Time of Managers

Tasks	**Completion Time (Expert User)**		
	First Way	**Second Way**	**Mean**
Task 1	57,72	42,88	50,30
Task 2	31,95		31,95
Task 3	46,41		46,41
Task 4	51,74		51,74
Task 5	7,12	14,94	11,03

Table 4.14: Ideal Completion Time of Personnel

Tasks	**Completion Time (Expert User)**		
	First Way	**Second Way**	**Mean**
Task 1	57,72	42,88	50,30
Task 2	24,72		24,72
Task 3	41,28		41,28
Task 4	54,75		54,75
Task 5	17,52		17,52
Task 6	15,47		15,47
Task 7	7,12	14,94	11,03

Table 4.15: Ideal Mouse Click Count of Managers

Tasks	**Mouse Clicks (Expert User)**		
	First Way	**Second Way**	**Mean**
Task 1	15	11	13
Task 2	10		10
Task 3	12		12
Task 4	8		8
Task 5	5	4	4,50

Table 4.16: Ideal Mouse Click Count of Personnel

Tasks	**Mouse Clicks (Expert User)**		
	First Way	**Second Way**	**Mean**
Task 1	15	11	13
Task 2	9		9
Task 3	20		20
Task 4	21		21
Task 5	9		9
Task 6	6		6
Task 7	5	4	4,50

4.4.1 Eye Tracking Results for Managers

All participants' data were evaluated for all the tasks of managers. There were 3 managers for the first stage. 2 managers attended the second stage since one of them was on annual leave. Finally, another 3 managers performed the third stage. The results of these participants are provided below for each stage.

4.4.1.1 *Task 1. You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works on behalf of you. For this reason, assign delegation the worker that will perform your works by filling the related date and time information. After assigning your delegation, assume that your annual leave has ended and cancel your delegation.*

4.4.1.1.1 Completion Time

The results of the completion time for managers are given separately below in the graph.

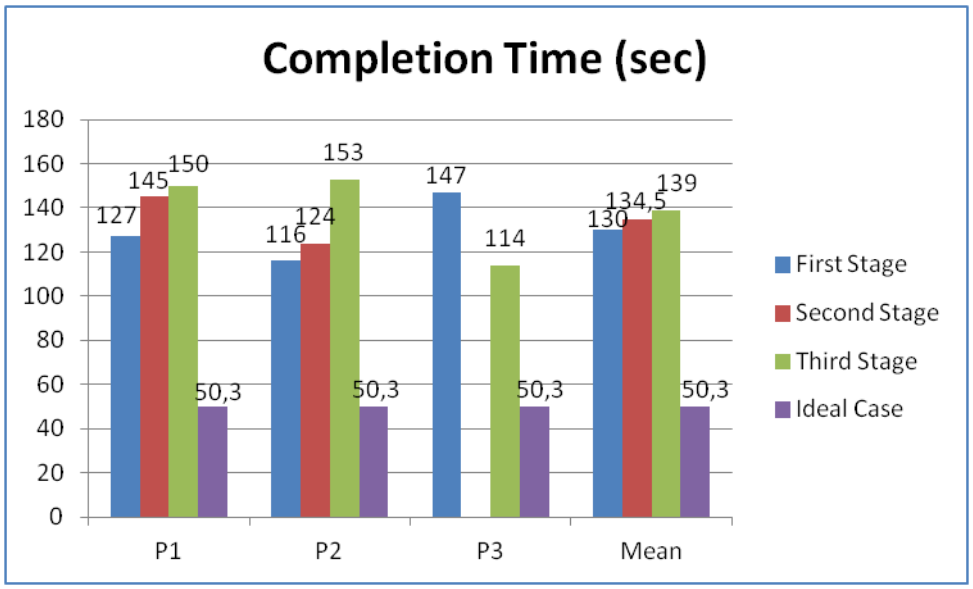

Figure 4.7: Task 1 Completion Time Graph for Managers

4.4.1.1.2 Mouse Clicks

The graph below demonstrates the results of mouse click estimations for managers.

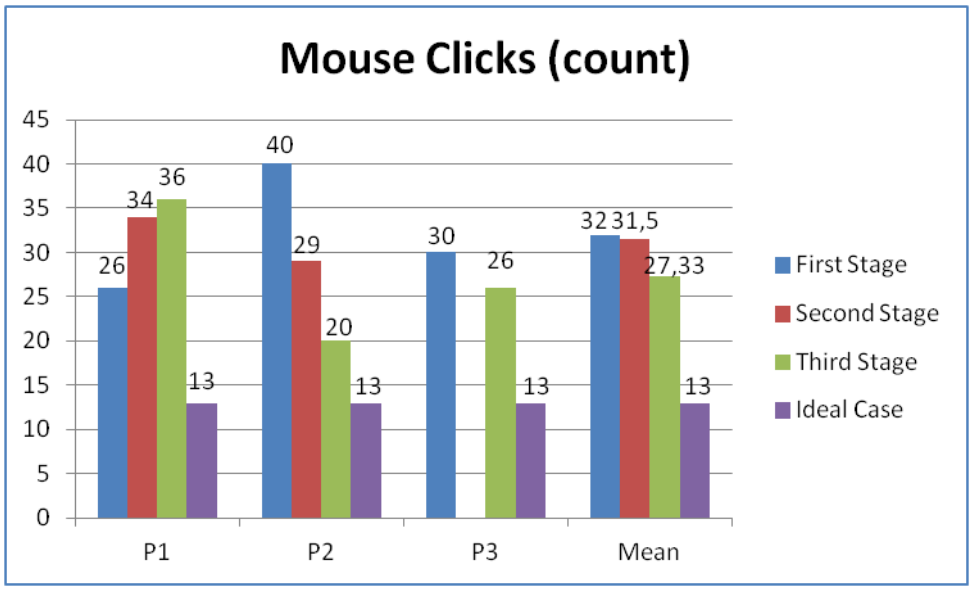

Figure 4.8: Task 1 Mouse Clicks for Managers

4.4.1.1.3 Areas of Interest

Area of Interest (AOI) indicates the appropriate parts on the screen that the participants should pay attention while trying to complete the related tasks. Moreover, AOI can give information about other areas which are not included in the area of interest. Therefore, defining AOIs helps to identify the unrelated objects and they can be used to reveal some statistics to compare the appropriate and inappropriate areas and objects. AOIs are defined by the researcher so as to analyze eye-tracking data with the help of the Tobii Studio software. The figure below shows the AOIs of the beginning of task 1.

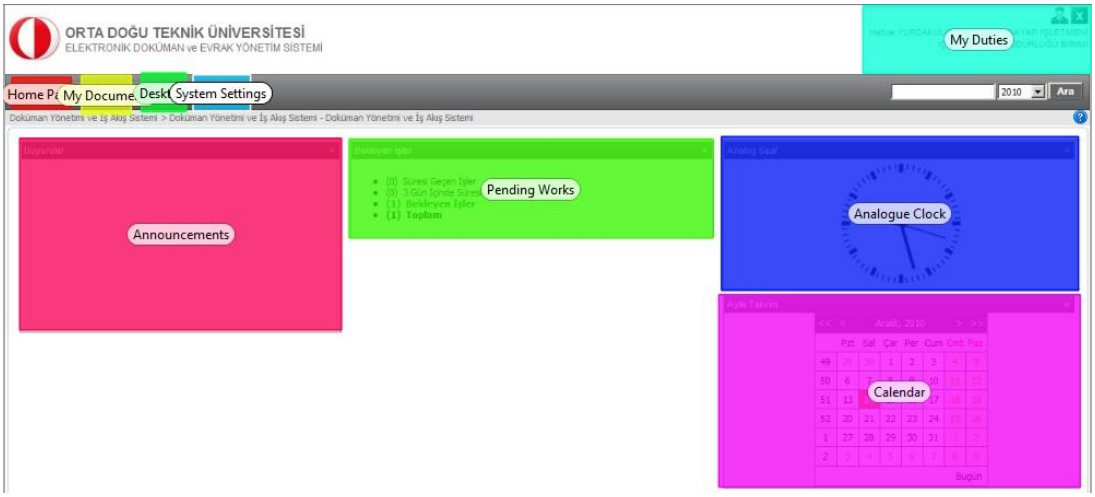

Figure 4.9: Areas of Interest for Task 1

There are totally 9 AOIs determined for the analysis of this task. However, 2 of these AOIs are appropriate for task 1. These appropriate areas are My Duties and System Settings areas. When the participants login the system, they see this screen and it is the starting phase of task 1. They are supposed to click on one of these two AOIs in order to complete the task successfully. The two AOIs in Figure 4.21 are represented with turquoise and green boxes. The other seven AOIs are inappropriate for this task. After clicking one of these AOIs, participants are required to take some other actions and click some other menus or areas. These screens are considered for the calculation of AOIs, too. The results of the participants are evaluated and the time spent on AOIs and Not AOIs are demonstrated in the following sections.

4.4.1.1.4 Fixation Count and Fixation Duration

Fixation duration indicates how much time participants stare at objects that were defined as Area of Interest (AOI) for the analysis of a task. All of the participants' data were analyzed in order to assess fixation durations. Fixation count and fixation duration statistics were calculated with the help of Tobii Studio software. Fixation duration tables were prepared and presented for all the tasks considering the three stages of the study. Moreover, aggregate fization durations and fixation counts percentages are shown with a figure for each task and stages. The table below shows how much time participants spent on areas of interest (AOI) and not areas of interest.

Table 4.17: Task 1 Fixation Durations for First Stage

Participant	**Fixation Durations (sec)**				
	Area of Interest (AOI)		**Not Area of Interest (NAOI)**		**Total Time (sec)**
	Time (sec)	**%**	**Time (sec)**	**%**	
P1	30,6	24	96,4	76	127
P2	26,4	22,7	89,6	77,3	116
P3	25, 5	17,4	121,5	82,6	147

Table 4.18: Task 1 Fixation Durations for Second Stage

Participant	**Fixation Durations (sec)**				
	Area of Interest (AOI)		**Not Area of Interest (NAOI)**		**Total Time (sec)**
	Time (sec)	**%**	**Time (sec)**	**%**	
P1	24,4	16,8	120,6	83,2	145
P2	27,3	22	96,7	78	124

Table 4.19: Task 1 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	32,6	21,7	117,4	78,3	150
P2	29,9	19,5	123,1	80,5	153
P3	26,2	23	87,8	77	114

In addition to the fixation durations, fixation counts of the participants were calculated, too. Fixation counts show the amount of fixations on the objects called area of interest (AOI). Fixation duration represents the time spent on AOIs whereas fixation counts demonstrate how many times fixations occurred on these AOIs. The percentages of fixation durations and fixation counts are visualized in the figures below. These percentages for each stage were calculated by adding all the participants' amount of fixation durations and fixation counts for the related AOI and NAOI.

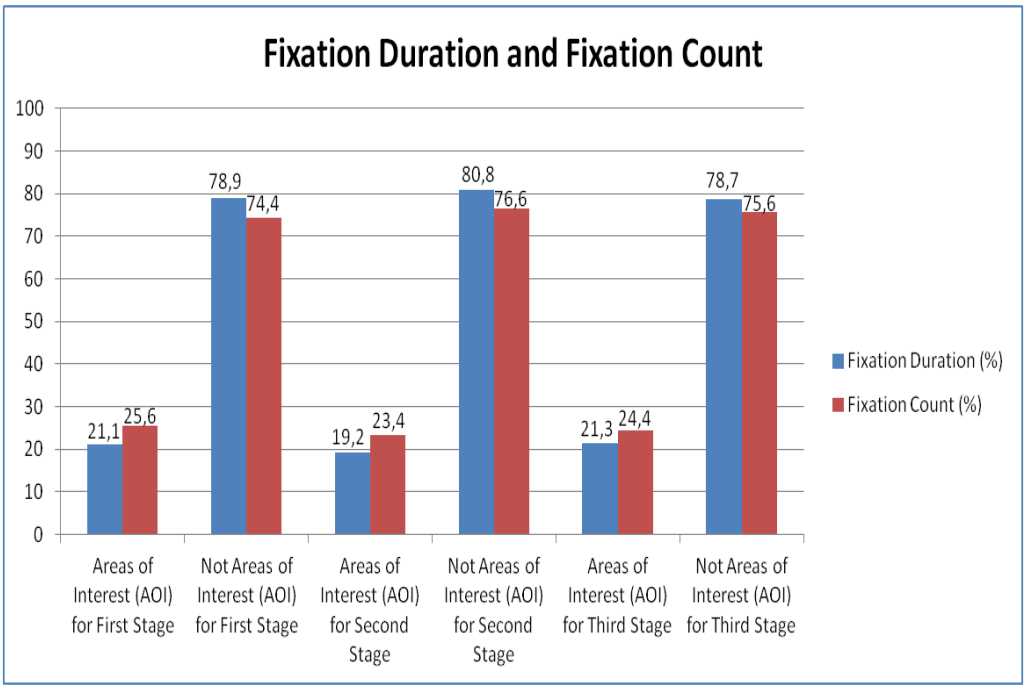

Figure 4.10: Total Fixation Durations and Fixation Counts Percentages of Task 1

4.4.1.1.5 Think-Aloud

"Vekalet verme özelliğini göremiyorum. Nerede acaba?"

"I cannot see assigning delegation. I wonder, where is it?"

"Vekalet verme mi? Burada böyle bir şey yok."

"Assigning delegation? There is not such a thing here. "

"Yıllık izin formuyla bir bağlantısı olabilir."

"There might be a connection with annual leave form."

"Vekalet verme simgesi nerede?"

"Where is assigning delegation icon?"

"Vekalet verme bu kadar zor olmamalı."

"Assigning delegation should not be that much difficult." Overall Ease of Use

"Vekalet vermeyi bulamıyorum."

"I cannot find assigning delegation."

4.4.1.2 Task 2. You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information. After previewing the document, learn where and on which phase this document is.

4.4.1.2.1 Completion Time

The graph below represents completion time for managers for each stage.

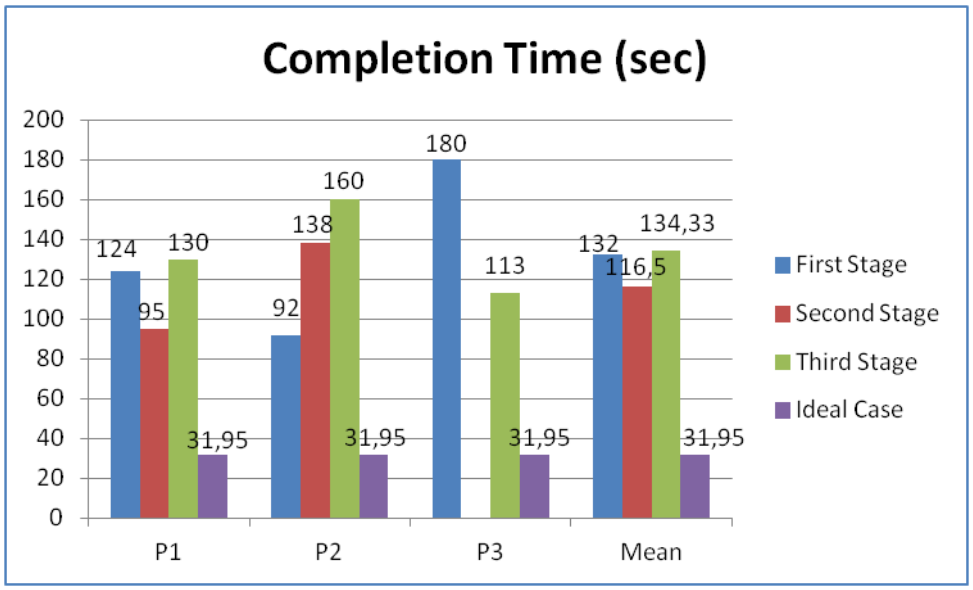

Figure 4.11: Task 2 Completion Time Graph for Managers

4.4.1.2.2 Mouse Clicks

The graph below shows the results of mouse click estimations for managers.

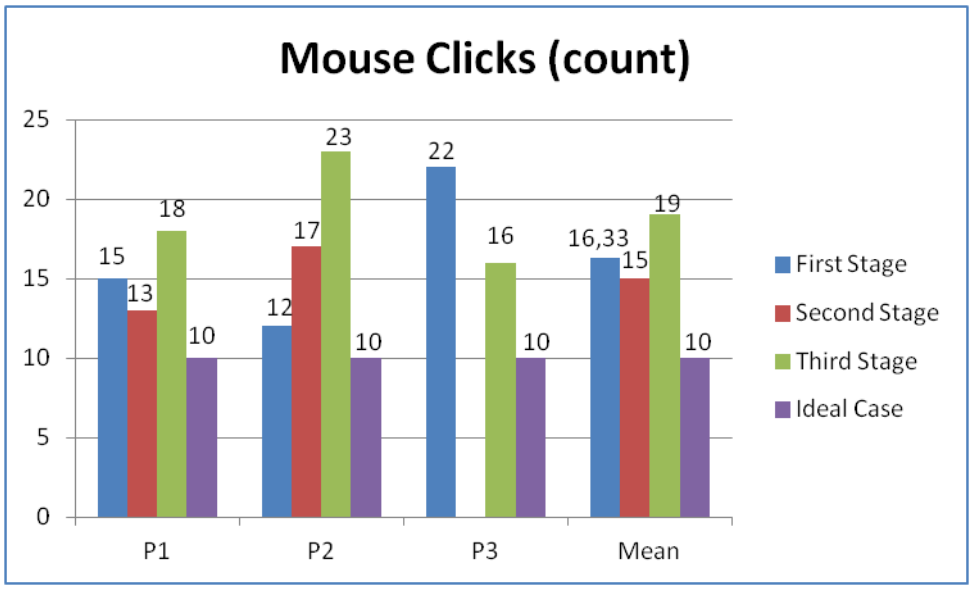

Figure 4.12: Task 2 Mouse Clicks for Managers

4.4.1.2.3 Areas of Interest

Areas of Interest (AOIs) were identified for task 2 so as to study fixation statistics. These AOIs are visualized in Figure 4.13. 7 areas were defined for this task and only 1 of them is appropriate for AOIs. The AOI is the processes menu that is shown with light blue box. The rest 6 box are not AOIs. All of these areas are shown below.

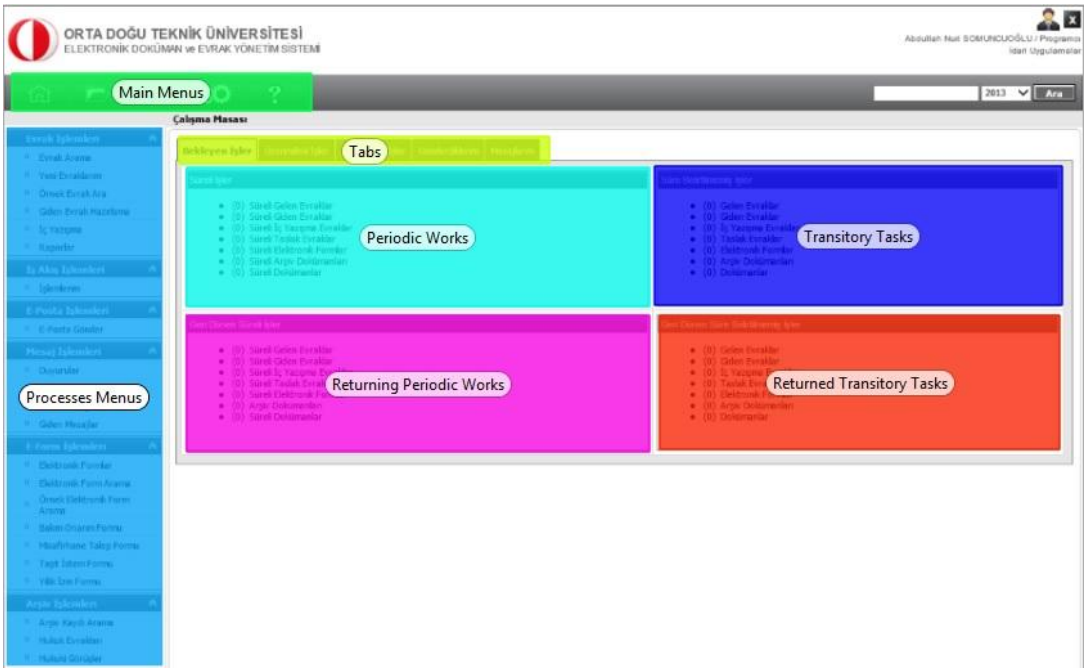

Figure 4.13: Areas of Interest for Task 2

4.4.1.2.4 Fixation Count and Fixation Duration

Table 4.20: Task 2 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	30,8	24,8	89,2	75,2	124
P2	34,6	19,2	145,4	80,8	180
P3	28,3	30,8	63,7	69,2	92

Table 4.21: Task 2 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	29,4	30,9	65,6	69,1	95
P2	31,8	23	106,2	77	138

Table 4.22: Task 2 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	36,7	28,2	93,3	71,8	130
P2	39,4	24,6	120,6	75,4	160
P3	35,8	31,7	77,2	68,3	113

The graph below demonstrates total fixation duration and fixation count percentages for task 2.

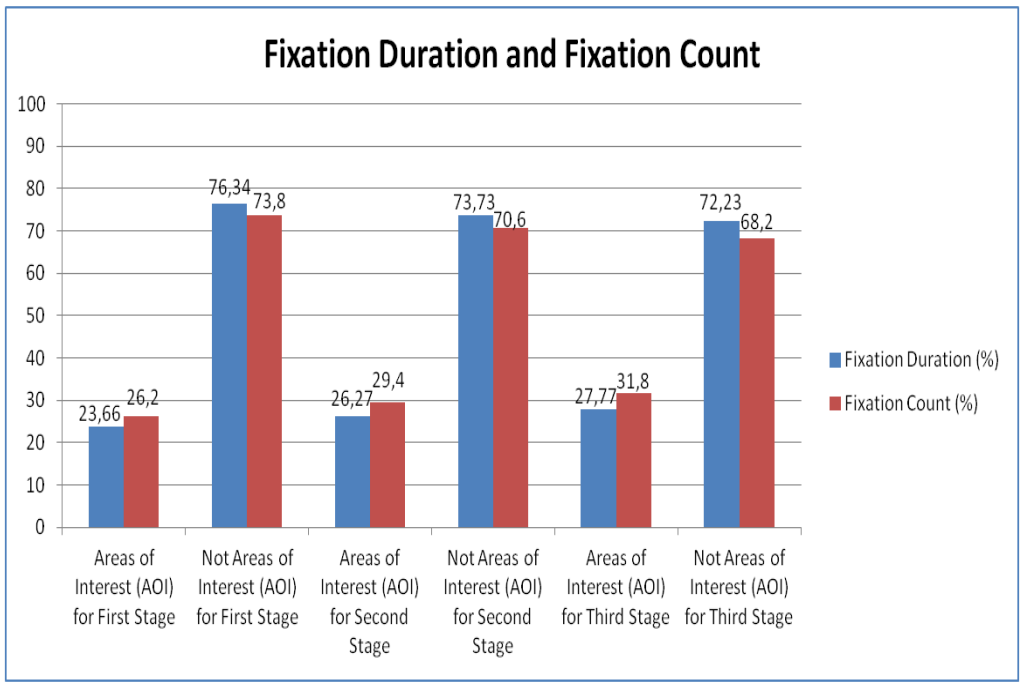

Figure 4.14: Total Fixation Durations and Fixation Counts Percentages of Task 2

4.4.1.2.5 Think-Aloud

"Bu formu ana sayfada arayabiliyor muyum?"

"Can I search this form at the home page?"

"Arama kısmı için çok seçenek var."

"There are too many criteria for search section." Layout / Screen Organization

"Elektronik form arama nerede olabilir?"

"Where could electronic form search be?"

"Araya tıklıyorum ama sonuçları göremiyorum"

"I click search but I cannot see the results." Response Time

"Elektronik form arama ve evrak aramanın ayrı olması ilginç."

"It is interesting that electronic form search and document search are separated." Consistency of Operations

"Ana sayfadan aradığımda formu bulamadım."

"I could not find the form when I searched from the home page." Consistency of Operations

"Formu buldum ama şimdi nasıl önizleyeceğim?"

"I found the form but now how will I preview it?"

4.4.1.3 Task 3: Preview the maintenance and repair form whose subject is "Eğitim Deneme" (Education Test) sent by the related personnel and make the essential changes by using Edit Text option. Send the document to the related personnel after you make the desired changes.

4.4.1.3.1 Completion Time

The results of the completion time for managers related with task 3 are given separately below in the graph.

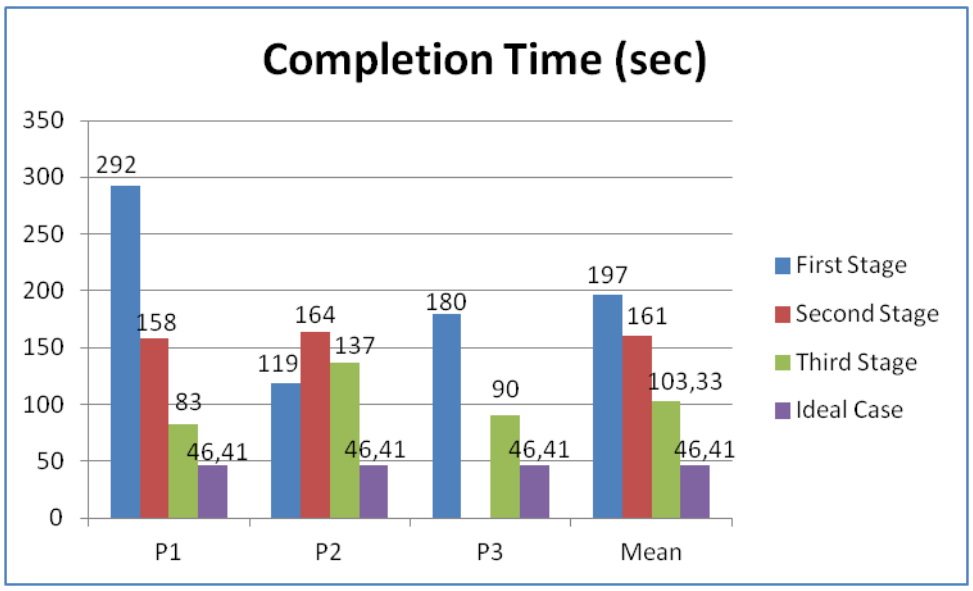

Figure 4.15: Task 3 Completion Time Graph for Managers

4.4.1.3.2 Mouse Clicks

The graph below represents the results of mouse click estimations for managers related with task 3.

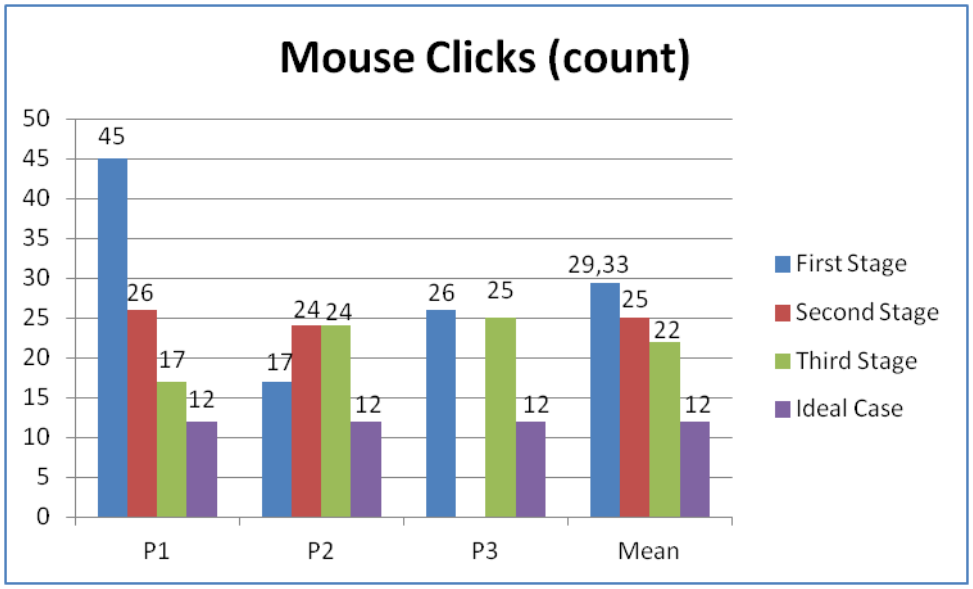

Figure 4.16: Task 3 Mouse Clicks for Managers

4.4.1.3.3 Areas of Interest

Areas of Interest (AOIs) identified for task 3 is the same with task 2 for the beginning phase. Therefore, the figure shown below is the same with task 2's. However, the AOIs of task 3 are different than task 2. There are totally 7 AOIs for this task and 3 of them are appropriate for this task. The names of these AOIs are Tabs, Periodic Works and Returning Periodic Works. These areas are represented with yellow, light green and purple boxes respectively in the figure below. All of the AOIs are visualized in Figure 4.17 below.

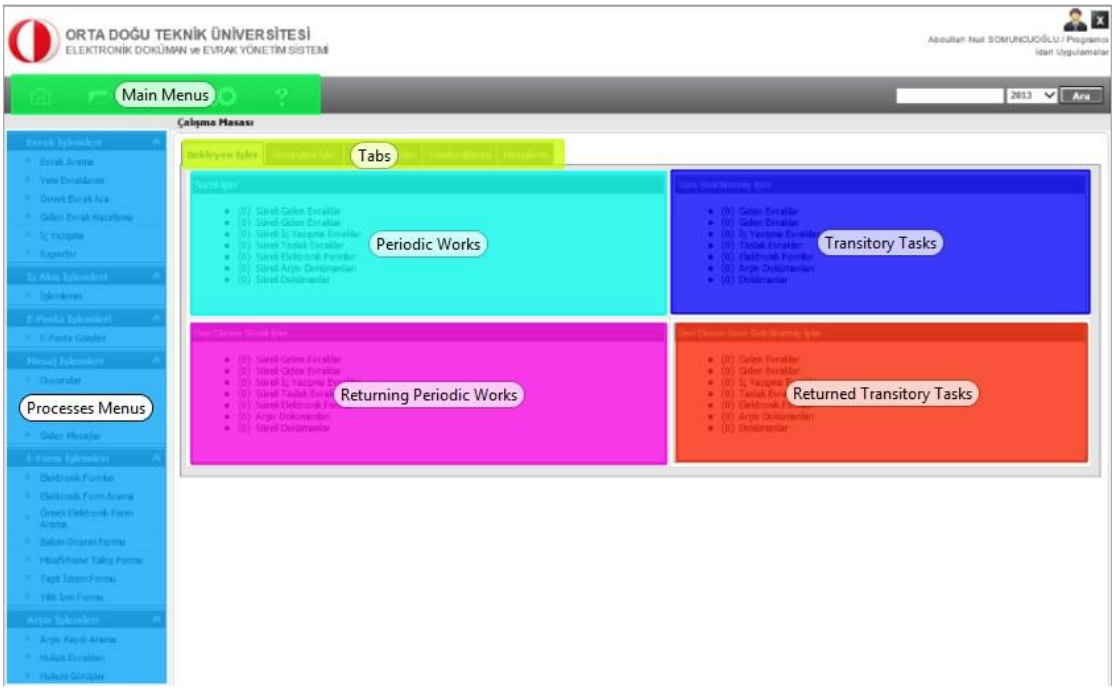

Figure 4.17: Areas of Interest for Task 3

4.4.1.3.4 Fixation Duration and Fixation Count

Table 4.23: Task 3 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	84,5	28,9	207,5	71,1	292
P2	61,3	34,1	118,7	65,9	180
P3	41,4	34,8	77,6	65,2	119

Table 4.24: Task 3 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	59,2	37,5	98,8	72,5	158
P2	64,5	39,3	99,5	60,7	164

Table 4.25: Task 3 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	30,4	36,6	52,6	63,4	83
P2	46,9	34,2	90,1	65,8	137
P3	35,6	39,56	54,4	60,44	90

The graph below visualizes total fixation duration and fixation count percentages for task 3.

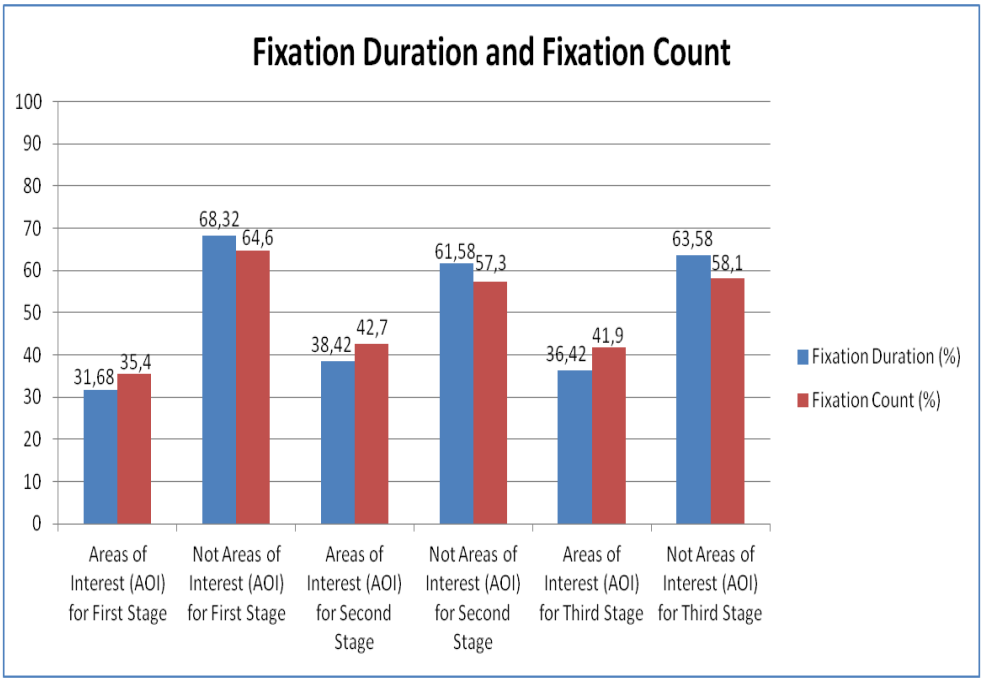

Figure 4.18: Total Fixation Durations and Fixation Counts Percentages of Task 3

4.4.1.3.5 Think-Aloud

"Ana sayfada bekleyen işlere tıkladım. Neden evrak direk olarak karşıma gelmiyor?"

"I clicked pending tasks at the home page. Why does not the document appear directly?"
Visibility of System Status

"Bu formu nasıl geri göndereceğim?"

"How will I send this form back?"

"Formun yazısını değiştince ne olacak merak ediyorum." Understanding of System Instructions / Error Messages

"I wonder what will happen when I change the text of form."

"Önizleme kısmı java ile olunca sorun çıkarır bence."

"It could make trouble since the document is previewed with java."

4.4.1.4 Task 4: Review the maintenance and repair form, which was filled and sent to you, related with central heating problem of a department and process it to the next phase (Sending it to the next department / manager or archiving).

4.4.1.4.1 Completion Time

The results of completion time for managers related with task 4 are shown in the graph below.

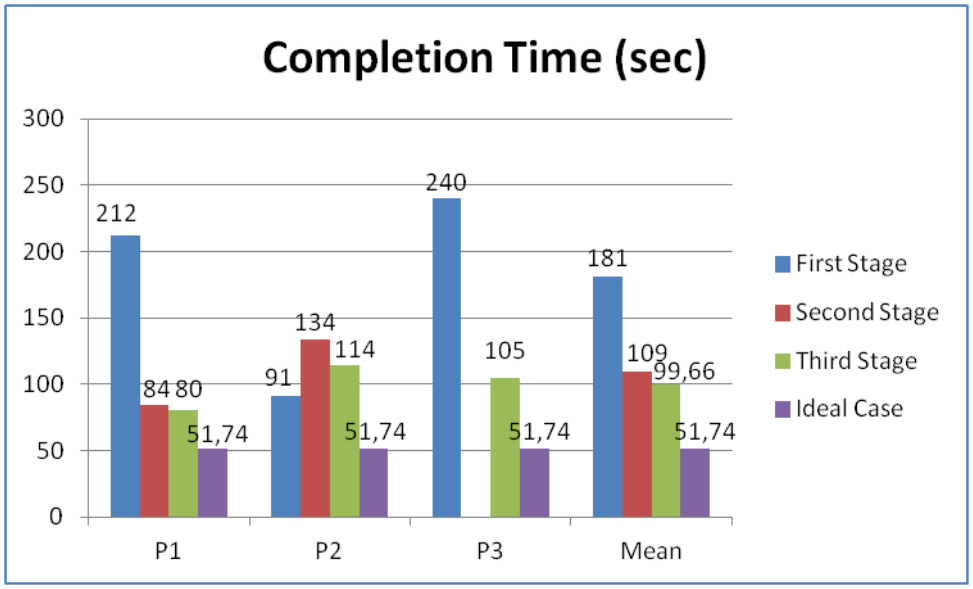

Figure 4.19: Task 4 Completion Time Graph for Managers

4.4.1.4.2 Mouse Clicks

The graph below represents the results of mouse click estimations for managers related with task 4.

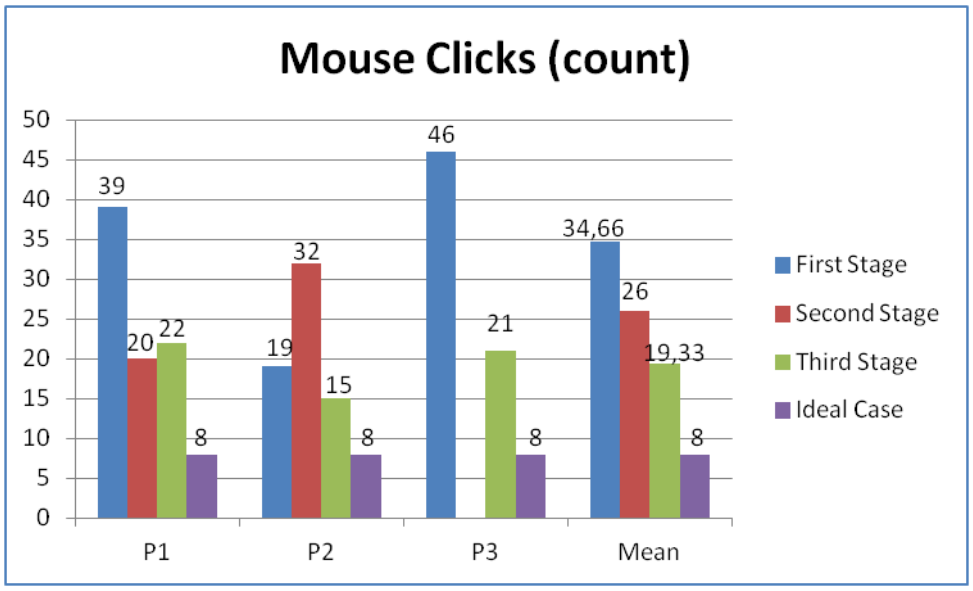

Figure 4.20: Task 4 Mouse Clicks for Managers

4.4.1.4.3 Areas of Interest

Areas of Interest (AOIs) identified for task 4 is the same with task 2 and task 3 since participants need to visit the same page for the beginning phase. However, they click on different areas after the beginning phase. There are totally 7 AOIs for this task and 3 of them are appropriate for this task. The names of these AOIs are Tabs, Periodic Works and Transitory Tasks. These areas are represented with yellow, light green and blue boxes respectively in the figure below. All of the AOIs are demonstrated in Figure 4.21 below.

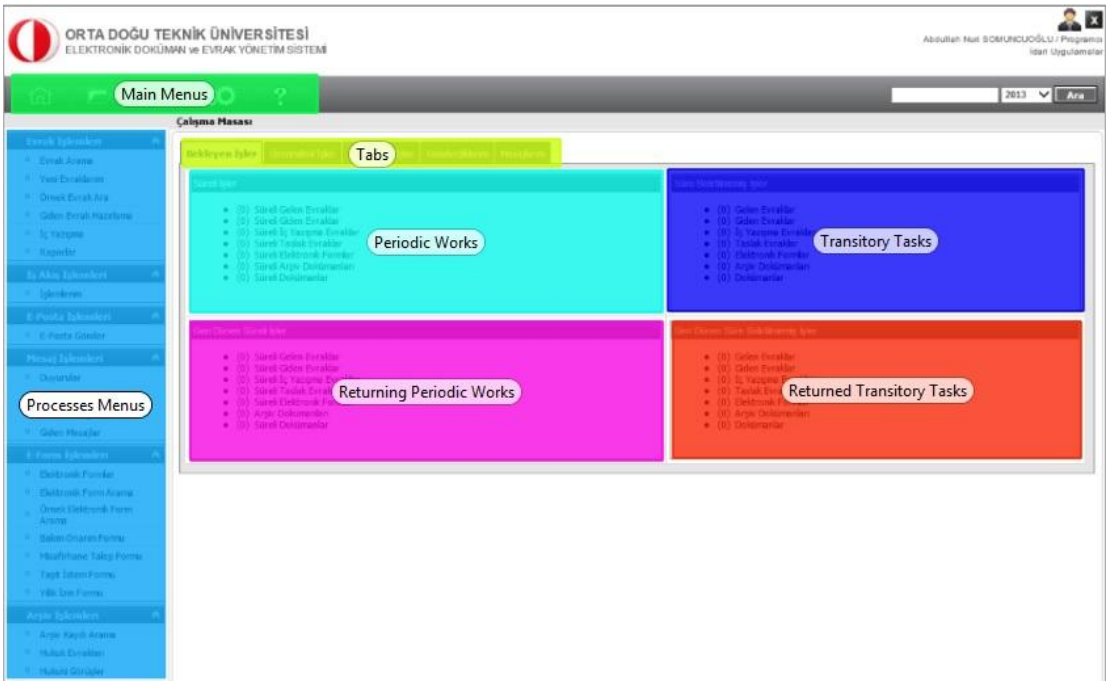

Figure 4.21: Areas of Interest for Task 4

4.4.1.4.4 Fixation Duration and Fixation Count

Table 4.26: Task 4 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	74,9	35,33	137,1	64,67	212
P2	72,4	30,16	167,6	69,84	240
P3	35,8	39,34	55,2	60,66	91

Table 4.27: Task 4 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	59,2	37,5	98,8	72,5	158
P2	64,5	39,3	99,5	60,7	164

Table 4.28: Task 4 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	30,4	36,6	52,6	63,4	83
P2	46,9	34,2	90,1	65,8	137
P3	35,6	39,56	54,4	60,44	90

The graph below shows total fixation duration and fixation count percentages for task 4.

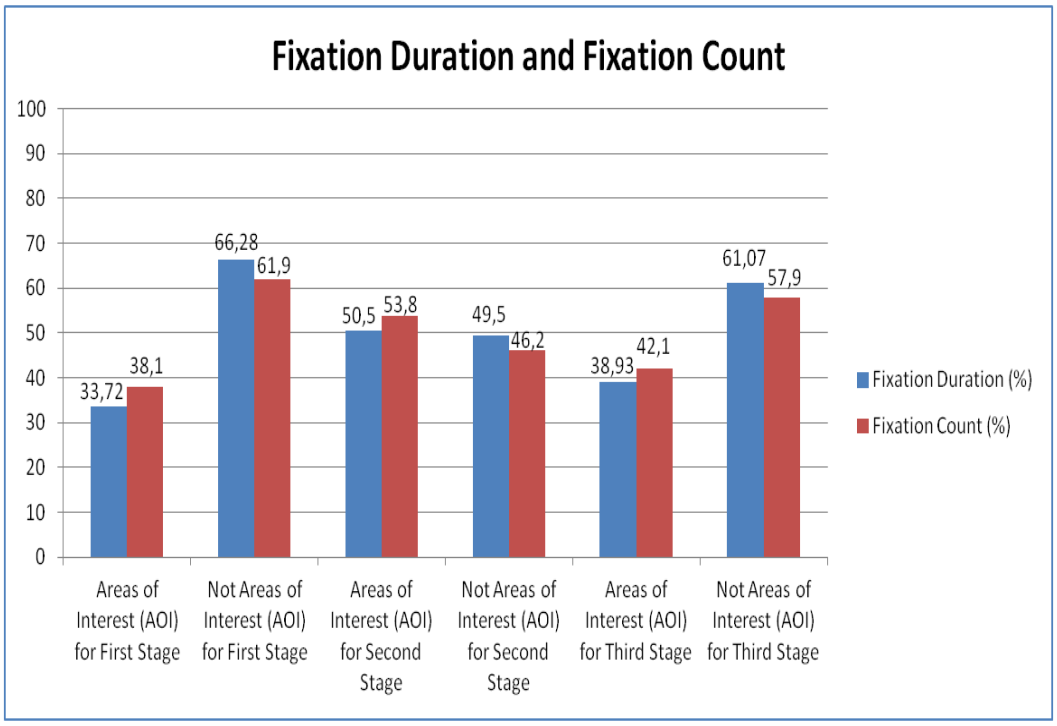

Figure 4.22: Total Fixation Durations and Fixation Counts Percentages of Task 4

4.4.1.4.5 Think-Aloud

"Formu arşive kaldırınca ne oluyor?"

"What happens when the form is archived?" Lack of Visibility of System Status

"Formu bir sonraki kişiye göndermek gayet kolay."

"It is very easy to send the form to the next person." Overall Ease of Use

"Seçenekler arasında arşive kaldır da olmalı."

"Archive option should be among the options." Consistency of Operations

"Arşive kaldırın sevket seçeneği içinde olması kullanışsız olmuş."

"It has been impractical that archive option is within the dispatch option." Overall Ease of Use

4.4.1.5 *Task 5: You want to make some changes on a repair and maintenance form's text. However, you do not know how to make these changes and direct it to the related personnel. Find the help menus inside the system so as to get help and get information about the related situation from these menus.*

4.4.1.5.1 Completion Time

The results of completion time for managers related with task 5 are demonstrated in the graph below.

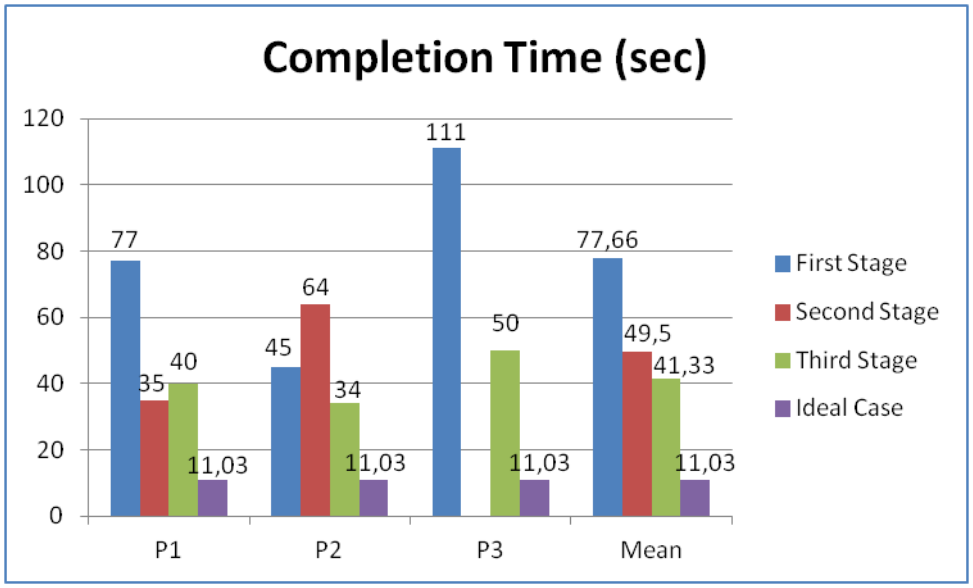

Figure 4.23: Task 5 Completion Time Graph for Managers

4.4.1.5.2 Mouse Clicks

The graph below visualizes the results of mouse click estimations for managers related with task 5.

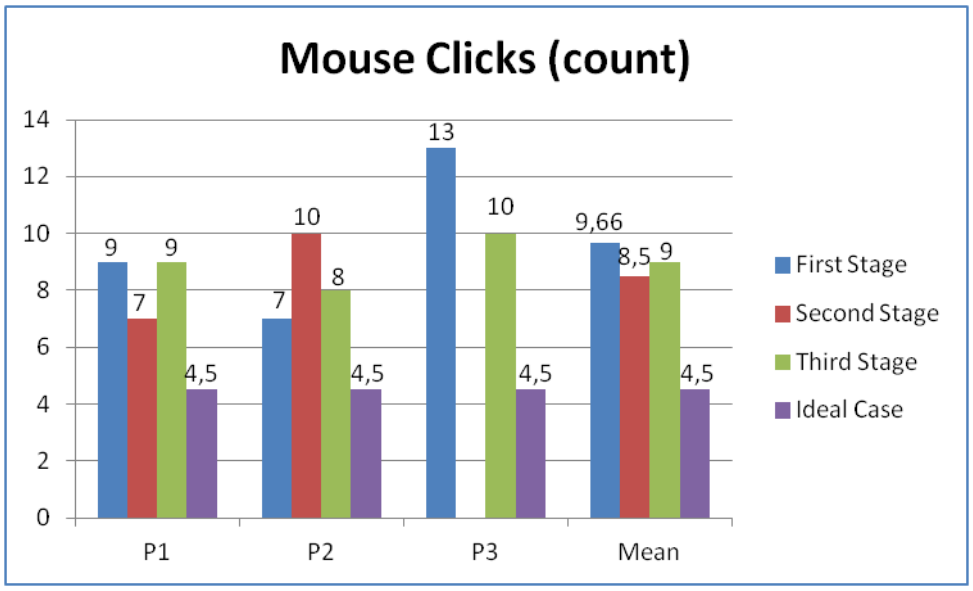

Figure 4.24: Task 5 Mouse Clicks for Managers

4.4.1.5.3 Areas of Interest

Areas of Interest (AOIs) identified for task 5 is the same with task 1 because participants see the same home page after logging in the system for the beginning phase. However, they click on different areas after the beginning phase. There are totally 9 AOIs for this task and 3 of them are appropriate for this task. The names of these AOIs are Desktop, System Settings and Announcements. These areas are represented with green, blue and pink boxes respectively in the figure below. All of the AOIs for the beginning phase are shown in Figure 4.25 below.

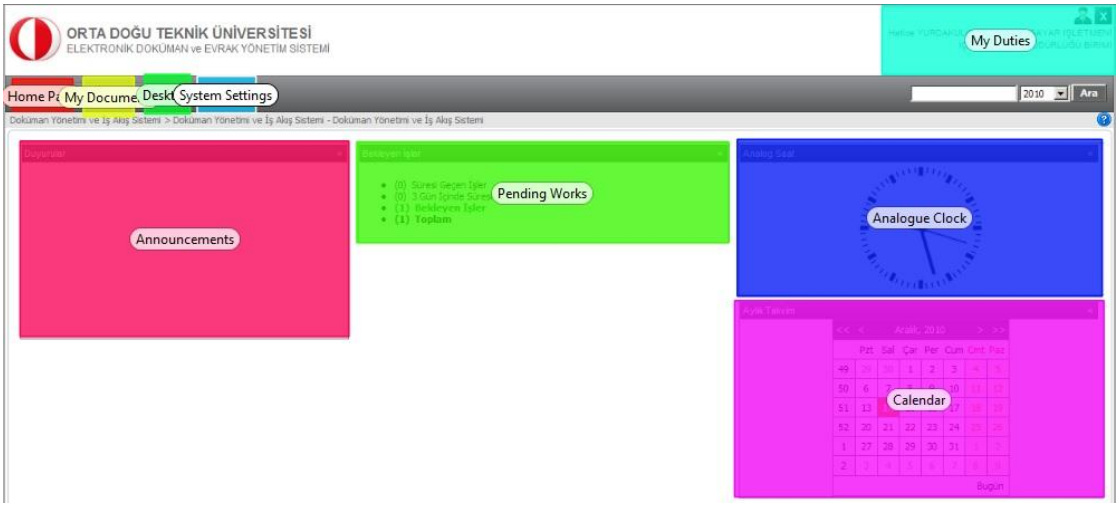

Figure 4.25: Areas of Interest for Task 5

4.4.1.5.4 Fixation Duration and Fixation Count

Table 4.29: Task 5 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	34,8	45,19	42,2	54,81	77
P2	33,7	30,36	77,3	66,3	111
P3	19,2	42,67	25,8	80,8	45

Table 4.30: Task 5 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	22,4	64	12,6	36	35
P2	24,7	38,59	39,3	61,41	64

Table 4.31: Task 5 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	26,8	67	13,2	33	40
P2	23,9	70,29	10,1	29,71	34
P3	31,4	62,8	18,6	37,2	50

The graph below demonstrates total fixation duration and fixation count percentages for task 5.

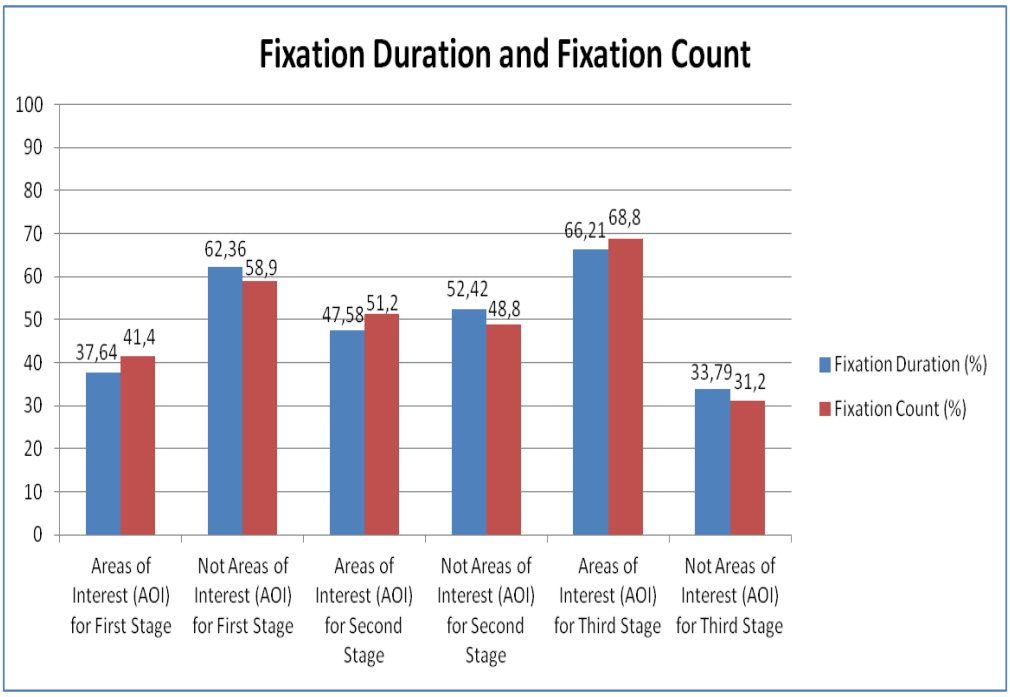

Figure 4.26: Total Fixation Durations and Fixation Counts Percentages of Task 5

4.4.1.5.5 Think-Aloud

"Ana sayfada yardım menüsü yok mu?"

"Is not there any help menu at the home page?" Layout / Screen Organization

"Ana sayfada yardım menüsü olmalı."

"There should be a help menu at the home page." Layout / Screen Organization

"Yardıma kolayca ulaşmam gerek."

"I should reach help easily." Overall Ease of Use

"Sadece formu oluştururken yardım sağlamak yeterli değil."

"Providing help just while creating the form is not enough."

"Sistem ayarlarında yardım yoktur herhalde."

"There is no help in system settings, I guess." Meaning of Labels

"Yardım videoları güzel olmuş."

"Help videos are good."

4.4.2 Eye Tracking Results for Personnel / Workers

All participants' data were evaluated for all the tasks of personnel. 7 officers attended the first stage of the study. The second stage of the study was with the same participants of the first stage. One of these officers had retired and therefore the second stage of the study was performed with 6 officers. Finally, the third stage of the study was conducted with 7 officers who did not participate in the first and second stage of the study.

4.4.2.1 Task 1. You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works on behalf of you. For this reason, assign delegation the worker that will perform your works by filling the related date and time information. After assigning your delegation, assume that your annual leave has ended and cancel your delegation.

4.4.2.1.1 Completion Time

The results of completion time for personnel / workers related with task 1 are shown in the graph below.

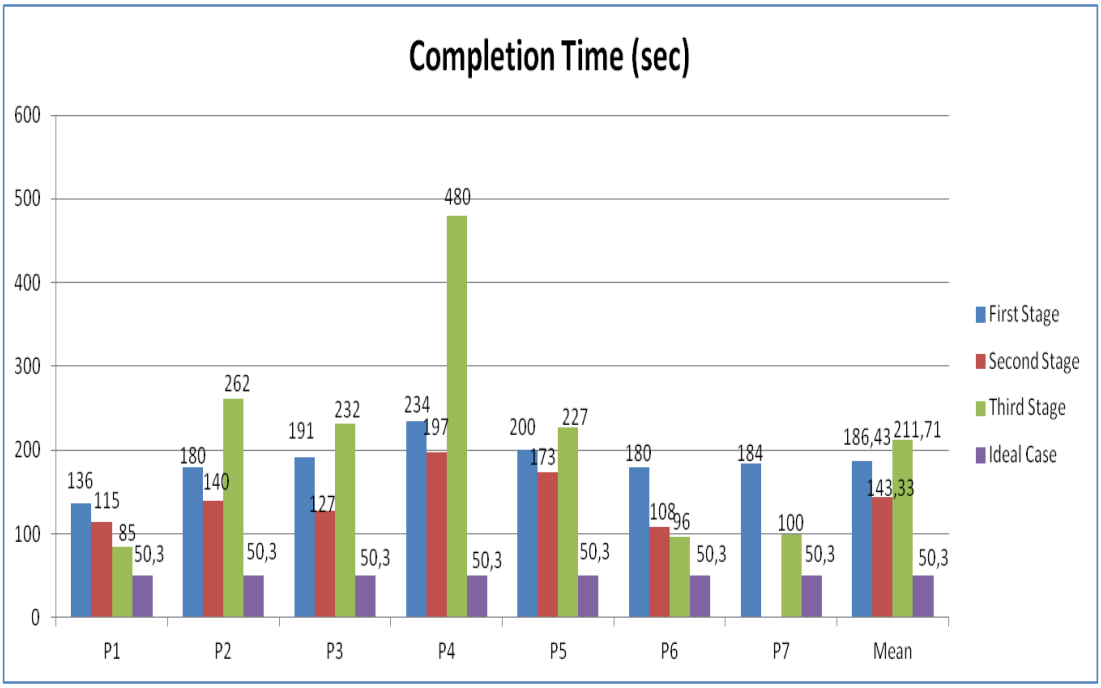

Figure 4.27: Task 1 Completion Time Graph for Personnel / Workers

4.4.2.1.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 1 are represented in the graph below.

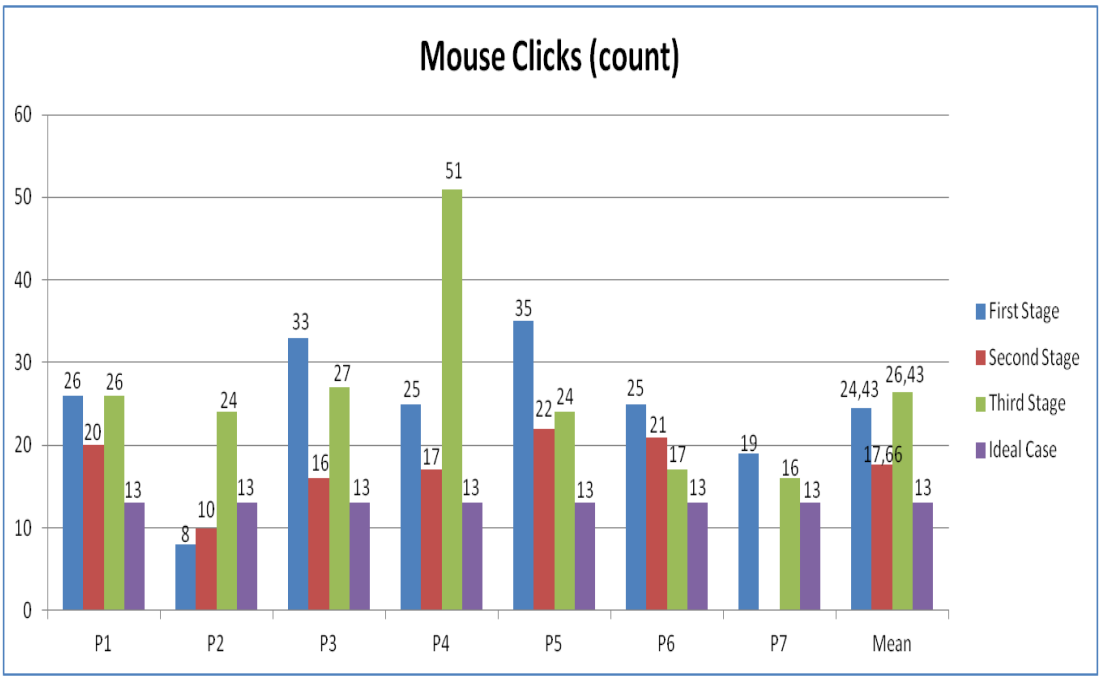

Figure 4.28: Task 1 Mouse Clicks for Personnel / Workers

4.4.2.1.3 Areas of Interest

Areas of Interest (AOIs) identified for task 1 is the same with manager's task 1 because the participants are required to achieve the same thing. There are totally 9 AOIs determined for the analysis of this task. However, 2 of these AOIs are appropriate for task 1. These appropriate areas are My Duties and System Settings areas. The two AOIs in Figure 4.71 are represented with turquoise and green boxes. All of the AOIs for the beginning phase are visualized in Figure 4.29 below.

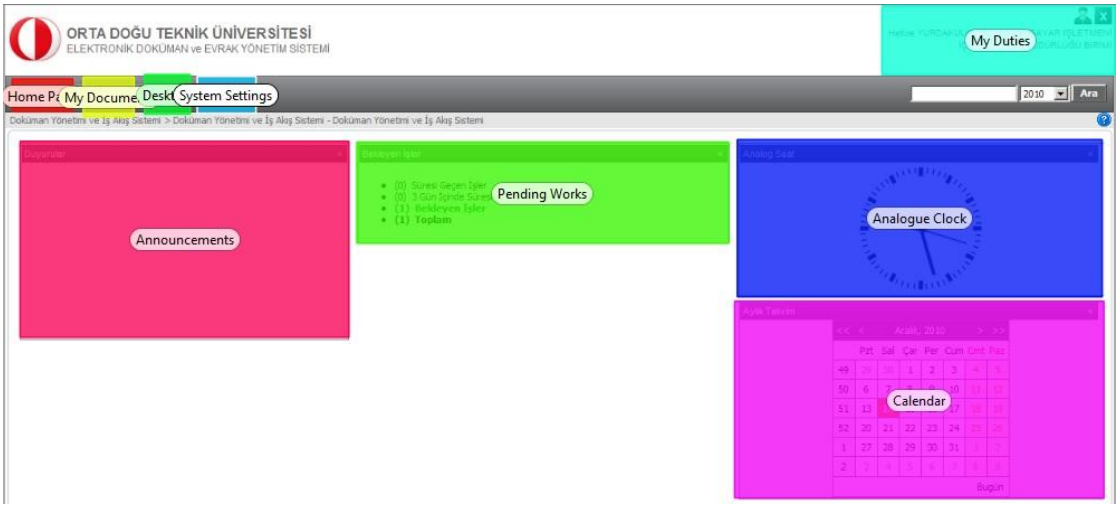

Figure 4.29: Areas of Interest for Task 1

4.4.2.1.4 Fixation Duration and Fixation Count

Table 4.32: Task 1 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	23,8	17,5	112,2	82,5	136
P2	30,2	16,78	149,8	83,22	180
P3	29,4	15,39	161,6	84,61	191
P4	36,8	15,73	197,2	84,27	234
P5	34,6	17,3	165,4	82,7	200
P6	29,9	16,61	150,1	83,39	180
P7	33,7	18,32	150,3	81,68	184

Table 4.33: Task 1 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	21,6	18,78	93,4	81,22	115
P2	34,7	24,79	105,3	75,21	140
P3	24,8	19,53	102,2	80,47	127
P4	32,4	16,45	164,6	83,55	197
P5	30,9	17,86	142,1	82,14	173
P6	23,3	21,57	84,7	78,43	108

Table 4.34: Task 1 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	19,7	23,18	65,3	76,82	85
P2	34,6	13,21	227,4	86,79	262
P3	39,8	17,16	192,2	82,84	232
P4	80,4	16,75	379,6	83,25	480
P5	39,6	17,44	187,4	82,56	227
P6	21,4	22,29	74,6	77,71	96
P7	24,9	24,9	75,1	75,1	100

The graph below shows total fixation duration and fixation count percentages for task 1.

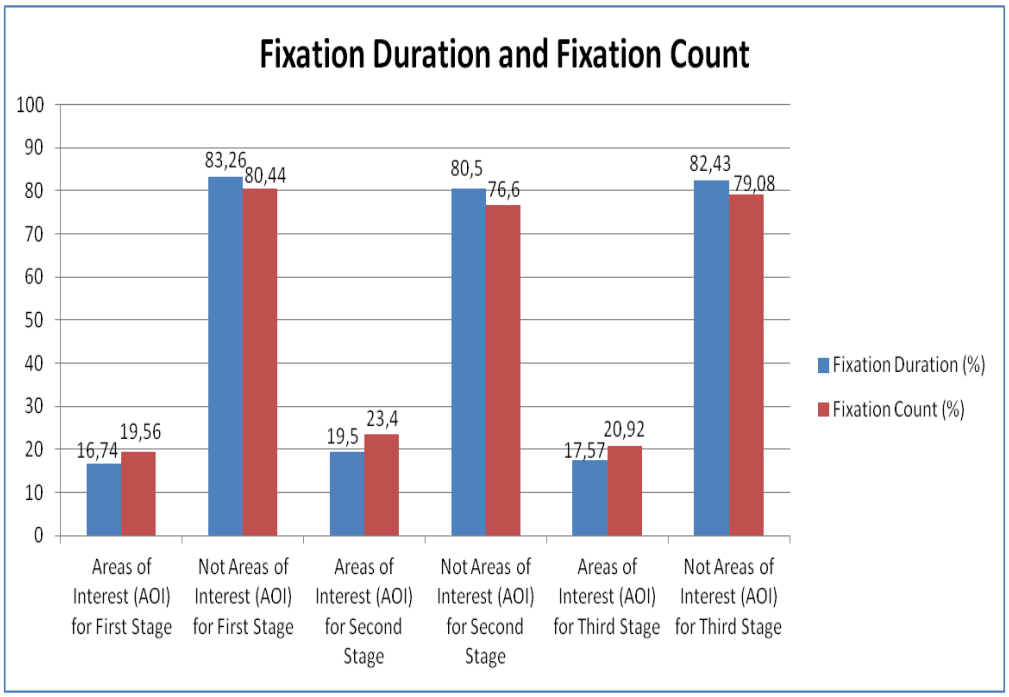

Figure 4.30: Total Fixation Durations and Fixation Counts Percentages of Task 1

4.4.2.1.5 Think-Aloud

"Uzun zamandır vekalet vermediğim için unutmuşum."

"I had forgotten since I have not assigned delegation for long time."

"Vekalet verme özelliğini şu ana kadar hiç kullanmadım. Bu yüzden bulamıyorum."

"I have never used assigning delegation property till now. Therefore, I cannot find it."

"Yıllık izin formu doldurarak vekalet versem daha iyi olur."

"It would be better if I assign delegation by filling annual leave form."

"Vekalet verme seçeneğini bulmak çok zor."

"It is very difficult to find assigning delegation property." Overall Ease of Use

"Vekalet verme nerede?"

"Where is assigning delegation?"

"Vekalet verme sistem ayarları menüsünün altında olmamalı."

"Assigning delegation should not be under system settings menu." Layout / Screen Organization

4.4.2.2 *Task 2. You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information.*

4.4.2.2.1 Completion Time

The results of completion time for personnel / workers related with task 2 are provided in the graph below.

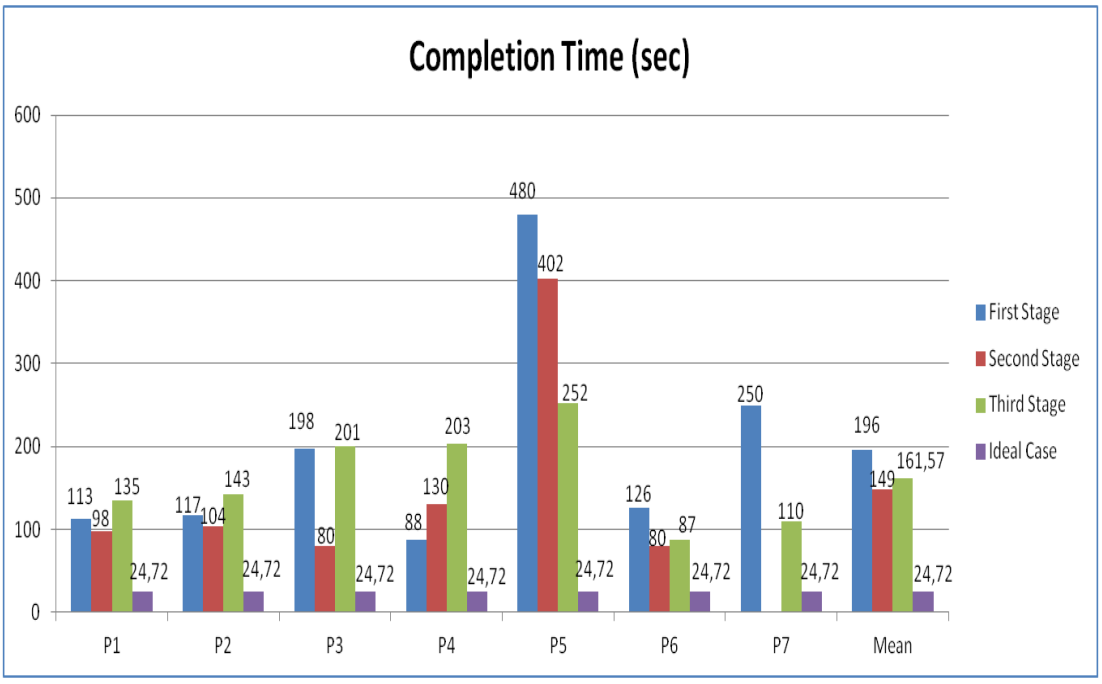

Figure 4.31: Task 2 Completion Time Graph for Personnel / Workers

4.4.2.2.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 2 are demonstrated in the graphs below.

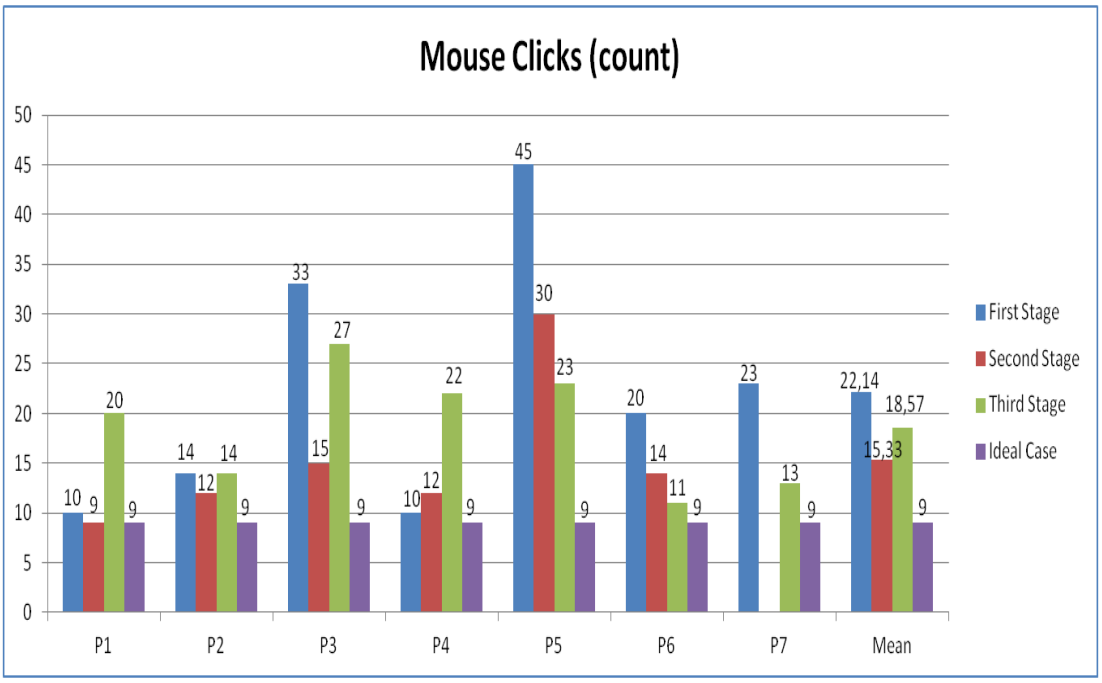

Figure 4.32: Task 2 Mouse Clicks for Personnel / Workers

4.4.2.2.3 Areas of Interest

There are totally 8 AOIs identified for this task. However, 3 of these AOIs are appropriate for task 2. These appropriate areas are Processes Menus, Search Criteria 4 and Results. These areas are represented with orange, red and yellow boxes in Figure 4.33 below.

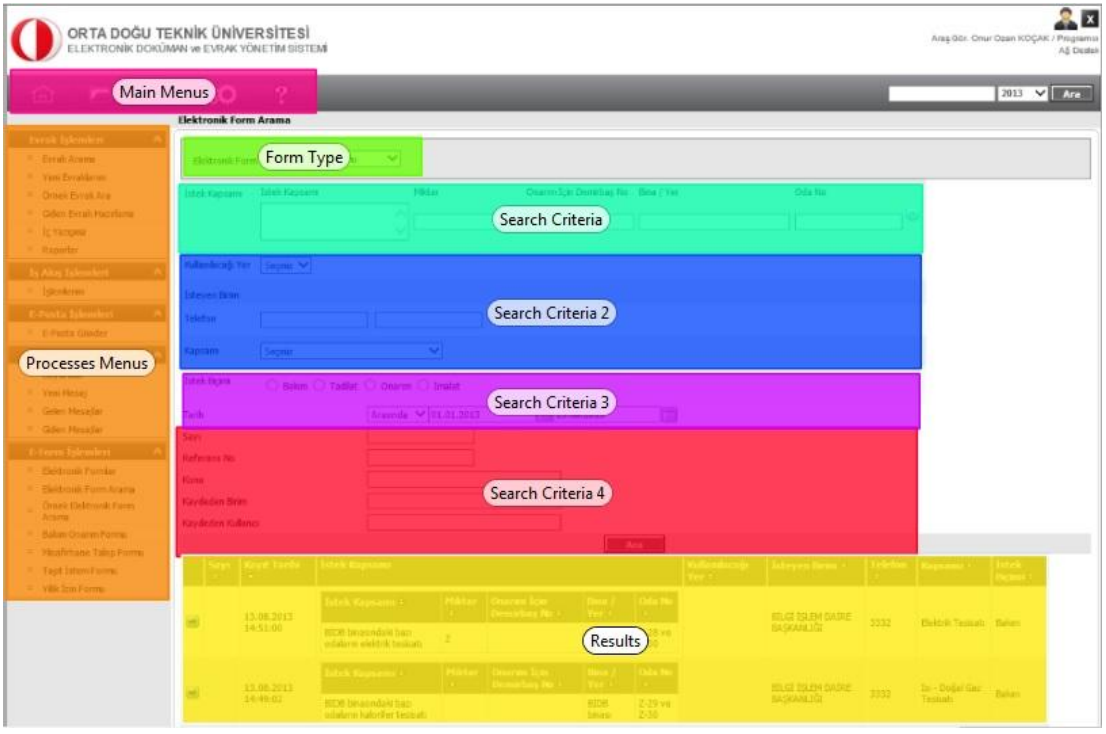

Figure 4.33: Areas of Interest for Task 2

4.4.2.2.4 Fixation Duration and Fixation Count

Table 4.35: Task 2 Fixation Durations for First Stage

Participant	**Fixation Durations (sec)**				
	Area of Interest (AOI)		**Not Area of Interest (NAOI)**		**Total Time (sec)**
	Time (sec)	**%**	**Time (sec)**	**%**	
P1	32,6	28,85	80,4	71,15	113
P2	34,5	29,49	82,5	70,51	117
P3	39,8	20,1	158,2	79,9	198
P4	30,4	34,55	57,6	65,45	88
P5	84,8	17,67	395,2	82,33	480
P6	29,4	23,33	96,6	76,67	126
P7	40,3	16,12	209,7	83,88	250

Table 4.36: Task 2 Fixation Durations for Second Stage

Participant	**Fixation Durations (sec)**				
	Area of Interest (AOI)		**Not Area of Interest (NAOI)**		**Total Time (sec)**
	Time (sec)	**%**	**Time (sec)**	**%**	
P1	38,9	39,69	59,1	60,31	98
P2	37,5	36,06	66,5	63,94	104
P3	34,9	43,63	45,1	56,37	80
P4	44,7	34,38	85,3	65,62	130
P5	86,4	21,49	315,6	78,51	402
P6	33,6	42	46,4	58	80

Table 4.37: Task 2 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	48,6	36	86,4	64	135
P2	45,4	31,75	97,6	68,25	143
P3	69,6	34,63	131,4	65,37	201
P4	61,9	30,49	141,1	69,51	203
P5	61,8	24,52	190,2	75,48	252
P6	35,2	40,46	51,8	59,54	87
P7	44,7	40,64	65,3	59,36	110

The graph below represents total fixation duration and fixation count percentages for task 2.

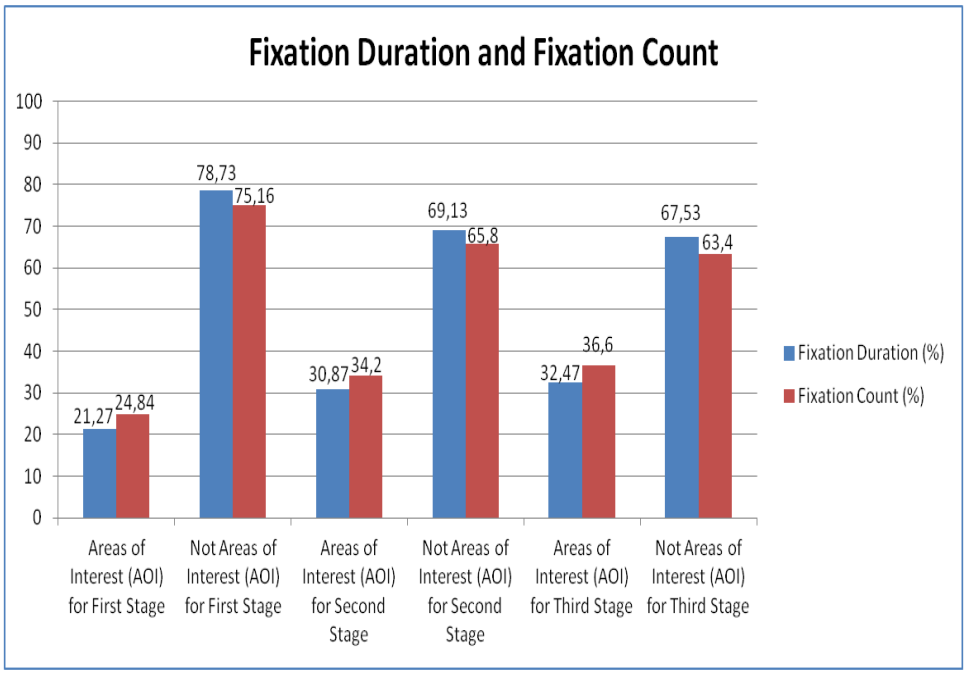

Figure 4.34: Total Fixation Durations and Fixation Counts Percentages of Task 2

4.4.2.2.5 Think-Aloud

"Formu önizlerken çok fazla java uyarısı geliyor."

"Too many java warnings appear while previewing the form?" Understanding of System Instructions

"Formları neden evrak arama seçeneğinden arayamıyorum?" Layout / Screen Organization

"Why cannot I search the forms with document search option?"

"Form arama seçeneğinde çok fazla seçenek olduğu için kafam karışıyor."

"I get confused since there are too many options in form search option." Layout / Screen Organization

"Arama için ana sayfada kısa yol olmalı."

"There should be a shortcut for searching at the home page" Layout / Screen Organization

4.4.2.3 Task 3. Since you had another work to do, you left a repair and maintenance form that you were filling incomplete. You want to continue filling your form after you completed the other work. Hence, find the shortcomings of the document whose subject is "Eksik Bilgileri Giriniz" (Enter Incomplete Information) in My New Records and send it to the related personnel by completing it.

4.4.2.3.1 Completion Time

The results of completion time for personnel / workers related with task 3 are shown in the graph below.

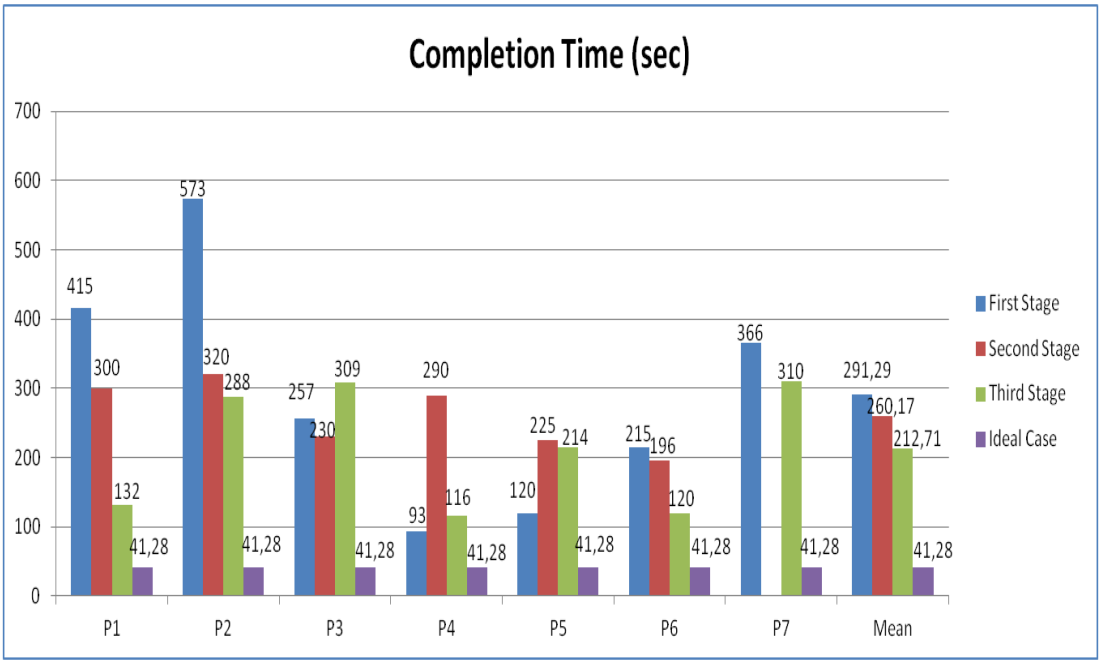

Figure 4.35: Task 3 Completion Time Graph for Personnel / Workers

4.4.2.3.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 2 are visualized in the graph below.

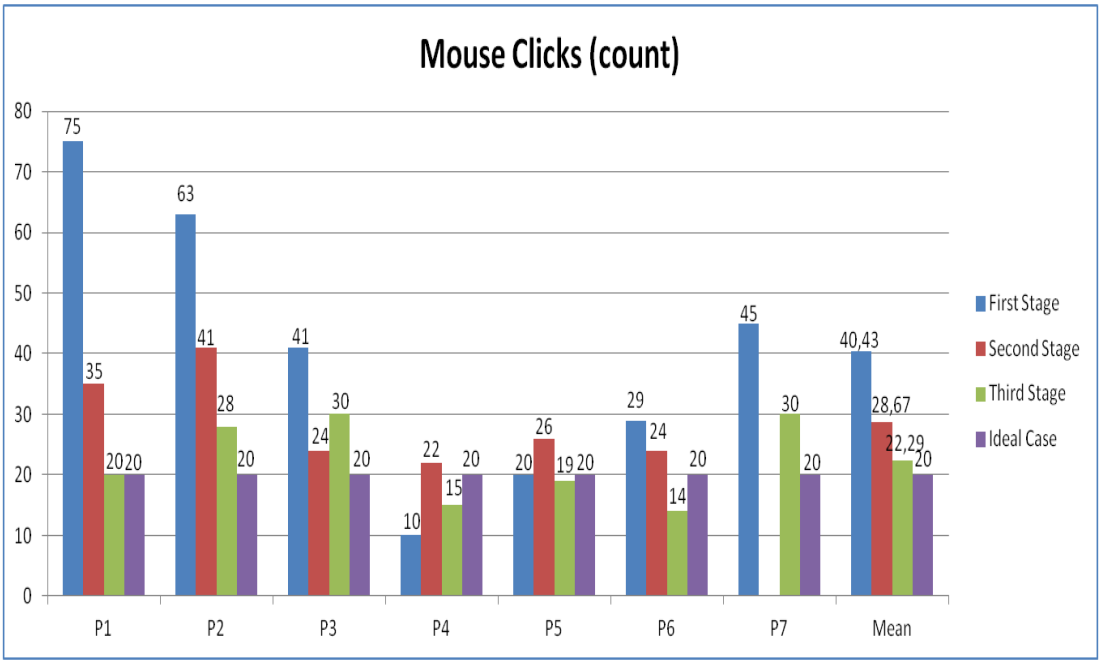

Figure 4.36: Task 3 Mouse Clicks for Personnel / Workers

4.4.2.3.3 Areas of Interest

There are totally 7 AOIs identified for this task. However, only 1 of these AOIs are appropriate for this task. The appropriate area is Processes Menus. Processes Menus is represented with light blue box in Figure 4.37 below.

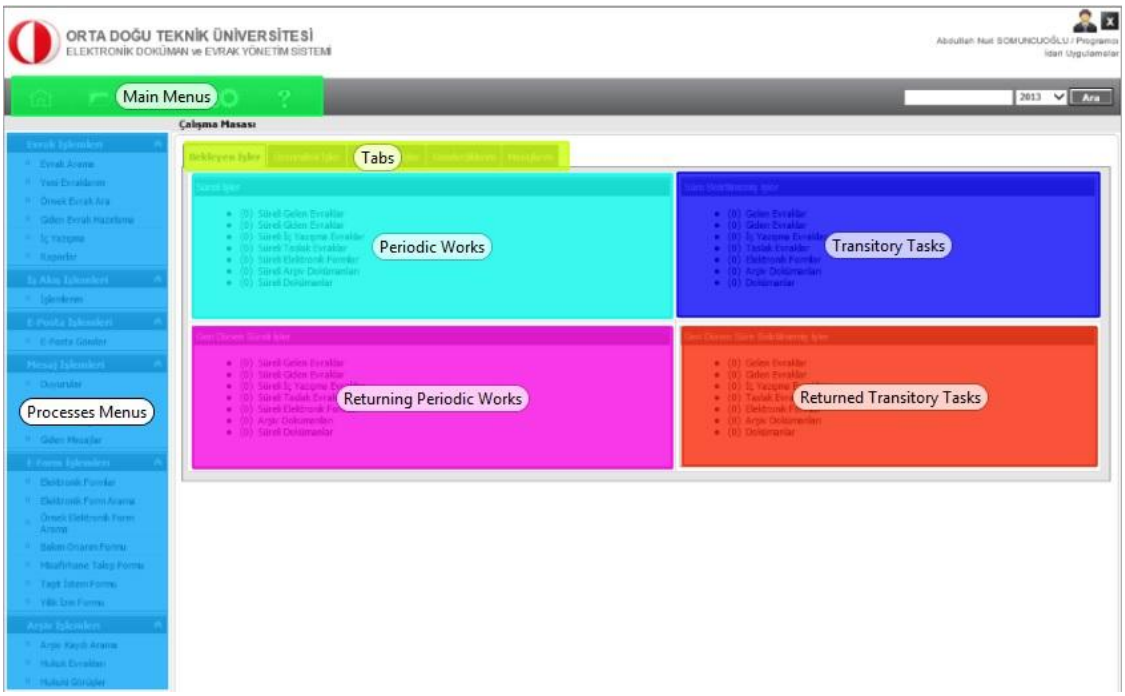

Figure 4.37: Areas of Interest for Task 3

4.4.2.3.4 Fixation Duration and Fixation Count

Table 4.38: Task 3 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	64,8	15,61	350,2	84,39	415
P2	70,6	12,32	502,4	87,68	573
P3	40,8	15,88	216,2	84,12	257
P4	20,6	22,15	72,4	77,85	93
P5	24,9	20,75	95,1	79,25	120
P6	34,7	16,14	180,3	83,86	215
P7	43,3	11,83	322,7	88,17	366

Table 4.39: Task 3 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	59,4	19,8	240,6	80,2	300
P2	49,7	15,53	270,3	84,47	320
P3	36,4	15,83	193,6	84,17	230
P4	66,2	22,83	223,8	77,17	290
P5	41,3	18,36	183,7	81,64	225
P6	38,7	19,74	157,3	80,26	196

Table 4.40: Task 3 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	28,4	21,52	103,6	78,48	132
P2	56,2	19,51	231,8	80,49	288
P3	61,5	19,90	247,5	80,10	309
P4	28,3	24,4	87,7	75,6	116
P5	42,9	20,05	171,1	79,95	214
P6	23,7	19,75	96,3	80,25	120
P7	47,6	15,35	262,4	84,65	310

The figure below demonstrates the total fixation duration and fixation count percentages for task 3.

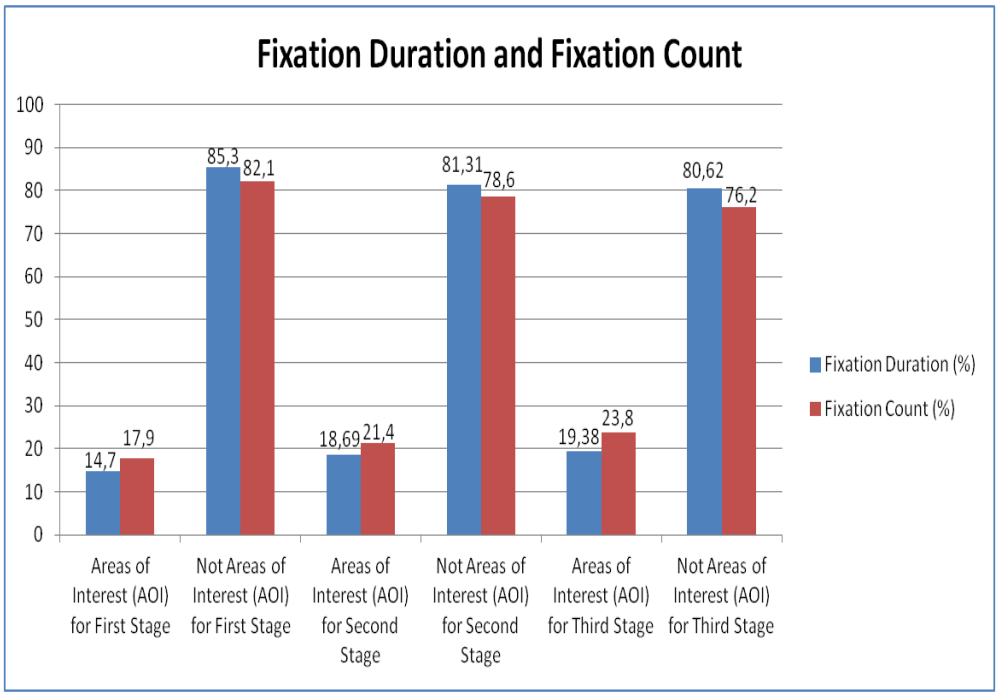

Figure 4.38: Total Fixation Durations and Fixation Counts Percentages of Task 3

4.4.2.3.5 Think-Aloud

"Yeni evraklarıma tıklıyorum ama benim formum burada yok. Benim formum nerede?"

"I click on my new records but my form is not here. Where is my form?" Visibility of System Status

"Formu bulamıyorum. Formu bulmak çok zor."

"I cannot find the form. Finding the form is very difficult." Overall Ease of Use

"Yeni evraklarıma tıkladım ama bu ekranda hiç form yok."

"I clicked on my new records but there is no form on that screen." Layout / Screen Organization

"Sistemde bir sorun mu var? Benim formum burda olmalı ama göremiyorum."

"Is there any problem with the system? My form should be here but I cannot see it."

"Çok fazla zaman harcadım ama formu bulamadım."

"I spent too much time but I could not find the form." Overall Ease of Use

4.4.2.4 Task 4. A malfunction has occurred for a room's heating system in your department or agency. Your head of department or manager demanded you to fill a repair and maintenance form related with this situation. Complete the repair and maintenance form by filling the essential information and dispatch it to the appropriate personnel.

4.4.2.4.1 Completion Time

The results of completion time for personnel / workers related with task 4 are demonstrated in the graph below.

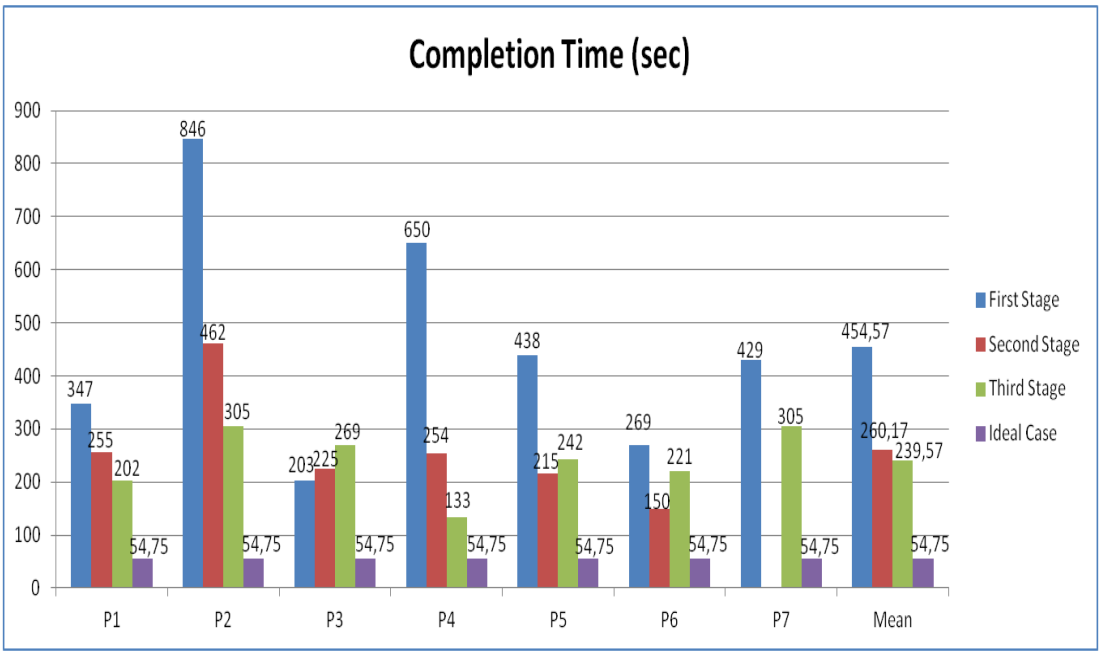

Figure 4.39: Task 4 Completion Time Graph for Personnel / Workers

4.4.2.4.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 2 are shown in the graph below.

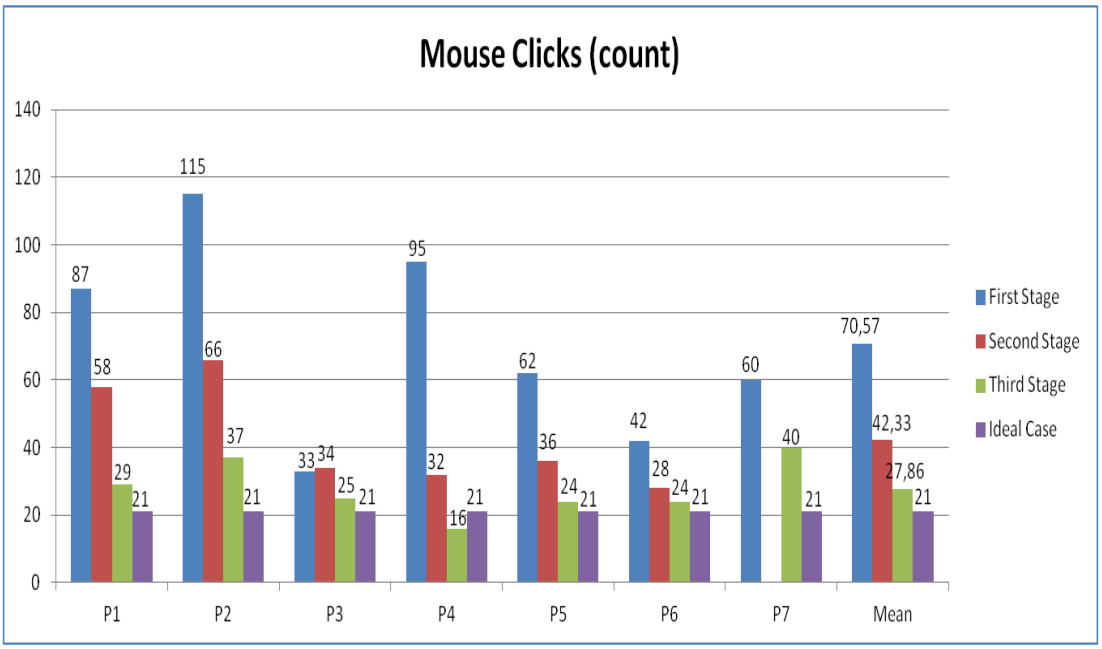

Figure 4.40: Task 4 Mouse Clicks for Personnel / Workers

4.4.2.4.3 Areas of Interest

There are totally 7 AOIs identified for the beginning phase of this task. However, only 1 of these AOIs are appropriate for this task. The appropriate area is Processes Menus. Processes Menus is represented with light blue box in Figure 4.41 below.

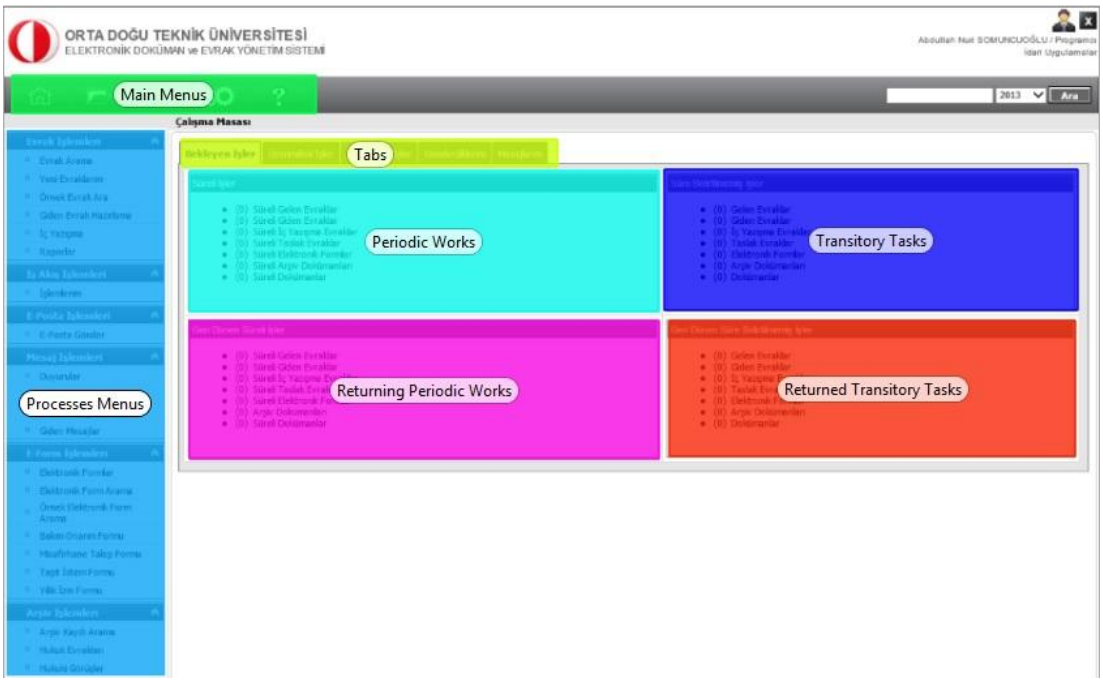

Figure 4.41: Areas of Interest for Task 4

4.4.2.4.4 Fixation Duration and Fixation Count

Table 4.41: Task 4 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	140,6	40,52	206,4	59,48	347
P2	224,8	26,57	621,2	73,43	846
P3	88,9	43,79	114,1	56,21	203
P4	170,2	26,18	479,8	73,82	650
P5	120,3	27,47	317,7	72,53	438
P6	74,5	27,7	194,5	72,3	269
P7	160,4	37,39	268,6	62,61	429

Table 4.42: Task 4 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	140,6	55,14	114,4	44,86	255
P2	280,7	60,76	181,3	39,24	462
P3	145,3	64,58	79,7	35,42	225
P4	151,9	59,8	102,1	40,2	254
P5	136,7	63,58	78,3	36,42	215
P6	94,8	63,2	55,2	36,8	150

Table 4.43: Task 4 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	124,3	61,53	77,7	38,47	202
P2	154,6	50,69	150,4	49,31	305
P3	144,8	53,83	124,2	46,17	269
P4	81,2	61,05	51,8	38,95	133
P5	119,5	49,38	122,5	50,62	242
P6	134,8	61	86,2	39	221
P7	151,9	49,8	153,1	50,2	305

The graph below shows total fixation duration and fixation count percentages for task 4.

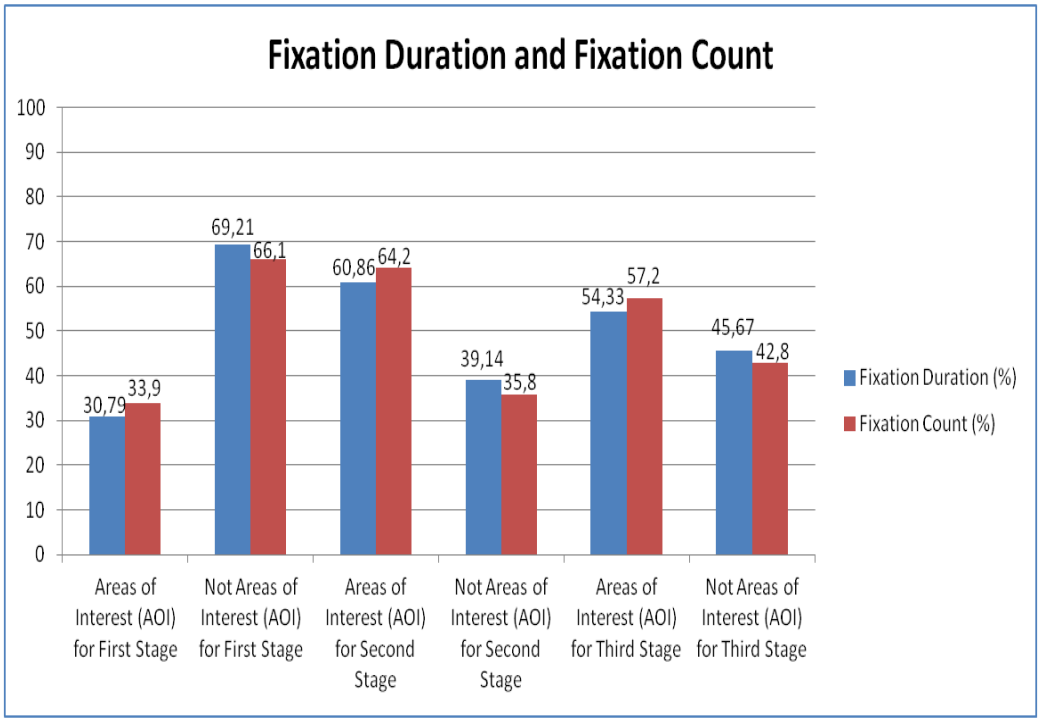

Figure 4.42: Total Fixation Durations and Fixation Counts Percentages of Task 4

4.4.2.4.5 Think-Aloud

"Formun bütün alanlarını doldurdum. O zaman, neden formu sevk edemiyorum?"

"I filled all the fields of the form. Then, why cannot I dispatch the form?"

"Formu kaydet butonuna tıkladım. Nasıl göndereceğim şimdi?"

"I clicked the save button. How will I send it now?"

"Bu verileri eklemek için neden '+' işaretine tıklıyorum ki? Çok saçma olmuş."

"Why do I click this '+' sign in order to add the data? This is very nonsense." Meaning of Labels

"Çok fazla zorunlu alan yok. Form sade ve güzel olmuş."

"There are not too many obligatory fields the form is simple and good." Layout / Screen Organization

"Önizleyince form güzel gözüküyor."

"Form seems nice when it is previewed." Graphics

"Formu doldururken çok fazla zaman harcadım. Formu doldurmak bu kadar zaman almamalı."

"I spent too much time while filling the form. It should not take this much time to fill the form." Overall Ease of Use

4.4.2.5 Task 5. Your head of department or manager wanted information about where and on which phase the repair and maintenance form that you had dispatched is after some time. For this reason, learn where and on which phase the repair and maintenance form that you had dispatched is by finding your document.

4.4.2.5.1 Completion Time

The results of completion time for personnel / workers related with task 4 are given in the graph below.

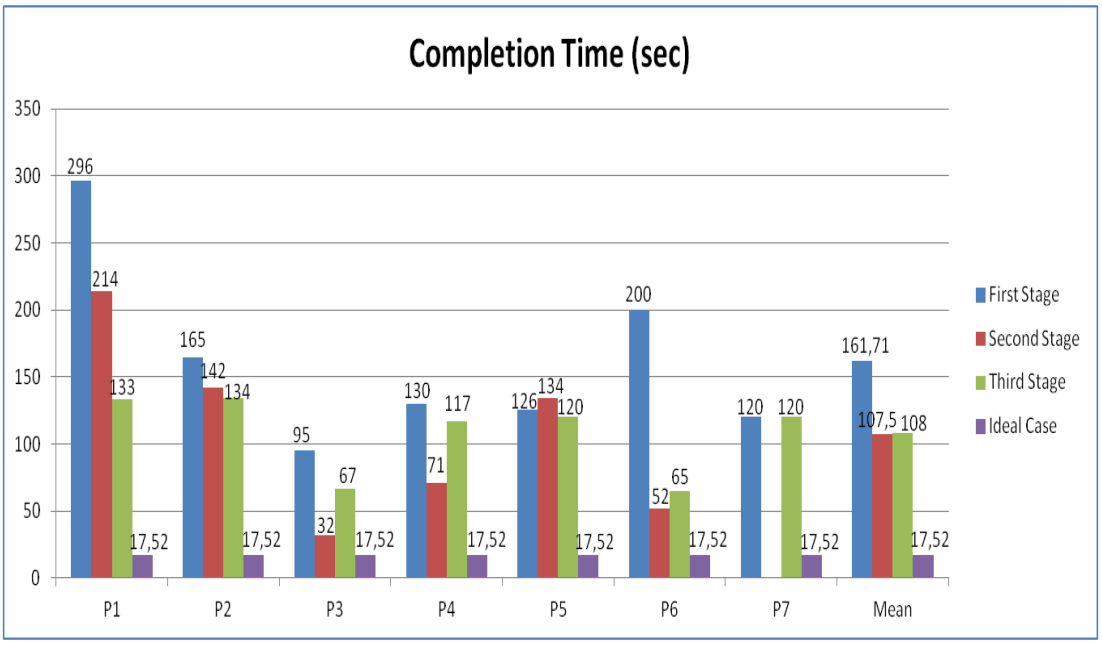

Figure 4.43: Task 5 Completion Time Graph for Personnel / Workers

4.4.2.5.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 2 are presented in the graph below.

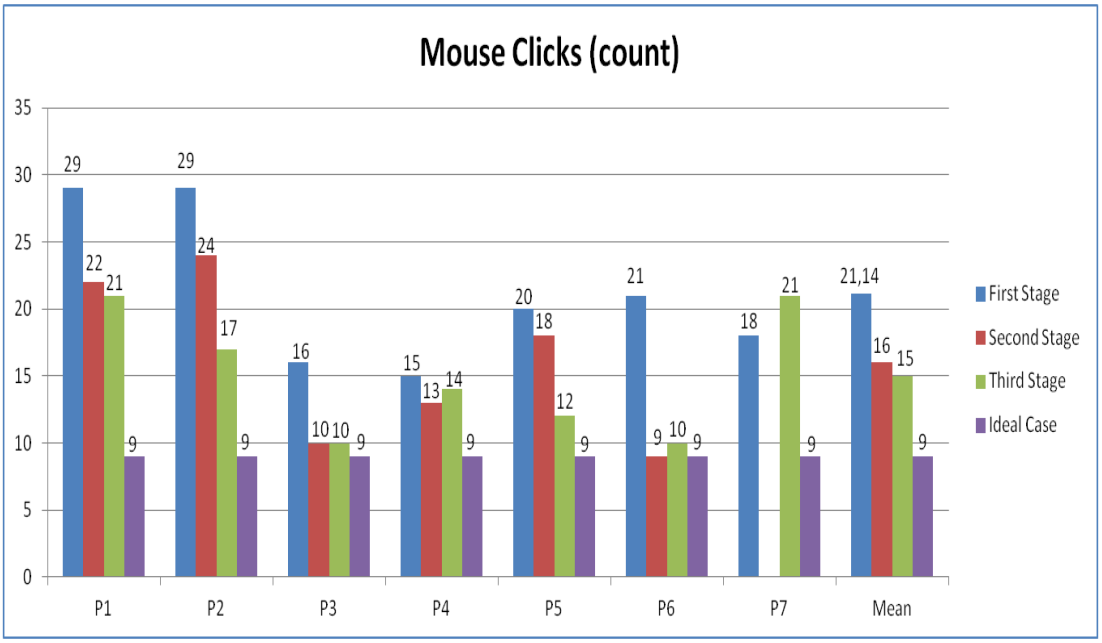

Figure 4.44: Task 5 Mouse Clicks for Personnel / Workers

4.4.2.5.3 Areas of Interest

There are totally 7 AOIs identified for the beginning phase of this task. 2 of these AOIs are appropriate for this task. The appropriate areas are Processes Menus and Tabs. These areas are represented with light blue and yellow boxes respectively in Figure 4.45 below.

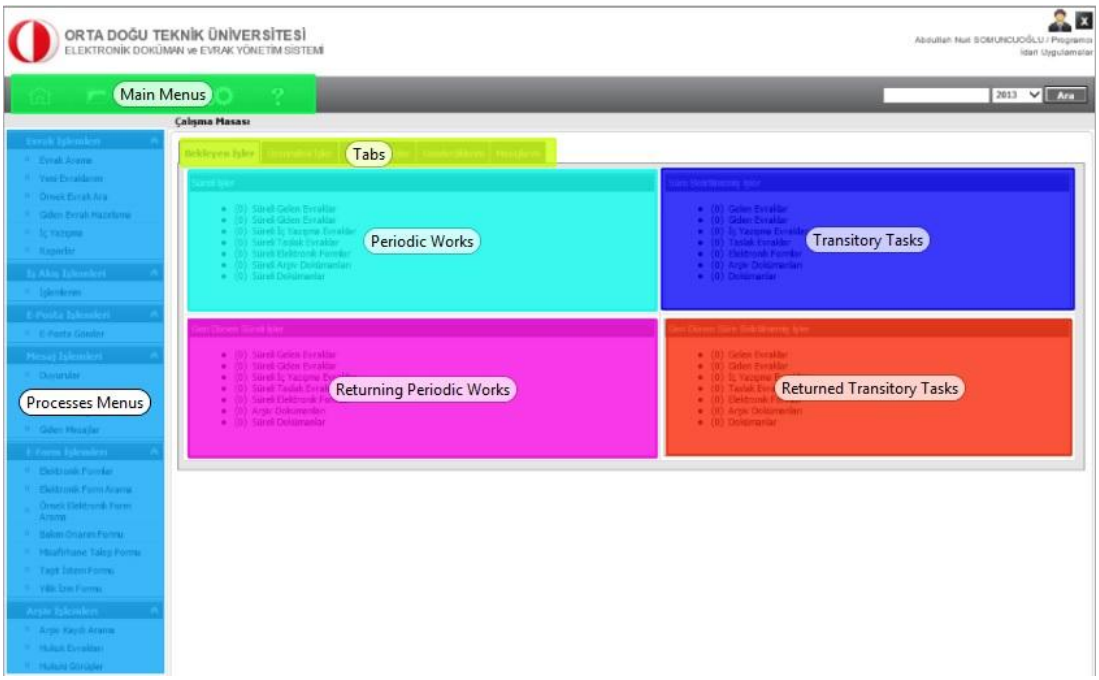

Figure 4.45: Areas of Interest for Task 5

4.4.2.5.4 Fixation Duration and Fixation Count

Table 4.44: Task 5 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	45,7	15,44	250,3	84,56	296
P2	34,5	20,91	130,5	79,09	165
P3	24,6	25,89	70,4	74,11	95
P4	23,9	18,38	106,1	81,62	130
P5	28,1	22,3	97,9	77,7	126
P6	29,3	14,65	170,7	85,35	200
P7	20,8	17,33	99,2	82,67	120

Table 4.45: Task 5 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	34,5	16,12	179,5	83,88	214
P2	24,6	17,32	117,4	82,68	142
P3	8,9	27,81	23,1	72,19	32
P4	18,3	25,77	52,7	74,23	71
P5	26,7	19,93	107,3	80,07	134
P6	14,8	28,46	37,2	71,54	52

Table 4.46: Task 5 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	23,9	17,97	109,1	82,03	133
P2	22,4	16,72	111,6	83,28	134
P3	15,6	23,28	51,4	76,72	67
P4	20,8	17,78	96,2	82,22	117
P5	26,4	22	93,6	78	120
P6	13,3	20,46	51,7	79,54	65
P7	22,7	18,92	97,3	81,08	120

The graph below represents total fixation duration and fixation count percentages for task 5.

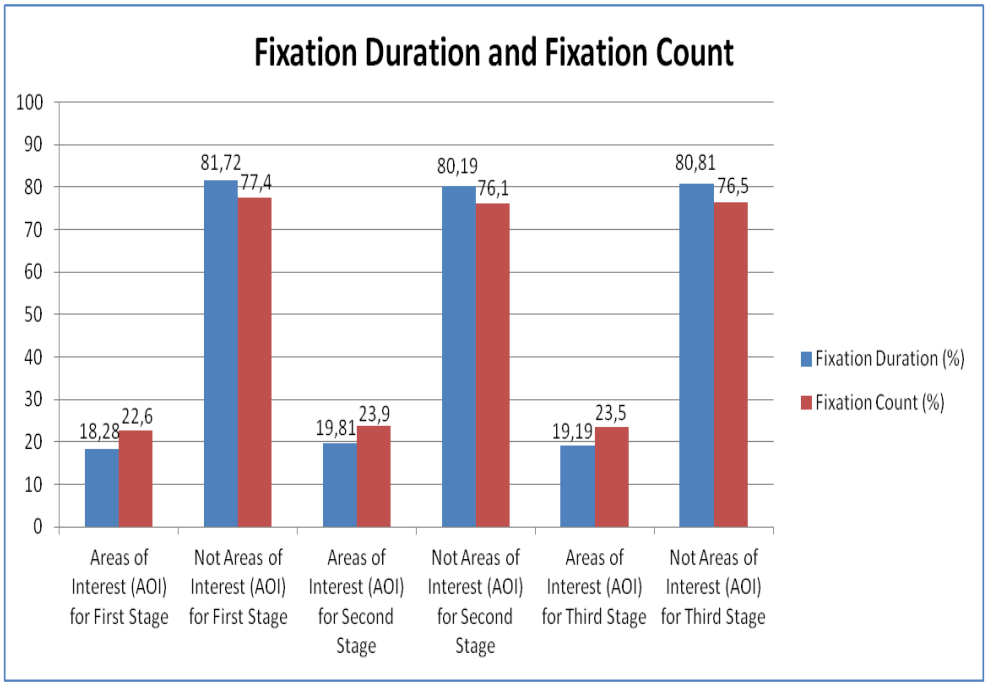

Figure 4.46: Total Fixation Durations and Fixation Counts Percentages of Task 5

4.4.2.5.5 Think-Aloud

"Formun nerede olduğunu gayet kolay buldum."
"I easily found where the form is." Overall Ease of Use
"Bu seçenek gayet kullanışlı."
"This option is very useful." Overall Ease of Use
"Formu bulmak için kimseye telefon etmek zorunda kalmıyorum."
"I do not have to call anyone so as to find the form."
"Formu değişik menülerden bulabiliyorum. Bu gayet güzel."
"I can find the form from different menus. This is very nice." Consistency of Operations
"Sevk günlük seçeneğinin adı farklı olabilir. Mesela, formum nerede?"
"The name of dispatch history could be different. For instance, where is my form?"

4.4.2.6 Task 6. You realized that you had sent the Repair and Maintenance form that you had filled based on your head of department or manager demand to a wrong personnel. Take your document back before the personnel that you had sent wrongly makes a change on your document.

4.4.2.6.1 Completion Time

The results of completion time for personnel / workers related with task 4 are demonstrated in the graph below.

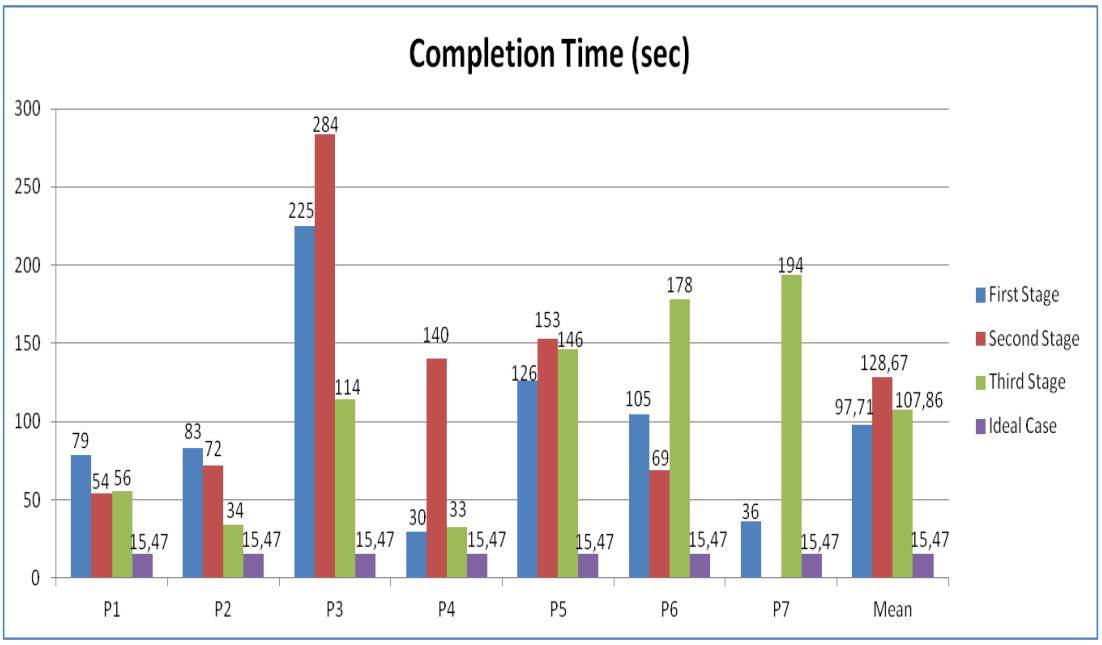

Figure 4.47: Task 6 Completion Time Graph for Personnel / Workers

4.4.2.6.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 2 are visualized in the graph below.

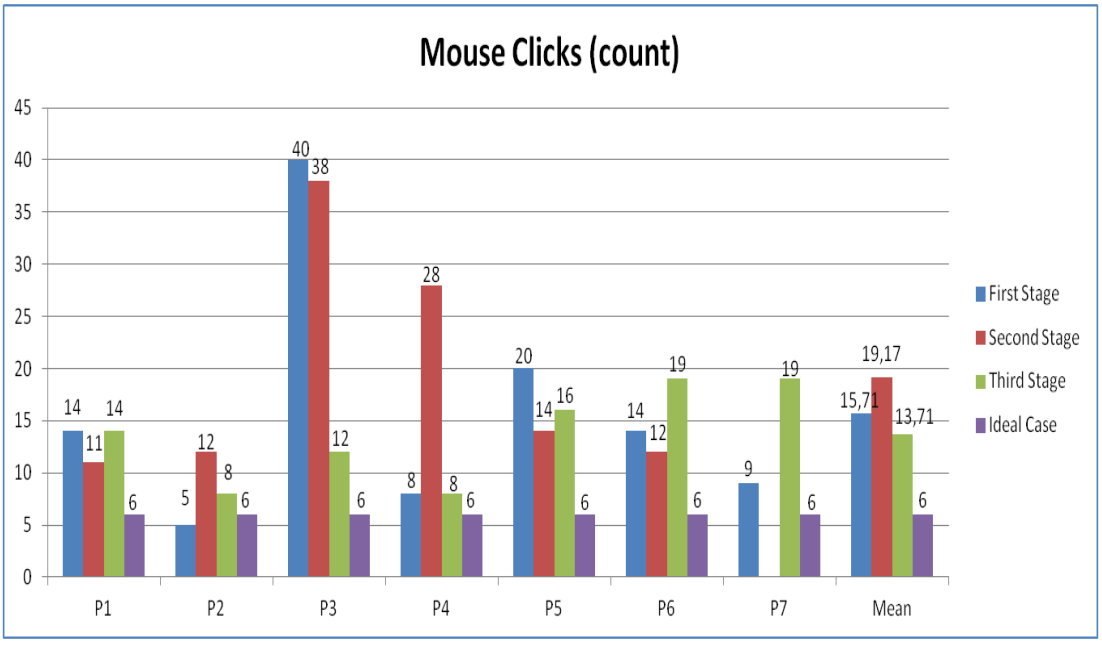

Figure 4.48: Task 6 Mouse Clicks for Personnel / Workers

4.4.2.6.3 Areas of Interest

There are totally 7 AOIs identified for the beginning phase of this task. However, only 1 of these AOIs is appropriate for this task. The appropriate area is Tabs. Tabs area is represented with yellow box in Figure 4.49 below.

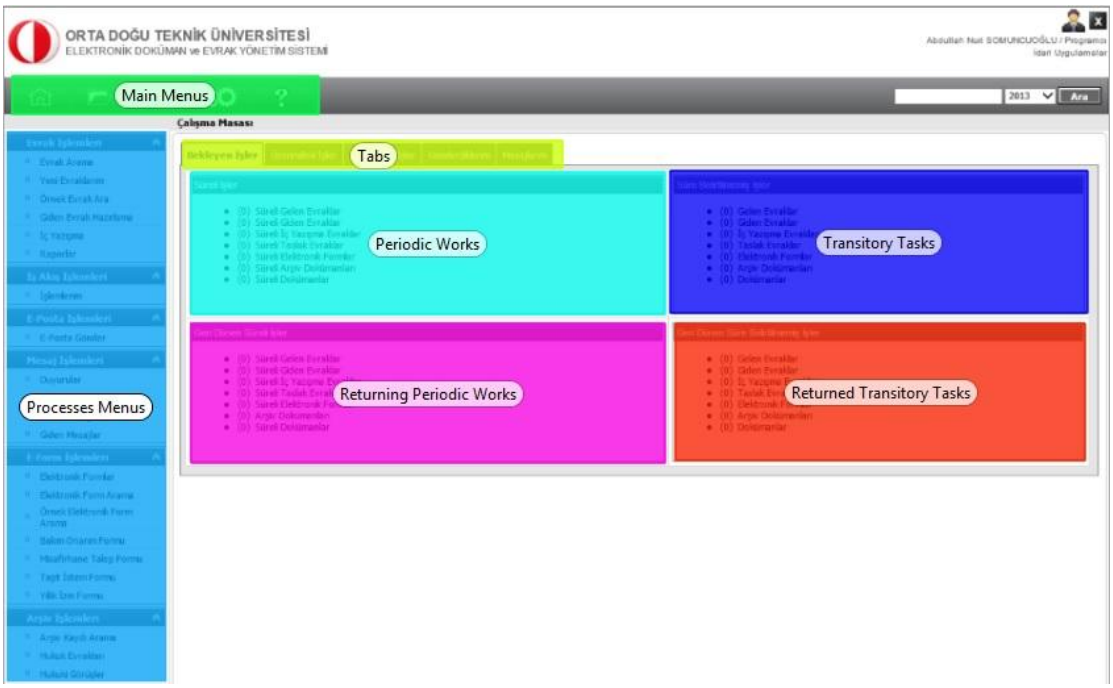

Figure 4.49: Areas of Interest for Task 6

4.4.2.6.4 Fixation Duration and Fixation Count

Table 4.47: Task 6 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	12,3	15,57	66,7	84,43	79
P2	15,4	18,55	67,6	81,45	83
P3	21,6	9,6	203,4	90,4	225
P4	7,3	24,33	22,7	75,67	30
P5	11,9	9,44	114,1	90,56	126
P6	13,4	12,76	91,6	87,24	105
P7	6,7	18,61	29,3	81,39	36

Table 4.48: Task 6 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	11,5	21,3	42,5	78,7	54
P2	12,9	17,92	59,1	82,08	72
P3	14,9	5,25	269,1	94,75	284
P4	16,8	12	123,2	88	140
P5	17,9	11,7	135,1	88,3	153
P6	10,6	15,36	58,4	84,64	69

Table 4.49: Task 6 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	9,4	16,79	46,6	83,21	56
P2	7,9	23,24	26,1	76,76	34
P3	12,1	10,61	101,9	89,39	114
P4	6,9	20,91	26,1	79,09	33
P5	16,7	11,44	129,3	88,56	146
P6	15,8	8,88	162,2	91,12	178
P7	16,9	8,71	177,1	91,29	194

The graph below demonstrates total fixation duration and fixation count percentages for task 6.

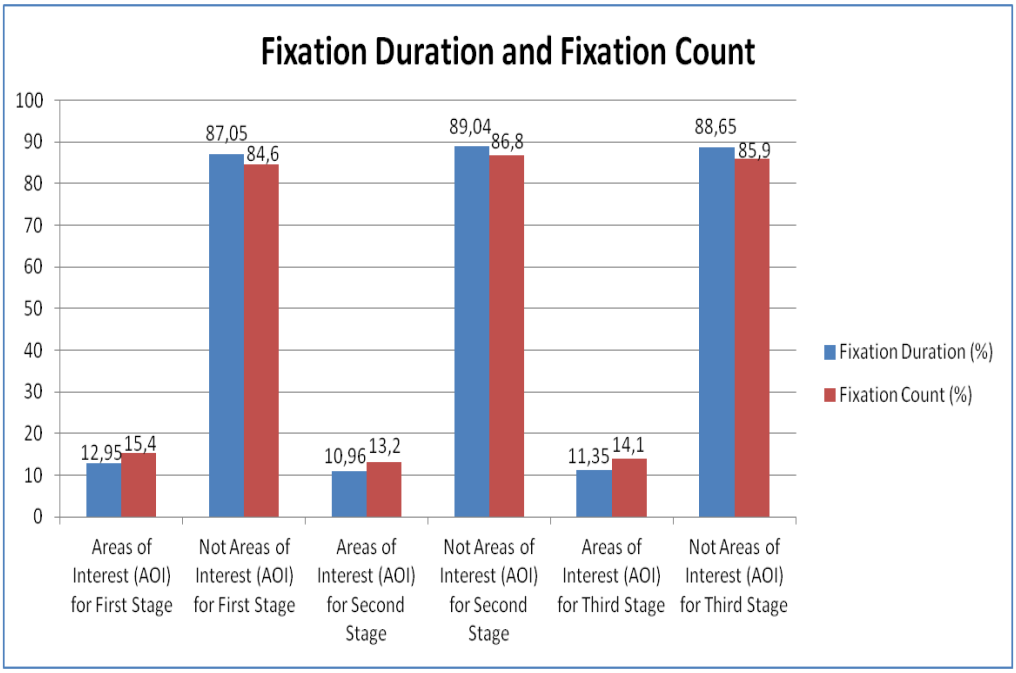

Figure 4.50: Total Fixation Durations and Fixation Counts Percentages of Task 6

4.4.2.6.5 Think-Aloud

"Form aramadan formu buldum. Neden geri alamıyorum?"

"I find the form with form search. Why cannot I take it back?" Understanding of System Instructions / Error Messages

"Geri al seçeneği iptal et seçeneği ile aynı mı?"

"Is the take it back option the same with cancel option?"

"Formu iptal ettim. Yani, formu geri aldım herhalde."

"I cancelled the form. In other words, I probably took the form back."

"Geri alı seçenekler arasında göremiyorum."

"I cannot see take it back among the options."

"Geri al seçeneği neden sadece gönderdiklerim sekmesinde gözüküyor?"

"Why does take it back option appear only in my sent tab?" Layout / Screen Organization

4.4.2.7 *Task 7. You could not guess what to write to some text fields that exist in Maintenance and Repair Form and you have difficulty in filling the form. Find the help menus inside the system so as to get help and get information about the related situation from these menus.*

4.4.2.7.1 Completion Time

The results of completion time for personnel / workers related with task 4 are shown in the graph below.

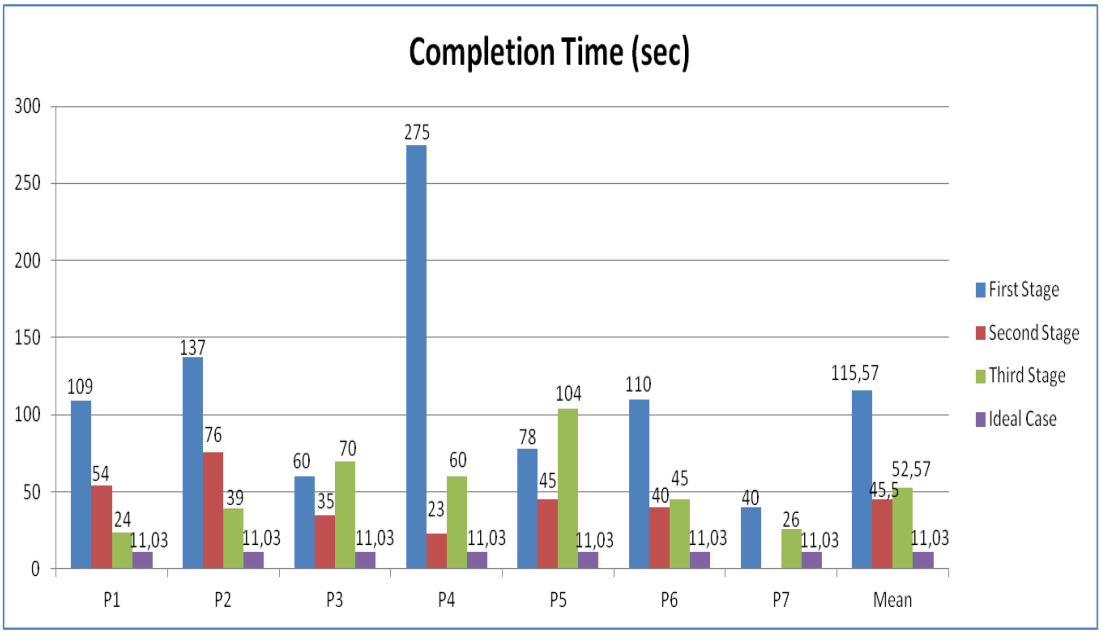

Figure 4.51: Task 7 Completion Time Graph for Personnel / Workers

4.4.2.7.2 Mouse Clicks

The results of mouse click estimations for personnel / workers related with task 2 are presented in the graph below.

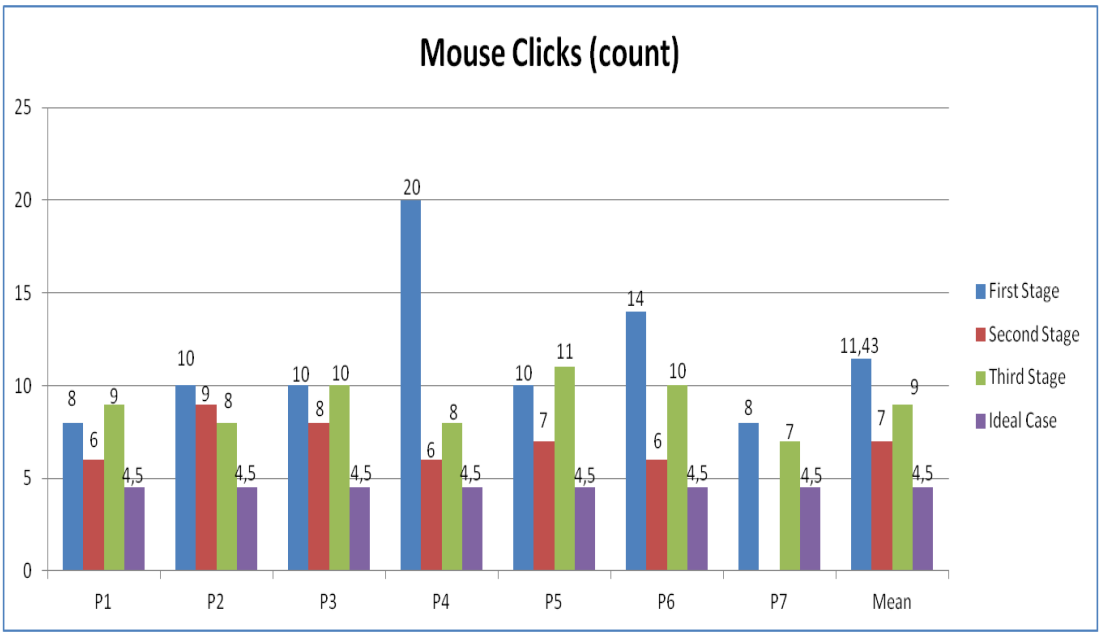

Figure 4.52: Task 7 Mouse Clicks for Personnel / Workers

4.4.2.7.3 Areas of Interest

Areas of Interest (AOIs) identified for this task is the same with manager's task 5 because the participants are required to achieve the same thing. There are totally 9 AOIs determined for the analysis of this task. However, 3 of them are appropriate for this task. The names of these AOIs are Desktop, System Settings and Announcements. These areas are represented with green, blue and pink boxes respectively in the figure below. All of the AOIs for the beginning phase are shown in Figure 4.53 below.

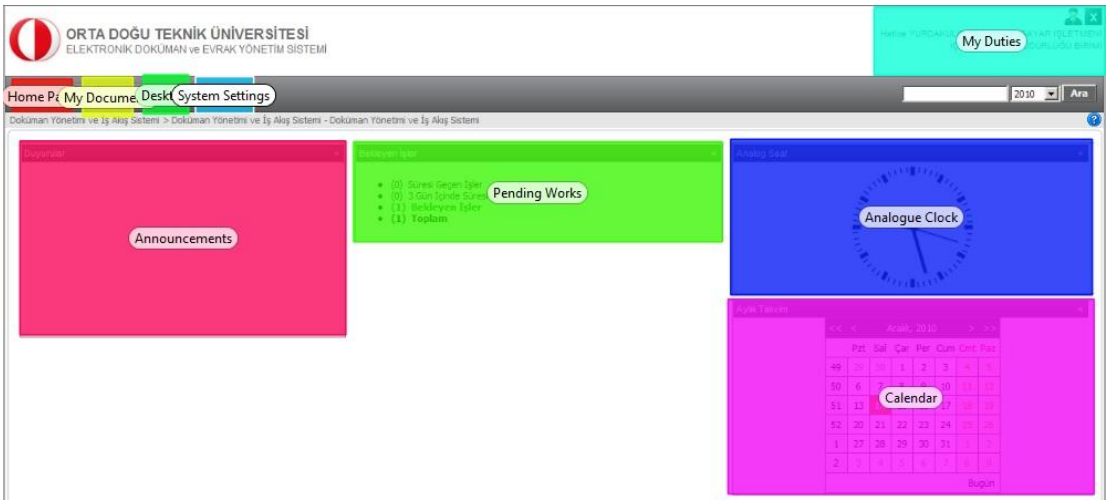

Figure 4.53: Areas of Interest for Task 7

4.4.2.7.4 Fixation Duration and Fixation Count

Table 4.50: Task 7 Fixation Durations for First Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	24,8	22,75	84,2	77,25	109
P2	31,5	22,99	105,5	77,01	137
P3	26,7	44,5	33,3	55,5	60
P4	45,7	16,62	229,3	83,38	275
P5	19,8	25,38	58,2	74,62	78
P6	26,8	24,36	83,2	75,64	110
P7	16,9	42,25	23,1	57,75	40

Table 4.51: Task 7 Fixation Durations for Second Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	32,9	60,93	21,1	39,07	54
P2	45,7	60,13	30,3	39,87	76
P3	24,8	70,86	10,2	29,14	35
P4	14,9	64,78	8,1	35,22	23
P5	30,6	68	14,4	32	45
P6	25,7	64,25	14,3	35,75	40

Table 4.52: Task 7 Fixation Durations for Third Stage

Participant	Fixation Durations (sec)				
	Area of Interest (AOI)		Not Area of Interest (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P1	16,8	70	7,2	30	24
P2	24,9	63,85	14,1	36,15	39
P3	30,6	43,71	39,4	56,29	70
P4	36,9	61,5	33,1	38,5	60
P5	50,3	48,37	53,7	51,63	104
P6	29,7	66	15,3	34	45
P7	19,4	74,62	6,6	25,38	26

The graph below visualizes total fixation duration and fixation count percentages for task 7.

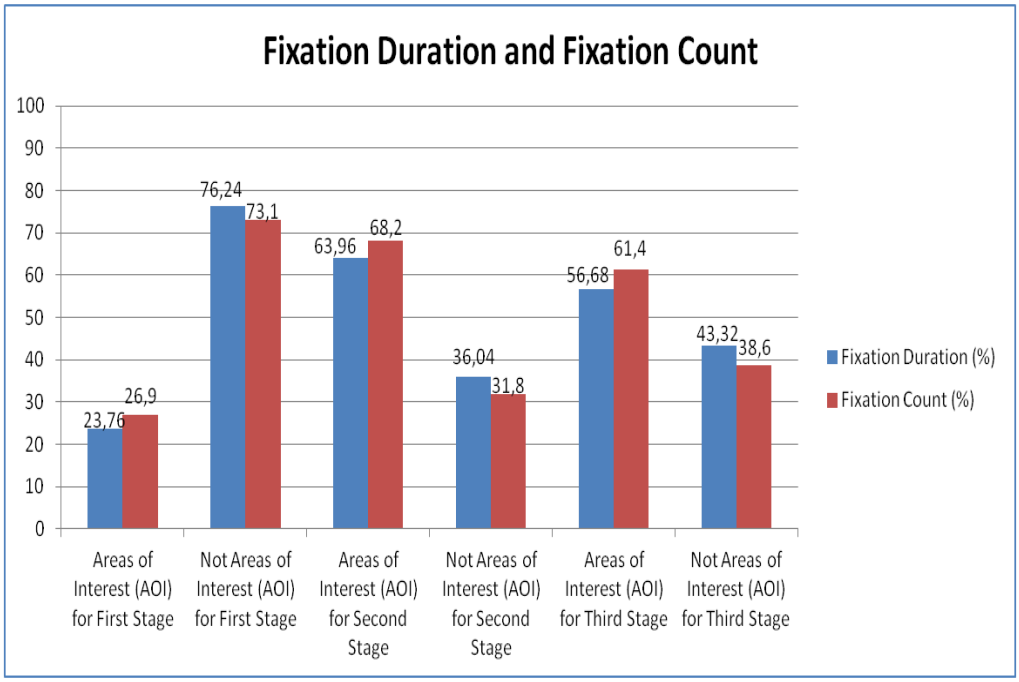

Figure 4.54: Total Fixation Durations and Fixation Counts Percentages of Task 7

4.4.2.7.5 Think-Aloud

"Yardım menüsünün soru işareti ile gösterilmesi güzel olmuş."
"It has been nice to represent help menu with question mark." Graphics
"Yardım menülerine ulaşmak kolay."
"It is easy to reach help menus." Overall Ease of Use
"Geçmişte ana sayfada yardım menüsü yoktu."
"There was no help menu at the home page in the past." Layout / Screen Organization
"Yardım videolarını izleyerek nasıl yapacağımı öğrenebilirim."
"I can learn how to do it by watching the help videos."

4.5 Heat Maps and Gaze Plots

Heat maps and gaze plots are helpful to visualize eye-tracking data. Heat maps show the distribution of fixation based on participants' focus density. Heat maps are represented with colored maps. Red colored area means there is more fixation on this area and green colored area means low fixation on this area. Two tasks are chosen so as to illustrate heat maps and gaze plots. These tasks are common tasks for both managers and workers. These common tasks are assigning delegation and finding help menus. Heat maps and gaze plots of these tasks are shown in figures below.

Figure 4.55: Heat Map of Task 1 (Assigning Delegation)

The screen shown in Figure 4.55 above is a part of task 1 that the participants had difficulty to find. The participants spent too much time to reach for this screen. When they reach this screen they mostly focus on irrelevant areas. As it can be seen from the heat map, the participants focus on the center and left side of the screen. However, assigning delegation (vekalet verme) icon is located on the right side of the screen. Most of the participants did not realize this icon even if they had reached this screen. Moreover, there was a shortcut to complete this task but none of the participants realized this shortcut. This shortcut was clicking the name of the participants located on the top right side of the screen.
Gaze plots demonstrate to which points on the screen the participants fixated commonly. Moreover, gaze plots make it easy to monitor the way that the participants followed on the screen since different colors are assigned for each participant. An example of gaze plot for task 1 is illustrated in the figure below.

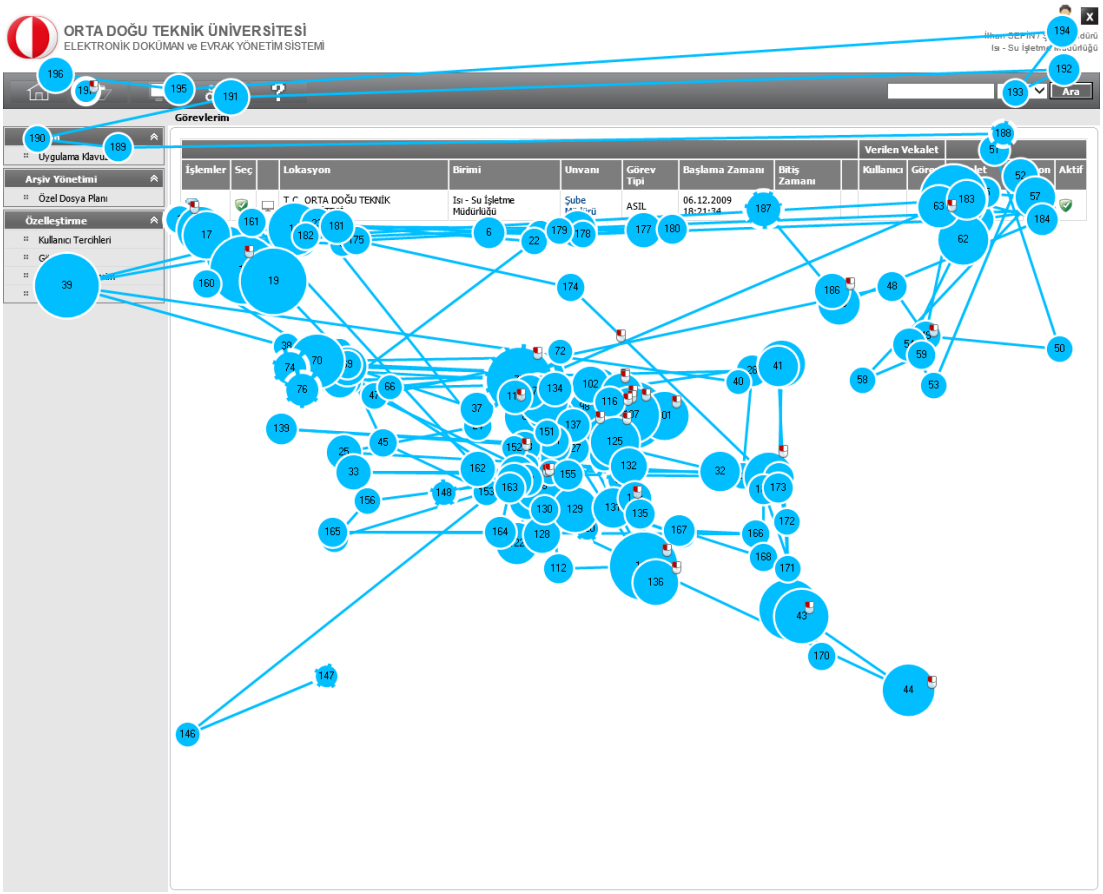

Figure 4.56: Gaze Plot of Task 1 (Assigning Delegation)

The bubbles in Figure 4.56 show the path that the participant followed on this screen. The participant has fixated on many irrelevant areas on the screen as it can be seen from the gaze plot.
The second task chosen to explain heat maps and gaze plots is finding help menus (managers' fifth and workers' seventh task). The participants were successful for finding the help menus during every stage of the study but it took less time for the second and the third stages. The heat map for this task is visualized in figure below.

Figure 4.57: Heat Map of Task 5 for Managers and Task 7 for Workers (Finding Help Menus)

As it is stated above, the participants were successful for this task for all stages. The reason why it took less for the second and the third stage is that there was no menu icon at the home page for the first stage. A help menu, represented with a question mark, was added to the main menus at the home page based on the findings of the first stage. The gaze plot of this task is shown in the figure below.

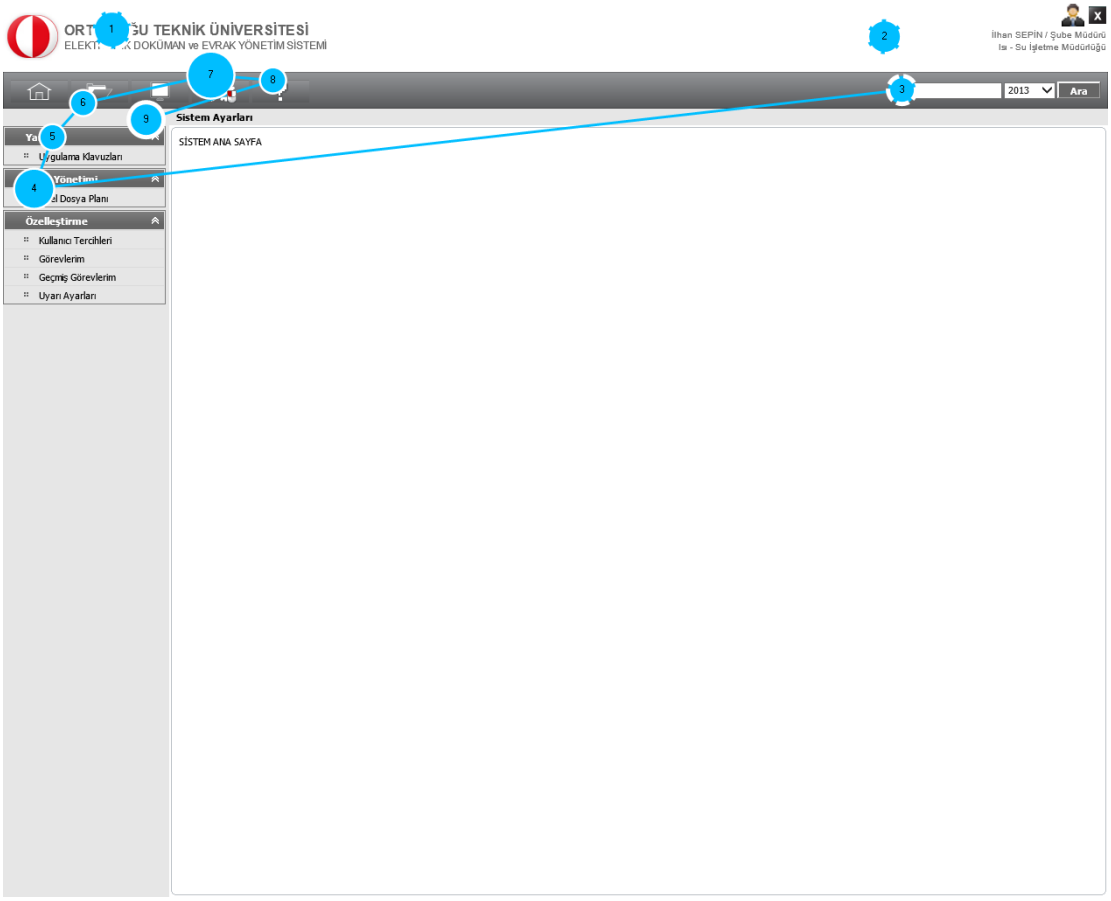

Figure 4.58: Gaze Plot of Task 5 for Managers and Task 7 for Workers (Finding Help Menus)

It could be said that the participants did not fixate as much as they did for the first task. Since the question mark is associated with the help metaphor, it is easy for the participants to understand this connection because the question mark is used for help for other systems, too.

4.6 Task Success Rate

This section includes information about the participants' task success rates for each stage of the study. Since the usability tests were conducted with two group of participants, managers and personnel, in three stages, the results of task success rates will be presented separately for each group and stage. The essential information is provided in the next sections in conjunction with the tables and graphs.

4.6.1 Task Success Rate for Managers

Task success rates of the managers for each stage are represented in tables and graphs below. The "+" sign in tables indicates that the participant successfully accomplished the related task whereas "-" indicates that the participant failed for the related task.

Table 4.53: Task Success Rates of Managers for First Stage

Participants	Task 1	Task 2	Task 3	Task 4	Task 5
P1	+	+	+	+	+
P2	-	-	-	-	+
P3	+	+	+	+	+
Total	2/3	2/3	2/3	2/3	3/3
Success Rate	66,7%	66,7%	66,7%	66,7%	100%

Table 4.54: Task Success Rates of Managers for Second Stage

Participants	Task 1	Task 2	Task 3	Task 4	Task 5
P1	+	+	+	+	+
P2	-	+	+	+	+
Total	1/2	2/2	2/2	2/2	2/2
Success Rate	66,7%	100%	100%	100%	100%

Table 4.55: Task Success Rates of Managers for Third Stage

Participants	Task 1	Task 2	Task 3	Task 4	Task 5
P1	+	+	+	+	+
P2	-	+	+	+	+
P3	-	+	+	+	+
Total	1/3	3/3	3/3	3/3	3/3
Success Rate	33,3%	100%	100%	100%	100%

4.6.2 Task Success Rate for Personnel / Workers

Table 4.56: Task Success Rates of Personnel / Workers for First Stage

Participants	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
P1	+	+	+	+	+	+	+
P2	-	-	-	+	+	-	+
P3	+	+	-	+	+	+	+
P4	+	+	+	+	+	+	+
P5	+	-	-	-	-	-	+
P6	-	-	-	-	-	-	+
P7	+	-	+	+	+	+	+
Total	5/7	3/7	3/7	5/7	5/7	4/7	7/7
Success Rate	71,4%	42,9	42,9	71,4%	71,4%	71,4%	100%

Table 4.57: Task Success Rates of Personnel / Workers for Second Stage

Participants	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
P1	+	+	+	+	+	+	+
P2	-	+	-	+	+	+	+
P3	+	+	+	+	+	+	+
P4	+	+	+	+	+	+	+
P5	-	+	+	+	-	+	+
P6	-	+	+	+	+	+	+
Total	3/6	6/6	5/6	6/6	5/6	6/6	6/6
Success Rate	50%	100%	83,3	100%	83,3%	100%	100%

Table 4.58: Task Success Rates of Personnel / Workers for Third Stage

Participants	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
P1	+	+	+	+	-	-	+
P2	+	+	+	+	-	+	+
P3	+	+	+	+	+	-	+
P4	+	+	+	+	-	+	+
P5	-	+	+	+	+	+	+
P6	+	+	-	+	+	+	+
P7	-	-	+	-	+	+	+
Total	5/7	6/7	6/7	6/7	4/7	5/7	7/7
Success Rate	71,4	85,7%	85,7%	85,7%	57,1%	71,4	100%

4.6.3 The Effect of Gender and Educational Level on Task Success Rates and Completion Time

There were two groups of participants for the eye tracking tests. These are managers and personnel. Since the usability tests were conducted in three stages, it was possible to compare the task success rates and average completion time of each stage with respect to the gender and educational level variables. Therefore, data gathered from all stages of the study was analyzed with a program called IBM SPSS Statistics (version 20). T-Tests were applied so as to analyze the data statistically and check whether there is a relationship between the gender and educational level for task success rates and average completion time.

The graphs below demonstrate the effect of gender on task success rates for each stage of the study.

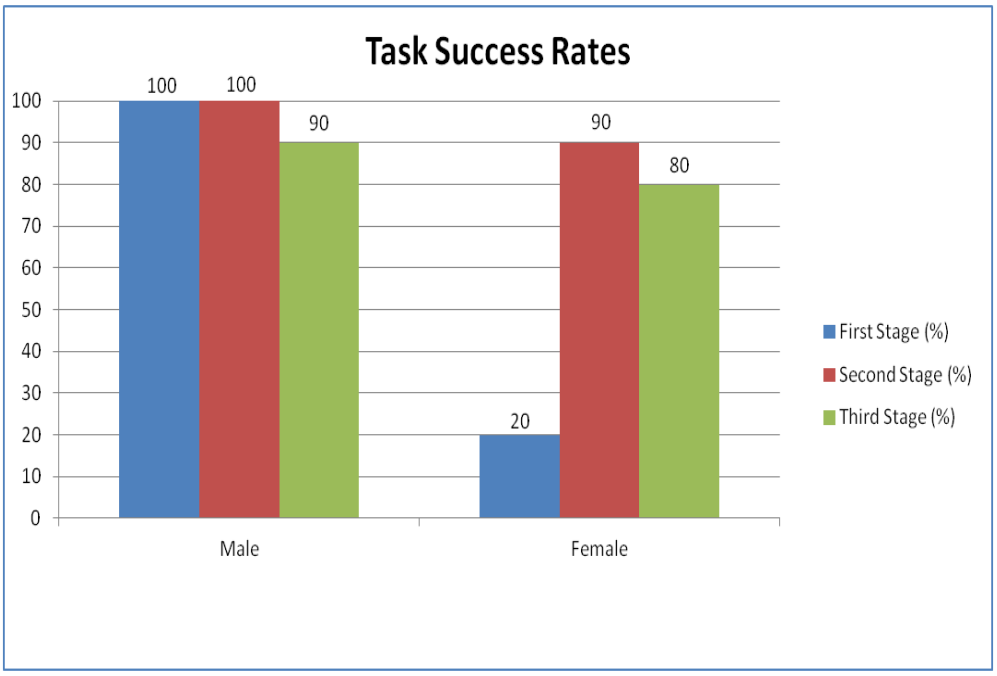

Figure 4.59: Task Success Rates of Managers for Each Stage

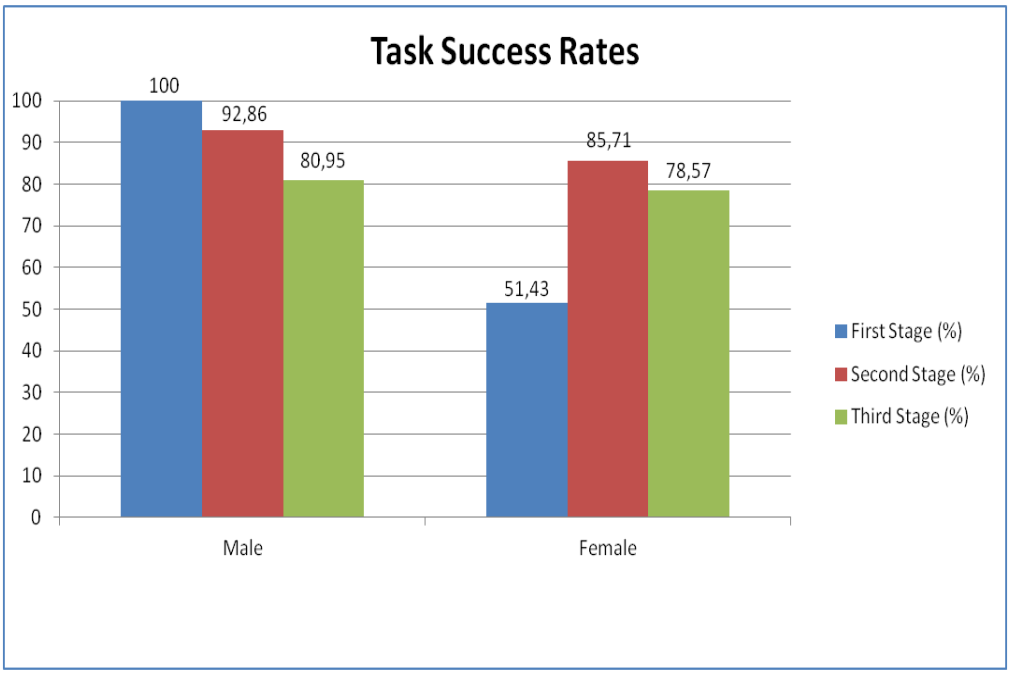

Figure 4.60: Task Success Rates of Personnel for Each Stage

Figure 4.59 and Figure 4.60 show that there is a significant effect of gender on task success rates for almost all stages. Male participants' task success rates are higher than the female participants' task success rates for all the stages except that the third stage of personnel

group. Another effected controlled on task success rate is educational level. Since there was no member for some educational levels or there was only 1 member, two groups of users were generated for the educational level. First group includes high school and associate degree and second group contains participants having B.S. and M.Sc. degrees. Figure 4.61 and Figure 4.62 demonstrate task success rates depending on the educational level.

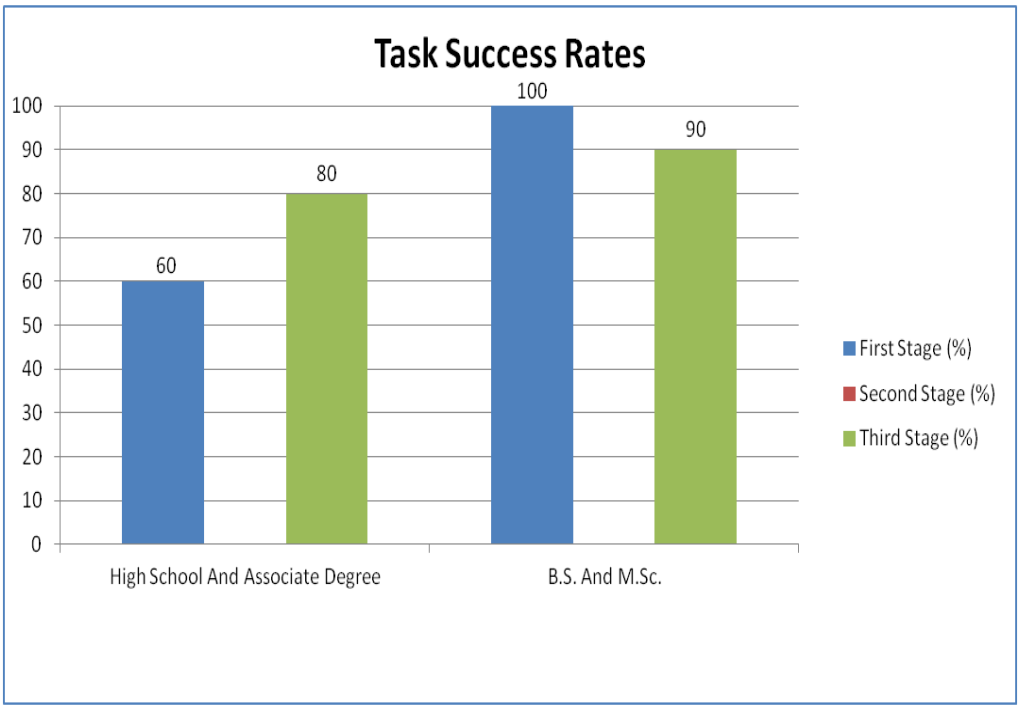

Figure 4.61: Task Success Rates of Managers for Each Stage Based on Educational Level

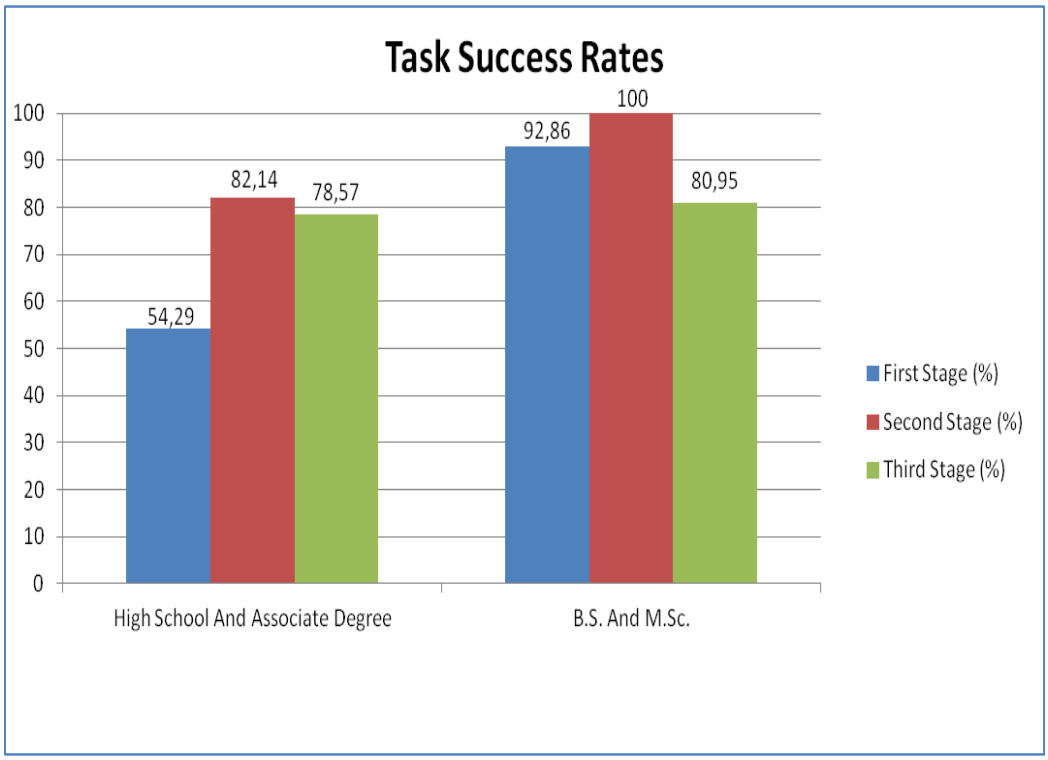

Figure 4.62: Task Success Rates of Personnel for Each Stage Based on Educational Level

If Figure 4.61 and Figure 4.62 are examined, it can be seen that the participants having B.S. and M.Sc. degrees performed better through all the stages both for managers and personnel. However, no comparison was made for managers' second stage since there were two managers and both of them had the same degree. Therefore, the data for this stage was not appropriate for any comparison.

Another effect that was analyzed is the effect of gender and educational level on average completion time. For this purpose, the data of all stages was analyzed with SPSS program by applying T-Tests. Table 4.59 and Table 4.60 represent the results of the T-Tests based on the gender.

Table 4.59: Average Completion Time Results of Managers for Each Stage Based on Gender (Sec)

Task	Gender	Mean for First Stage	Mean for Second Stage	Mean for Third Stage
Task 1	male	121,50	145	132
Task 1	female	147	124	153
Task 2	male	108	95	121,50
Task 2	female	180	138	160
Task 3	male	205,50	158	86,50
Task 3	female	180	164	137
Task 4	male	151,50	84	92,50
Task 4	female	240	134	114
Task 5	male	61	35	45
Task 5	female	111	64	34

When Table 4.59 is examined, it can be observed that there is a significant difference for male and female managers. For the first stage, male participants performed better than females since the means of male participants' for task 1, 2, 4 and 5 are lower than female's. However, female participants performed better for task 3. For the second stage, male participants performed better for task 2, 3, 4, and 5 and female participants performed better for task 1. For the third stage, male participants performed better for task 1, 2, 3 and 4. Female participants performed better for task 5.

Table 4.60: Average Completion Time Results of Personnel for Each Stage Based on Gender (Sec)

Task	Gender	Mean for First Stage	Mean for Second Stage	Mean for Third Stage
Task 1	male	185	156	193
Task 1	female	187	137	225,75
Task 2	male	100,50	114	159,67
Task 2	female	234,20	166,50	163
Task 3	male	254	295	243
Task 3	female	306,20	242,75	190
Task 4	male	498,50	254,50	258,67
Task 4	female	437	263	225,25
Task 5	male	213	142,50	111,33
Task 5	female	141,20	90	105,50
Task 6	male	54,50	97	68
Task 6	female	115	144,50	137,75
Task 7	male	192	38,50	44,33
Task 7	female	85	49	58,75

When Table 4.60 is examined, it can be observed that there is a significant difference for male and female personnel. For the first stage, there is no significant difference for task 1. Male participants' average completion times are lower for task 2, 3 and 6. On the other hand, female participants' average completion times are lower for task 4, 5 and 7. For the second stage, male participants' average completion time is lower for task 2, 4, 6 and 7. However, female participants completed task 1, 3 and 5 faster than the male participants. For the third stage, male participants' average completion time is lower for task 1, 2, 6 and 7 whereas female participants finished task 3, 4 and 5 faster than male participants.

The effect of educational level on average completion time was also examined with T-Tests. Educational levels were divided into two groups. First group includes high school (HS) and associate degree (AD) and second group contains participants having B.S. and M.Sc.

degrees. Table 4.61 and Table 4.62 demonstrate the results of the T-Tests based on the educational level.

Table 4.61: Average Completion Time Results of Managers for Each Stage Based on Educational Level

Task	Educational Level	Mean for First Stage	Mean for Third Stage
Task 1	HS and AD	137	150
Task 1	B.S. and M.Sc.	116	133,50
Task 2	HS and AD	152	130
Task 2	B.S. and M.Sc.	92	136,50
Task 3	HS and AD	236	83
Task 3	B.S. and M.Sc.	119	113,50
Task 4	HS and AD	226	80
Task 4	B.S. and M.Sc.	91	109,50
Task 5	HS and AD	94	40
Task 5	B.S. and M.Sc.	45	42

When Table 4.61 is examined, it can be said that there is a significant difference for all tasks for the first stage. Participants B.S. and M.Sc. degrees completed all tasks faster than the participants having high school and associate degrees. No comparison was made for the second stage since one manager did not attend this stage and the other two managers had the same degree. For the third stage, there is no significant difference for task 2 and 5. Participants having high school and associate degree completed task 3 and 4 faster than the other group whereas participants with B.S. and M.Sc. degrees finished task 1 faster.

Table 4.62: Average Completion Time Results of Personnel for Each Stage Based on Educational Level

Task	Educational Level	Mean for First Stage	Mean for Second Stage	Mean for Third Stage
Task 1	HS and AD	176	134	225,75
Task 1	B.S. and M.Sc.	212,50	162	193
Task 2	HS and AD	217,20	171	163
Task 2	B.S. and M.Sc.	143	105	159,67
Task 3	HS and AD	337,80	260,25	190
Task 3	B.S. and M.Sc.	175	260	243
Task 4	HS and AD	465,80	270,50	225,25
Task 4	B.S. and M.Sc.	426,50	239,50	258,67
Task 5	HS and AD	181,40	135,50	105,50
Task 5	B.S. and M.Sc.	112,50	51,50	111,33
Task 6	HS and AD	85,80	87	137,75
Task 6	B.S. and M.Sc.	127,50	212	68
Task 7	HS and AD	94,80	53,75	58,75
Task 7	B.S. and M.Sc.	167,50	29	44,33

When Table 4.62 is examined, it can be said that there is a significant difference for all tasks for the first stage. Participants with B.S. and M.Sc. degrees completed task 2, 3, 4, and 5 faster whereas the participants having high school and associate degrees finished task 1, 6 and 7 sooner. For the second stage, there is n significant difference for task 3. However, participants with B.S. and M.Sc. degrees completed task 2, 4, 5 and 7 faster. Task 1 and 6 were completed faster by the participants having high school and associate degrees. For the third stage, task 1, 2, 6 and 7 were completed faster by the participants having B.S. and M.Sc. degrees. On the other hand, participants having high school and associate degrees completed task 3, 4 and 5 faster than the other group.

4.7 Summary of Results

Valuable findings were gathered with the help of the methods applied. A pretest questionnaire was conducted before the participants performed the usability test. The

demographic information of the participants was collected with the help of this questionnaire. Moreover, data about participants' computer usage and time spent while using computer was collected. A task analysis about METU EDMS was performed in order to identify the most frequently used tasks with the help of system administrators. The flow charts for each task were generated as a result of the task analysis and these charts are presented in Appendix C. After identifying the tasks, the ideal completion time and mouse clicks count were calculated with the help of an expert user. The information about these ideal case is provided at the tables in section 4.4. Moreover, the ideal case for each task was demonstrated at the completion time and mouse clicks count graphs. After the tasks analysis, eye tracking tests were conducted with the participants in three stages. Participants' eye movements and gaze plot data were recorded in METU HCI Lab so as to analyze this information. The participants were chosen among METU administrative workers. The data was recorded with the help of an eye tracker device. The recorded videos were analyzed for each stage of the study and the results of these phases are presented in section 4.4. Eye tracking tests revealed significant quantitative data for METU EDMS interface. These quantitative data are presented under the subtopics of completion time, mouse clicks, areas of interest, fixation duration and fixation count. Moreover, heat maps and gaze plots were generated by the help of Tobii Studio software. Heat maps demonstrate the fixation areas of the participants on the screen and gaze plots show the path of eye movements that the participants followed during the task. One of the methods applied was think-aloud method. This method was beneficial to interpret the ideas of the participants together with the eye tracking tests' results. The findings of think-aloud method were divided into categories based on the statements of the participants. These statements were important to understand the opinions of the end users and identify the problematic design issues based on their perspective. Another indication of the results was task success rates. The data gathered from the eye tracking tests was used to estimate the task success rates of the participants for each stage and these rates are shown in section 4.6. Task success rates were helpful so as to identify the tasks that the participants face with difficulties. Finally, the effect of gender and education level on task success rates, completion time and mouse clicks showed that there is significant difference for some tasks with respect to the total task completion time, average task completion time and mouse clicks.

CHAPTER 5

5 DISCUSSION AND CONCLUSION

Four usability evaluation methods were used in this study. These methods are conducting two different types of questionnaires (pretest and posttest questionnaires), eye tracking and think aloud. Data collected with the help of these methods were analyzed and presented in the previous chapter. The findings will be summarized and discussed in detail based on the research questions of the study in this chapter.

There are mainly three research questions for this study. All of these questions include at least two subtopics. The 3 main research questions are as follows:

- (RQ1) What are the most significant tasks performed by managers and personnel on METU EDMS?
- (RQ2) Which usability issues are present on the current METU EDMS interface with respect to the significant tasks?
- (RQ3) How can METU EDMS interface be developed in the light of usability issues determined?

Second research question was divided into 3 subtopics depending on the standardized definition of usability. These subtopics are effectiveness, efficiency and satisfaction.

To evaluate the *effectiveness* of METU EDMS;

- (RQ2.1) What are the task success rates of the users for each task?
- (RQ2.2) Which tasks are the most difficult for the users to accomplish? What kinds of errors/problems do they experience when they were not able to accomplish a task?
- (RQ2.3) Is there a positive change in terms of using the system effectively for the users of first and second stages who took the system test one year ago?
- How many steps do the users take in order to complete the predefined tasks?

To evaluate the *efficiency* of METU EDMS;

- (RQ2.4) How long does it take for the users to complete each task?
- (RQ2.5) How many mouse clicks do the users execute to finalize each task?
- (RQ2.6) How long do the users stare at the task-related and non-task-related areas?

To examine the user *satisfaction* aspect of the usability;

- (RQ2.7) How do the users evaluate the perceived usefulness of METU EDMS?
- (RQ2.8) What kind of interpretations do the users make about the interface of METU EDMS?

5.1 RQ 1. What are the most significant tasks performed by managers and personnel on METU EDMS?

Task analysis methodology was used so as to identify the most important tasks performed by managers and personnel. Task analysis sessions were conducted with the administrators of METU EDMS to benefit from their experience before identifying the tasks for managers and personnel. Since one of the main purpose of this study is to show the usability issues of METU EDMS, the most significant tasks were needed for proper evaluation of the system. The chosen tasks for managers and personnel were explained in a detailed way in methodology and result chapters. In addition to the task analysis, the opinions of the system administrators were asked for the identification of the tasks. As a result of the task analysis and informal interview with METU EDMS administrators, 5 tasks for managers and 7 tasks for personnel were chosen for the usability study of METU EDMS. After chsing the related tasks, the flow charts of these tasks were sketched by using the test environment of the system. Then, the necessary paths for the completion of the tasks were clarified and these paths are visualized in Appendix C. Finally, the ideal cases for the completion time and mouse clicks of the identified tasks were calculated with METU EDMS administrators. In other words, this estimation was calculated by the expert users.

5.2 RQ 2. Which usability issues are present on the current METU EDMS interface with respect to the significant tasks?

The purpose of the second research question is to identify and show the usability issues of METU EDMS interface with respect to the significant tasks determined by the result of RQ1. This question was divided into sub questions depending on the elements of standardized definition of usability. These elements are effectiveness, efficiency and satisfaction. Therefore, the effectiveness and efficiency of METU EDMS are evaluated with the help of the methods applied and eye tracking study results. The user satisfaction aspect of usability was evaluated with the questionnaires conducted and think aloud method. The following sub questions of RQ2 show the usability issues of METU EDMS for each stage of the study.

5.2.1 RQ 2.1. What are the task success rates of the users for each task?

The purpose of this question is to evaluate the effectiveness of METU EDMS. To evaluate the effectiveness of METU EDMS, task success rates were revealed with the help of the eye tracking tests. These tests were conducted by two groups of participants; namely managers and personnel. After three stages of the usability tests, the data gathered with the eye-tracking device were examined with the software called Tobii Studio that is explained in Chapter 3. The results of the success rate show the achievement of the participant for the related task. Task success rates are provided in Tables 4.53, 4.54, 4.55, 4.56, 4.57 and 4.58 for each stage and group of participants in Chapter 4. When these tables are examined, it can be said that the success rate of the tasks for managers increased in the second and the third stage compared to the first stage except task 1 and task 5 of workers. However, when these tables are examined for personnel, the success rates of task 1 and task 5 fluctuate for the second and third stages. This situation indicates that improvement is needed for these tasks.

5.2.2 RQ 2.2. Which tasks are the most difficult for the users to accomplish? What kinds of errors/problems do they experience when they were not able to accomplish a task?

The purpose of this question is to evaluate the effectiveness of METU EDMS, too. When the results of the data gathered from the eye tracking tests were examined considering the research question 2.1, it can be specified that Task 1 was one of the most difficult tasks both for managers and personnel. The success rates of this task decreased to 50 % from 66.7% for managers considering the first and the second stages. Moreover, task success rate decreased further to 33.3 % for the third stage of managers. The task success rates of this task for personnel fluctuate. The success rate for the first stage is 71.4%. This rate decreased to 50% for the second stage and increased to 71.4% again for the third stage. This task is related with assigning delegation. One of the main reasons for this problem is that the participants were not able to find the assigning delegation function. They tried to find this function after they entered into METU EDMS with their usernames and passwords. Firstly, they tried to find this function at the home page of the system assuming that assigning delegation function was located on that screen. Then, they started to navigate between the pages to find the related function. There were two ways to achieve this task. One of them was using the system settings menu and the other one was using mmy positions shortcut. However, some of the participants did not recognize this function even if they found the related page.When the overall fixation duration and fixation count percentages of Task 1 were examined for managers and personnel in Figure 4.10 and Figure 4.30 with respectively, it can be seen that the participants mostly focused on the irrelevant objects for this task. This situation is also an indicator that the participants could not find the needed button or link.in addition to the task success rates. Another difficult task for personnel is task 6. This task was related with taking a document that had been sent by mistake back. The task success rates of this task seem to increase and stay the same for the second and third stage respectively. However, total fixation duration and fixation count percentages is an indicator for the difficulty of this task. The percentage of fixation duration for the participants focusing on relevant areas is 12.95% for the first stage. This ratio decreased to 10,96% and 11,35% for the second and third stages with respectively. Moreover, the comments of the participants while trying to accomplish this task showed that they face with difficulty.

5.2.3 RQ 2.3. Is there a positive change in terms of using the system effectively for the users of first and second stages who took the system test one year ago?

Task success rates, obstacles and errors for the first and second stages are evaluated so as to answer this question. The results of the first and second stages' participants are appropriate for this question since a comparison is needed for the same participants. When we evaluate the results of the task success rates given in section 4.6, it could be seen that all the participants performed better at the second stage excluding task 1. Only task 1's success rate is lower than the first stage. It means that the design and the usability of the system still needs improvement for this task. However, even if the participants performed better at the second stage, that does not mean there is no problem for the other tasks. When the completion time of the tasks were evaluated, some tasks such as task 4 and task 6 take too much time to complete. Therefore, it could not be said that the design and the usability of the system are very good since the participants performed better at the second stage.

The participants' eye movements and gaze plots were recorded during the task performance. These records were analyzed in replay sessions with the help of Tobii Studio software. These

sessions are helpful to see the obstacles and the errors that the participants face with during the first and second stage usability tests. It can be said that the participants face with less obstacles and errors during the second stage. However, the participants are still not satisfied with the performance of java technology while previewing the documents.

5.2.4 RQ 2.4. How long does it take for the users to complete each task?

The purpose of this question is to evaluate the efficiency of METU EDMS. Completion time of each task was analyzed in order to answer this question. Completion time for each task of managers and personnel were provided in Chapter 4. All the participants' task completion time values for each task were calculated and compared to the ideal case so as to see the divergence from the expert users' completion time. For instance, Figure 4.27 represents the completion time of task 1 for personnel. When this figure is analyzed, it could be seen that each participant's completion time was provided for each stage of the study together with the ideal case completion time. When all the figures of the completion time for each task are interpreted, it can be observed that all the tasks were completed by spending more time compared to the ideal cases. This situation demonstrates that the participants need to search and find the relevant sections or the objects. Therefore, they lost too much time while trying to accomplish the necessary tasks. When all the completion time graphs were analyzed, it can be interpreted that task 3 for managers and task 4 for personnel are the most time consuming tasks. Figure 5.1 and Figure 5.2 below represent the average completion time for managers and personnel. During the calculation of average completion time, participants who could not complete tasks were excluded. Especially task 4 for some personnel took too much time to complete. 2 participants finished this task above 10 minutes. There was "+" sign for task 4 that the participants need to click in order to add information to a field. Most of the participants forgot to click on this sign because it was not visible. Then, when they received the error message, they did not understand what the mistake was since the error message was not explanatory. At that point, the system was not able to direct the user to the point where the mistake had been made. Therefore, the participants lost time in order to understand and solve this problem. Considering the completion time of all the tasks provided in Chapter 4, it could be said that the navigation of the system across different pages is weak. Therefore, overall complexity of the layout confuses the participants and they face with difficulty while trying to find the necessary button or function.

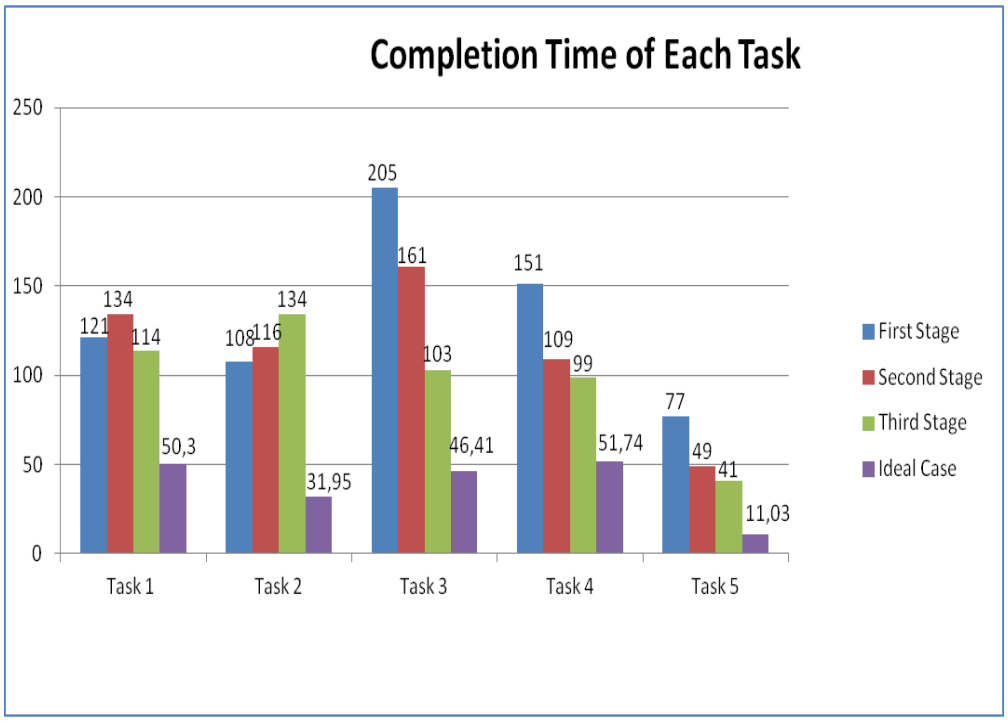

Figure 5.1: Average Completion Time of Managers for Each Task (Sec)

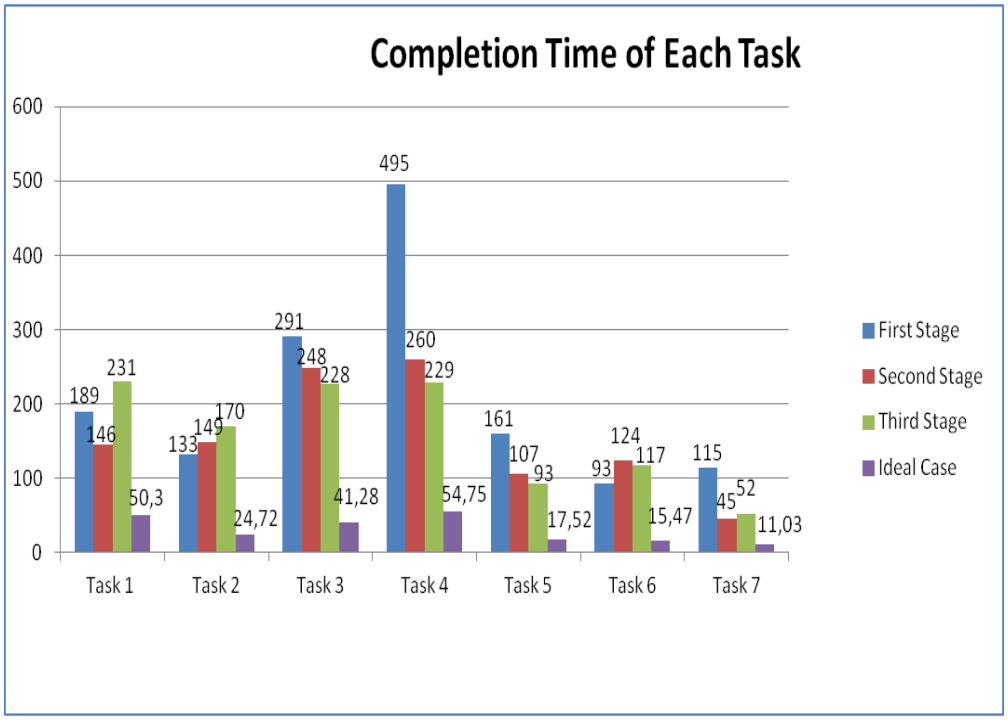

Figure 5.2: Average Completion Time of Personnel for Each Task (Sec)

5.2.5 RQ 2.5. How many mouse clicks do the users execute to finalize each task?

The purpose of this question is to evaluate the efficiency of METU EDMS, too. Video records of the participants were analyzed with Tobii Studio so as to estimate the number mouse clicks of each participant. Since METU EDMS is a website and it is an online system, the steps that the users take to complete the tasks are mostly related with the mouse clicks. Participants need to click on items and menus on the screen and navigate across the screens in order to accomplish the defined tasks. Mouse click statistics is provided in section 4.4 as the second subtopic of each task both for the managers and the workers. Mouse clicks can be interpreted as an indicator for quick completion of tasks. When we consider management systems, the users naturally would like to accomplish a task as soon as possible. Therefore, the system should lead the user to the result quickly with less mouse clicks. When we examine the mouse click counts for the tasks, it can be seen that the participants use less mouse clicks at the second and the third stages than the first stage for most of the tasks. However, the mouse clicks that the participants execute are more than the ideal case for all of the tasks. Consequently, the participants are orientated to the results with less mouse clicks for the latter stages.

Figure 5.3 and Figure 5.4 below demonstrate the average mouse click for managers and personnel. During the calculation of average completion time, participants who could not complete tasks were excluded. The graphs show the results of each stage. Therefore, a comparison can be made between the stages. When these figures are examined, it can be seen that managers' average mouse clicks for task 1 have the highest difference from the ideal case. For personnel group, task 4 is the one that received far more clicks than the ideal case. This task was also the most time consuming task for personnel. Even if the "+" sign causes more clicks for this task, the number of clicks for this task is considerably high.

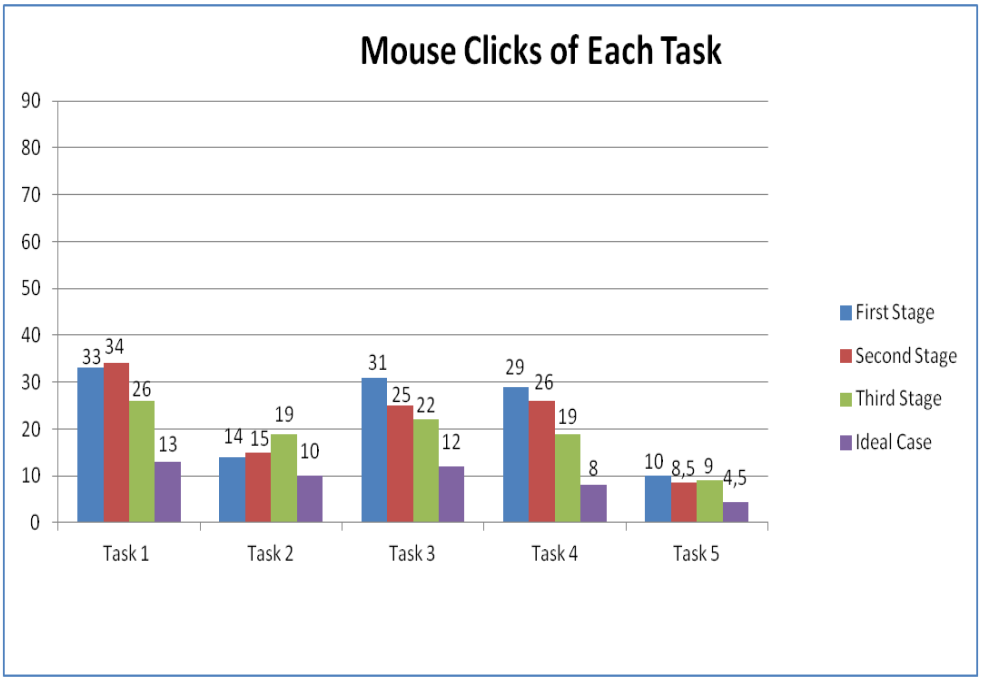

Figure 5.3: Average Mouse Clicks of Managers for Each Task

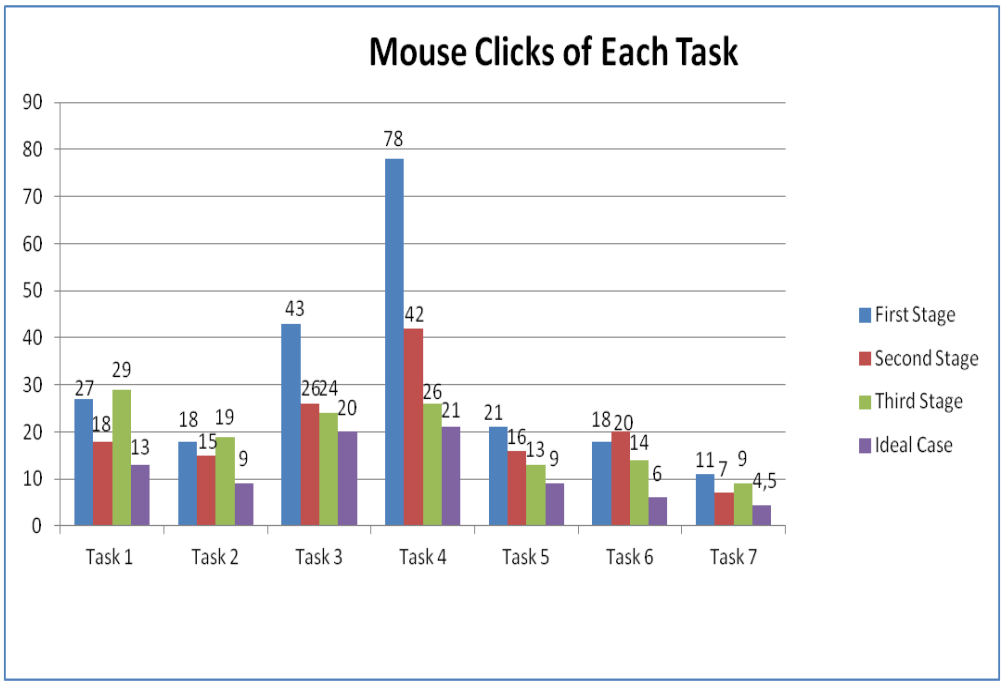

Figure 5.4: Average Mouse Clicks of Personnel for Each Task

5.2.6 RQ 2.6. How long do the users stare at the task-related and non-task-related areas?

The aim of this research question is to examine how long users fixate on rask-related and non-task-related objects based on the fixation duration and fixation percentages. The data obtained from the usability experiments was analyzed with Tobii Studio software. Fixation duration metric indicates how much time the participants spent on definite objects. Boxes called Area of Interest (AOI) need to be define dby the researcher so as to calculate the fixation durations. Fixation duration was calculated by summing up participants' all fixation on interested and uninterested areas that were defined before the data analysis. Fixation durations and fixation count percentages of all task are provided in section 4.4. Considering the managers' tasks, it can be observed that the lowest fixation duration belong to task 1. This task is the one that was completed with the most click by the managers, too. This fixation duration statistics can explain the number of clicks. Since the participants did not fixate on the AOIs, they continued to search for the related task. Therefore, they used more mouse clicks while trying to accomplish the task. For personnel group, the task whose fixation duration is the lowes is task 6. This task has a duration of 12,95%, 10,96% and 11,35% for the first, second and third stages respectively. This task was related with the taking a document back from the sent box after realizing that the document had been sent to the wrong personnel. Most of the users were not able to find the place from where they were required to take the document back. Considering the low total fixation durations of the aforementioned tasks, the functions and screens that help to accomplish these tasks should be simplified.

5.2.7 RQ 2.7. How do the users evaluate the perceived usefulness of METU EDMS?

The purpose of this question is to search the user satisfaction dimension of usability. The post-test questionnaire was conducted with the participants after the usability tests in order to measure the participants' satisfaction. This questionnaire can be seen in Appendix B. The questionnaire have both open-ended questions and likert type questions. The results of this questionnaire were presented in section 4.3 for each stage and group of participants. When the results of this questionnaire were analyzed by considering the completion time, mouse clicks and total fixation duration and fixation count percentages, it could be said that the participants completed most of the tasks faster at the latter stages compared to the first stage. However, when the results of the questionnaire were examined it can be said that most of the participants have developed a negative attitude towards the system even if they completed the tasks faster. The reason why they have developed such a negative attitude should be studied in future studies.

The opinions of the participants are important for the satisfaction dimension. For instance, one of the participants from the first stage stated an opinion about the appearance of the system. This opinion is as follows:

> *"Ekranda çok fazla yazı ve menü bulunmakta. Bu da kafamı karıştırıp ürkütüyor. Daha sade bir şekilde 3-4 başlık olsa kullanıcı alt kırılımlar yardımıyla istediği evrak veya forma ulaşabilir. Yardım menüsü sayfanın en başında olmalı ve adı yardım olarak görülmeli."*
>
> *"There is too many text and menu on the screen. That scares me and make me confused. The user could reach the document or form that is desired simply if there are 3 or 4 menus with the help of breakdowns. "*

When we consider the comments of the participants about the appearance and usability of the system for the first and other two stages, it could be said that the participants' attitude is more positive after the second and third stages for this issue. However, one of the participants' from the third stage comment about the design of METU EDMS is as follows:

> *"Sistemin görünüşü diğer internet sitelerinde olan sadeliğe uymuyor. Bir bölüme gitmek için izlenebilecek yollar çok sınırlı. Bu da ararken kaybolmaya sebebiyet veriyor. Sistem e-posta sistemleri gibi olsa daha güzel olur."*
>
> *"The appearance of the system does not suit simplicity of the other websites. The paths that need to be followed to a section are limited. This causes to get lost while searching. It would be better if the system is similar to e-mail systems."*

Another participant from the first stage offered a suggestion about the search function and the system was developed after the first stage as the participant suggested. This suggestion is stated below:

> *"Evrak ararken çok ayrıntı var. Gelen ve giden evrakları neye göre ayıracağımı bilemiyorum. Ayrıntılar ikinci seçenek olarak yapılabilir mi?"*
> *"There are too many details while searching the document. I do not know relative to what I will distinguish the inbound and outbound documents."*

Even if the participants' attitude and suggestions above seem to be positive, most of the ratings given for the second and the third stages fluctuate and the results for the second and

the third stages have a negative tendency compared to the first stage. The opinions of the participants from all the stages were recorded. These records will be used to improve the interface of METU EDMS in the near future.

5.2.8 RQ 2.8. What kind of interpretations do the users make about the interface of METU EDMS?

This research question aims to investigate the user satisfaction aspect of usability. Think aloud method was used to answer this research question. The participants were asked to express their feelings and make comments during the eye tracking study. Participants' voice, comments and screen actions were recorded. The results of the think aloud data were provided in Chapter 4 for each task of managers and personnel. The appropriate expressions were grouped into categories mentioned in section 3.4.3.2. The expressions and comments of the participants gave an idea about the possible usability problems with related the task. Problems were identified for each category and these problems are stated below:

Navigation;
- Forms have scrolling and having scrolling causes error messages at the top of the screen to be missed
- Unnecessary clicks across pages

Graphics;
- Java preview

Layout / Screen Organization;
- Error messages that are not understandable
- Crowded text screen at the desktop menu
- Too many criteria for search section
- The place of assigning delegation function

Color;
- Lack of different colored objects

Resolution;
- Small font sizes that decrease readability

Meaning of Labels;
- "+" sign located in Maintenance and Repair Form

Understanding of System Instructions / Error Messages;
- Incomprehensible error messages

Consistency of Operations;
- Not having the same options on the same document
- Not being able to search for documents and forms at the same screen

Overall Ease of Use;
- Complicated screens
- Having archive option in the dispatch option
- Finding the related form or document

- Assigning delegation function

Response Time;
- Previewing document take time

Visibility of System Status
- Lack of visibility of system status across pages
- Some error messages appear at the top of the page and the user cannot see it
- No information is provided when a document is sent.

5.3 RQ 3. How can METU EDMS interface be developed in the light of usability issues determined?

Several methods were applied for this study and usability problems of METU EDMS were revealed. The identified problems of METU EDMS should be solved so as to improve the interface of the system. The problems identified are categorized based on the severity level and detailed recommendations are presented in 5.5 Recommendations to Improve Usability of METU EDMS section. Some important problems that should receive high priority by the administrators of METU EDMS are listed below;

- Inconsistency of the actions taken on a document
- Document search screen should be simplified and document and form search should not be separated.
- Scrolling should be avoided.
- Assigning delegation function should be more visible.
- Taking the document back from the sent box should be easier.
- The error messages of the system should be more understandable and essential feedback should be provided to the users.

Even if the participants' performances were better at the second and the third stage with the new design of METU EDMS, the system still needs improvements. These improvements should be applied considering the results of the usability tests and the participants' answers to the questionnaires.

5.4 Conclusion

This study was conducted to evaluate the usability of METU EDMS and its components. The users could reach this system online from the https://www.edys.metu.edu.tr address. Usability tests were performed with real users in three stages. Firstly, the system was tested with 10 participants. For the second stage, the same 10 participants were invited to repeat the same test so as to evaluate the usability of the system again and see whether the improvements made had an effect or not. Finally, another group of 10 participants were invited to perform a third stage for the study. The aim of conducting the third stage was to see whether there is a difference between the participants who attended the usability tests before and the users who did not attend the usability test beforehand. However, the results of the second and the third stage are similar to each other. There were two user groups for the participants: Principals and Personnel / Workers. They had different tasks to accomplish during the system test. System tests were conducted in METU Computer Center HCI Lab. Two different user groups had some common tasks. All of the tasks were evaluated

separately for each group and their results are presented in Chapter 4. Participants filled a pretest questionnaire before the usability test. This questionnaire had questions about the demographics and computer usage of the participants. Then, the usability tests were conducted with the participants. After the usability tests, participants filled a posttest questionnaire. This questionnaire contains five main parts: system experience, general user reaction, appearance of the METU EDMS pages, terms used in METU EDMS pages and learning the system usage. The answers of these questionnaires were evaluated and the results provided in Chapter 4. Moreover, the answers provided by the participants were used to respond the research questions of the study and offer recommendations for improvement. Users faced with errors and difficulties during the usability tests. These errors need to be debugged for the later version of the system. Moreover, the difficulties that the participants faced with should be evaluated and considered for the future studies.

5.5 Recommendations to Improve Usability of METU EDMS

Three stages of usability tests were performed with the real users of the system. Moreover, two questionnaires were given to the users; one before the usability test and one after the usability test. Based on the system tests and the questionnaires, some issues attracted special attention. The recommendations were categorized based on their severity levels. There are 3 categories: Critical (C), Medium (M) and Low (L). Critical means the related issue or recommendation inhibits the flow of the system. In this case, the user is not able to accomplish the related task. Medium level indicates that the issue or recommendation affects the user but does not stop the flow of the system. Finally, low level represents the issue or recommendation that does not affect both the system and the user's action. The severity level of the issue or recommendation is indicated at the beginning of the sentences with C, M and L letters each representing the first letter of the levels. The issues and recommendations are provided below under the related topics.

5.5.1 Recommendations for the First Stage

- **(M)** Icons at the home page should be more explicit. The name of the system setting menu could be changed into "User Settings". Thus, when the users want to change a setting related with its account, they could achieve it via this menu.
- **(M)** An important component of such a system is shortcuts. Therefore, some useful shortcuts should be provided to the users on the home page.
- **(L)** The order of the desktop menu is good. Since the users are familiar with the desktop metaphor, they could guess what they would probably find under this menu.
- **(C)** Document search task one of the most time consuming tasks for the users. There are too many criteria on this page and all of them have the same priority. Therefore, the users are confused when they open this page because they see tens of criteria.
- **(C)** Another important observation is the inconsistency of the action button. When the users reach the same document with different paths, they could not do the same thing on the document. The icon of the action and the document are the same but the contents are different.
- **(M)** Message boxes should be used while warning the users for an error that they had made. If the errors appear at the top of the page, the users do not have chance to see that message. They need to see the error message directly on the screen.
- **(M)** Feedbacks are important for the actions taken. Necessary feedback should be provided to the users when they complete a task. For example, they should see a

warning message after dispatching a document. Otherwise, they could not know whether their document was sent or not.

- **(C)** Scrolling should be avoided especially for forms that need to be filled vertically. For instance, they fill a vertical form for the maintenance and the repair form. However, there is an obligatory "+" sign that they need to click on but they cannot see it without scrolling the page horizontally.

5.5.2 Recommendations for the Second and Third Stages

- **(M)** The search action should direct users to correctly and the users should be able to search both documents and forms on that screen.
- **(M)** The home page of METU EDMS should be simplified since the users get confused according to the results of the usability studies and the questionnaires.
- **(C)** When the users click on the pending tasks at the home page, the system should lead the users to the pending tasks. The users are directed to a page that they need to click pending tasks again. In this case, the home page does not function as a real home page.
- **(L)** Desktop menu includes too many menu and options according to the users. This menu should be specialized based on the users' choices.
- **(C)** Assigning delegation function should be more visible in the system because the users spent too much time to find this function.
- **(C)** Taking the document back property should be more visible. Moreover, the users should be able to see this option when they reach the related document.
- **(M)** When the save button on the Maintenance and Repair Form is clicked, the screen is directed to the top of the page. Then, the users are not able to see the options button located at the bottom of the page and they do not understand whether they saved the document or not.
- **(M)** Necessary feedbacks should be provided to the users by the system. For instance, when the users save the Maintenance and Repair Form, the system should warn the users about the save action.
- **(L)** When the users try to find a document, they use document search option. However, this screen is still complicated and contains too many options even if it is simplified after the first stage.

5.6 Limitations of the Study

One of the most significant limitations is that the usability tests applied do not include all components of the system. Therefore, it is not possible to evaluate all parts of the system. Another limitation is that test environment is not the users' real environment. Since the eye movements of the participants need to be recorded, usability tests were conducted in METU HCI Lab. Another limitation could be related with the eye tracker device. Tobii T120 eye tracker device is a sensitive machine and it may not perceive some eye movements of the participants if the eye calibration is not adjusted properly at the beginning of the study. The average age of the participants is around 40. The average is normal for the university workers but there could be more participants who are under 30 or above 50.

5.7 Contributions of the Study

Electronic Document Management System (EDMS) is not an obligatory system in Turkey to use in government agencies. However, the government is considering to make this system obligatory in order to reduce the costs and accelerate document circulation to gain time. This study is conducted about METU EDMS's usability. Therefore, the findings and the results of this study contributes to the research of EDMS's usability. Moreover, other universities and the institutions could use this study as a guide to apply usability studies for their systems. Furthermore, the results of this study can be used as base for the design of the EDMSs before these systems become obligatory. The recommendations to improve the usability of METU EDMS can be used to enhance other EDMSs if similar conditions apply to these systems, too.

5.8 Future Studies

Considering the discussion of the findings of the study, this study can be repeated in a more detailed way. Following issues can be researched in future studies.

- The data acquired from these tests would be used to make necessary changes mentioned above in the recommendation sections. A new version of the system will be installed soon with new properties. Therefore, these properties need to be tested with the real users again.
- Since the main component of the system was the maintenance and the repair form with the current version of the system, the test was based on the tasks related with it. Because of this, using my documents menu did not receive a special attention for this test. However, when the new record properties become active for the system, this menu needs to be tested, too.
- Since the academic staff of the university has just started to use METU EDMS, the system should be tested with the participants who use the system for academic purposes.
- Participants who attended the usability tests have developed positive and negative attitudes towards the system based on their experience. Participants' attitudes and acceptance can be studied in the future.

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APPENDIX A: PRETEST QUESTIONNAIRE

ÇALIŞMA ÖNCESİ KATILIM ANKETİ

Bu çalışma Orta Doğu Teknik Üniversitesi (ODTÜ), Enformatik Enstitüsü, Bilişim Sistemleri Bölümü yüksek lisans öğrencisi Alpay Karagöz tarafından yürütülmektedir. Bu anket genel olarak; nüfus bilgileriniz ve bilgisayar kullanımınız ile ilgili sorulardan oluşmaktadır. Cevaplarınız ve isim bilgileriniz kesinlikle gizli tutulacak ve sadece araştırmacı tarafından ilgili araştırma için kullanılacaktır. Çalışma çerçevesinde topolanacak veriler sadece bilimsel yayımlarda kullanılacaktır.

1. Cinsiyetiniz:

Bay _____ Bayan_____

2. Yaşınız: _____

3. Eğitim durumunuz nedir?

İlkokul _____ Ortaokul _____ Lise _____

Üniversite – Lisans _____ Üniversite - Yüksek Lisans _____Üniversite - Doktora

4. Evinizde kendinize ait bilgisayarınız var mı?

Evet _____ Hayır _____

5. Ne kadar zamandır bilgisayar kullanıyorsunuz?

1 yıldan az _____

1-2 yıl arası _____

2-3 yıl arası _____

3-4 yıl arası _____

4-5 yıl arası _____

5 yıldan fazla _____

6. Bilgisayarı en çok nerede kullanıyorsunuz?

Ev _____

İş yeri _____

Diğer _____

7. Günde kaç saat bilgisayar kullanıyorsunuz?

2 saatten az _____ 2-4 saat arası _____ 4-6 saat arası _____

6-8 saat arası _____ 8 saatten fazla _____

Sorular bitmiştir. Araştırmacı size kullanılabilirlik çalışmasına başlamak için yardımcı olacaktır.

APPENDIX B

ODTÜ EDYS Web Sayfası

Test Sonrası Kullanılabilirlik Anketi

Katılımcı Numarası:

BÖLÜM 1 : Sistem Tecrübesi

1. EDYS Sayfası'nı ne kadar sıklıkla kullanıyorsunuz?

Hiç kullanmadım__ Haftada bir__ Haftada birkaç kere__
Günde 1 defa__Günde bir defadan fazla__

BÖLÜM 2 : Genel Kullanıcı Tepkileri

Bu çalışma için hazırlanan ODTÜ EDYS Sayfası kullanımından edindiğiniz izlenimleri yansıtan en uygun sayıyı yuvarlak içine alınız. İlgili Değil = ID

2.1	EDYS Sayfası hakkındaki genel düşünceler	berbat muhteşem 1 2 3 4 5 6 7 8 9	ID
2.2		tatmin edici değil tatmin edici 1 2 3 4 5 6 7 8 9	ID
2.3		sıkıcı motive edici 1 2 3 4 5 6 7 8 9	ID
2.4		zor kolay 1 2 3 4 5 6 7 8 9	ID
2.5		sayfa yeterince güçlü değil sayfa yeterince güçlü 1 2 3 4 5 6 7 8 9	ID
2.6		katı esnek 1 2 3 4 5 6 7 8 9	ID

BÖLÜM 3: EDYS Sayfası'nın görünüşü

3.1 Sayfadaki karakterlerin okunması — zor — kolay
1 2 3 4 5 6 7 8 9 ID

3.1.1 Karakterlerin görüntüsü — bulanık — net
1 2 3 4 5 6 7 8 9 ID

3.1.2 Yazı tipi — okunaksız — okunaklı
1 2 3 4 5 6 7 8 9 ID

3.2 Sayfa bileşenlerinin düzeni çok yardımcıydı — hiç bir zaman — her zaman
1 2 3 4 5 6 7 8 9 ID

3.2.1 Sayfada görüntülenen bilgi miktarı — yetersiz — yeterli
1 2 3 4 5 6 7 8 9 ID

3.2.2 Bilginin sayfadaki yerleşimi — mantıksız — mantıklı
1 2 3 4 5 6 7 8 9 ID

3.3 Birbirini takip eden sayfalar, linkler — kafa karıştırıcı — düzenli
1 2 3 4 5 6 7 8 9 ID

3.3.1 Linkler tıklandığında karşılaşılacak Sayfa (bir sonraki ekran görüntüsü) — tahmin edilebilir değil — tahmin edilebilir
1 2 3 4 5 6 7 8 9 ID

3.3.2 Birbirini takip eden sayfalarda bir önceki sayfaya dönmek — imkansız — kolay
1 2 3 4 5 6 7 8 9 ID

3.3.3 Task'lerde istenen bilgiye ulaşmak için izlenen yol — karmaşık — basit
1 2 3 4 5 6 7 8 9 ID

3.4 Hareketsiz resimlerin ve fotoğrafların kalitesi — kötü — iyi
1 2 3 4 5 6 7 8 9 ID

3.4.1 Resimler ve fotoğraflar — belirsiz — belirgin
1 2 3 4 5 6 7 8 9 ID

3.4.2 Resim yada fotoğrafların parlaklığı — bulanık — parlak
1 2 3 4 5 6 7 8 9 ID

3.5 Kullanılan renkler — doğal değil — doğal
1 2 3 4 5 6 7 8 9 ID

3.5.1 Varolan renklerin miktarı — yetersiz — yeterli
1 2 3 4 5 6 7 8 9 ID

EDYS Sayfası'nın görünüşü hakkındaki görüşlerinizi lütfen aşağıdaki boş alana yazınız:

_____
_____
_____
_____
_____
_____

BÖLÜM 4: EDYS Sayfasında Kullanılan Terimler

4.1 EDYS Sayfası de kullanılan terimler	tutarsız tutarlı 1 2 3 4 5 6 7 8 9	ID
4.1.2 Bağlantıların ve ikonların isimleri	belirsiz açıkça anlaşılabilir 1 2 3 4 5 6 7 8 9	ID
4.1.3 Sayfa isimleri (başlıklar)	tutarsız tutarlı 1 2 3 4 5 6 7 8 9	ID
4.2 Ekranda beliren mesajlar	tutarsız tutarlı 1 2 3 4 5 6 7 8 9	ID
4.2.1 Ekranda beliren talimatların yerleri	tutarsız tutarlı 1 2 3 4 5 6 7 8 9	ID
4.3 Bilgisayar ne yaptığına dair kullanıcıyı bilgilendiriyor	hiçbir zaman her zaman 1 2 3 4 5 6 7 8 9	ID
4.3.1 Bir işlemi gerçekleştirmek tahmin edilebili sonuç doğuruyor	hiçbir zaman her zaman 1 2 3 4 5 6 7 8 9	ID

EDYS Sayfası'nda kullanılan terimler hakkındaki görüşlerinizi aşağıdaki boş alana yazınız:

_____
_____
_____
_____
_____

BÖLÜM 5: Sistem Kullanımını Öğrenme

5.1	Sayfada gezinmeyi (navigation) öğrenmek	zor kolay 1 2 3 4 5 6 7 8 9	ID
5.1.1	Başlangıç aşamasındaki öğrenme	zor kolay 1 2 3 4 5 6 7 8 9	ID
5.1.2	Sistemi kullanmayı öğrenme zamanı	kısa uzun 1 2 3 4 5 6 7 8 9	ID
5.2	Deneme yanılma yoluyla sayfanın özelliklerini keşfetmek	zor kolay 1 2 3 4 5 6 7 8 9	ID
5.2.1	Sayfa özelliklerinin keşfi	riskli güvenli 1 2 3 4 5 6 7 8 9	ID
5.2.2	Yeni özelliklerin keşfedilmesi	zor kolay 1 2 3 4 5 6 7 8 9	ID
5.3	Kullanılan fonksiyonların kullanım şekillerini hatırlamak	zor kolay 1 2 3 4 5 6 7 8 9	ID
5.4	Verilen task'ler doğrudan yerine getirilebiliyordu (oyalama olmadan)	asla her zaman 1 2 3 4 5 6 7 8 9	ID
5.4.1	Yapılacak her iş için katedilmesi gereken aşamaların sayısı	çok fazla uygun sayıda 1 2 3 4 5 6 7 8 9	ID
5.4.2	Bir işi bitirmek için takip edilen adımlar mantıklı bir sırada	asla her zaman 1 2 3 4 5 6 7 8 9	ID

Sistemin öğrenimi ile ilgili görüşlerinizi aşağıdaki boş alana yazınız:

_____
_____
_____
_____
_____

Anketi doldurduğunuz için teşekkür ederiz.

APPENDIX C

TASK ANALYSIS RESULTS

Tasks for Managers

Task 1: You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works on behalf of you. For this reason, assign delegation the worker that will perform your works by filling the related date and time information. After assigning your delegation, assume that your annual leave has ended and cancel your delegation.

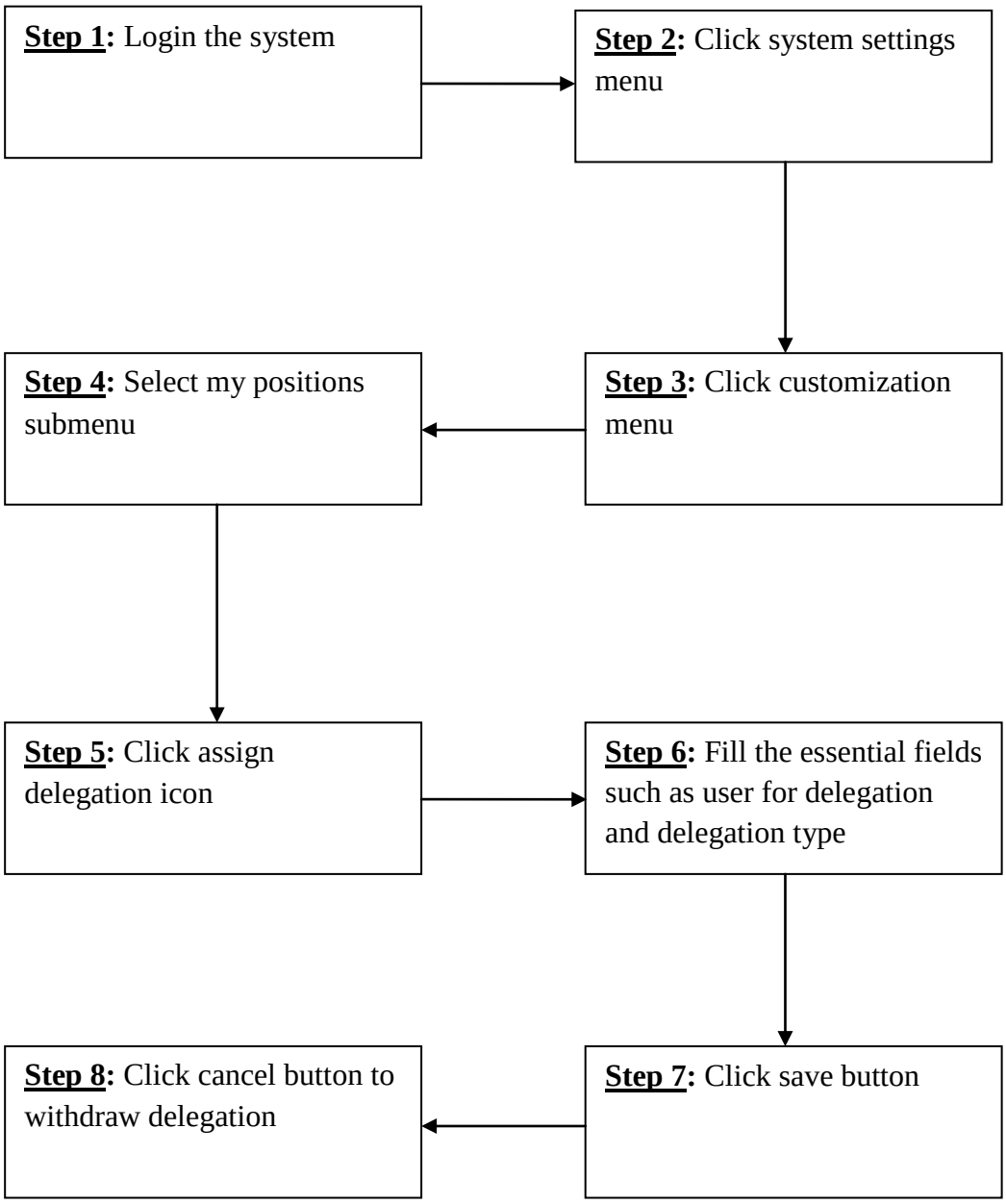

Figure C.0.1: Steps of Completin Task 1 (First way)

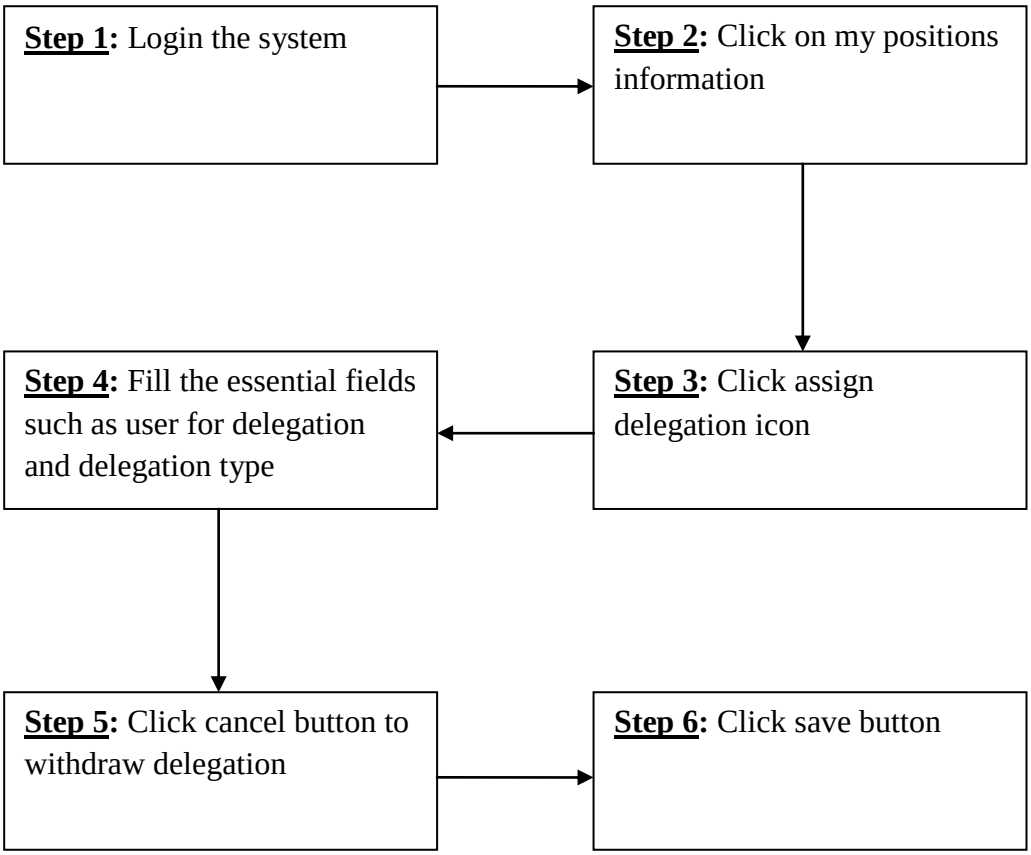

Figure C.0.2: Steps of Completing Task1 (Second way)

Task 2: You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information. After previewing the document, learn where and on which phase this document is.

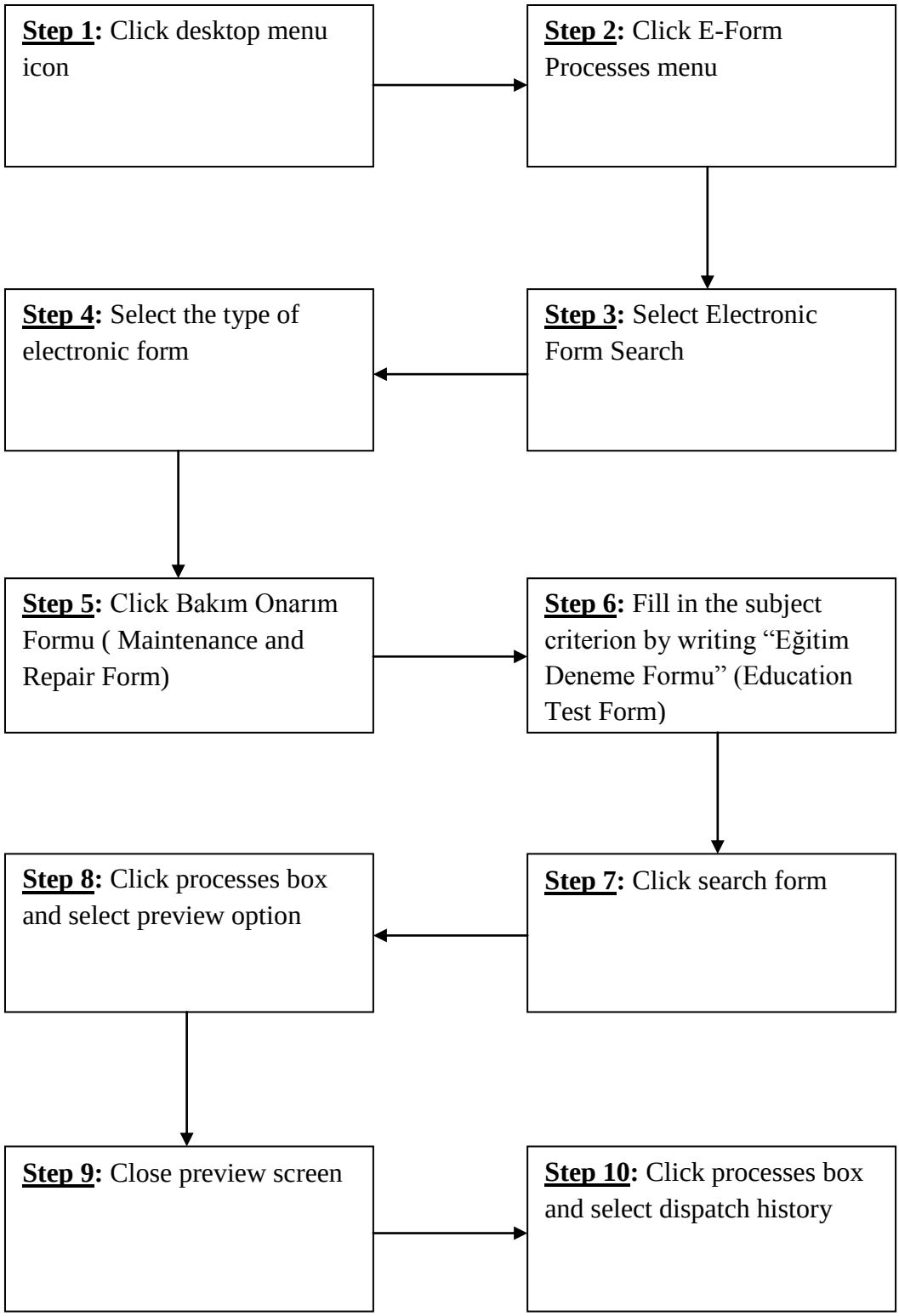

Figure C.0.3: Steps of Completing Task 2

Task 3: Preview the maintenance and repair form whose subject is "Eğitim Deneme" (Education Test) sent by the related personnel and make the essential changes by using Edit Text option. Send the document to the related personnel after you make the desired changes.

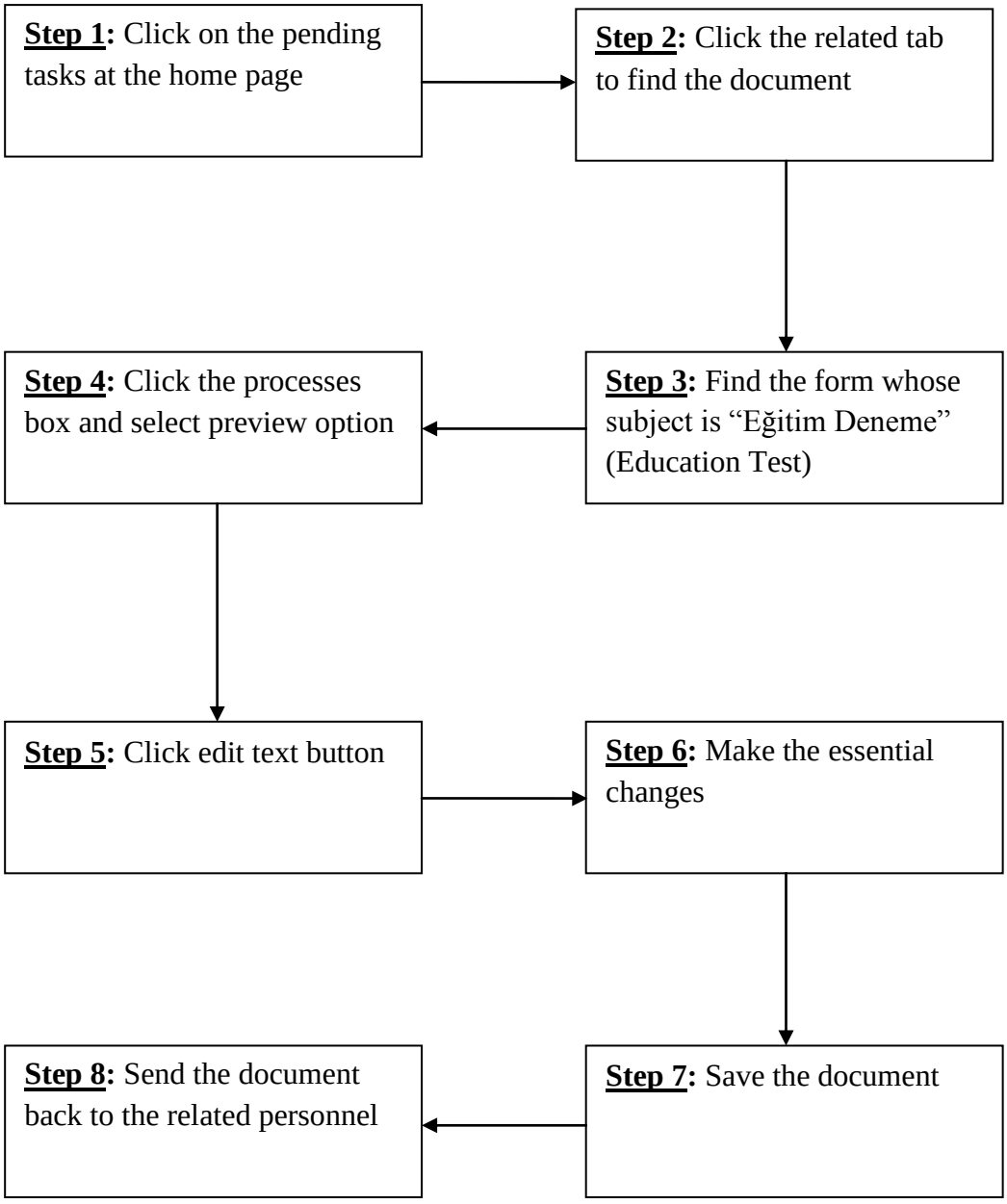

Figure C.0.4: Steps of Completing Task 3

Task 4: Review the maintenance and repair form, which was filled and sent to you, related with central heating problem of a department and process it to the next phase (Sending it to the next department / manager or archiving).

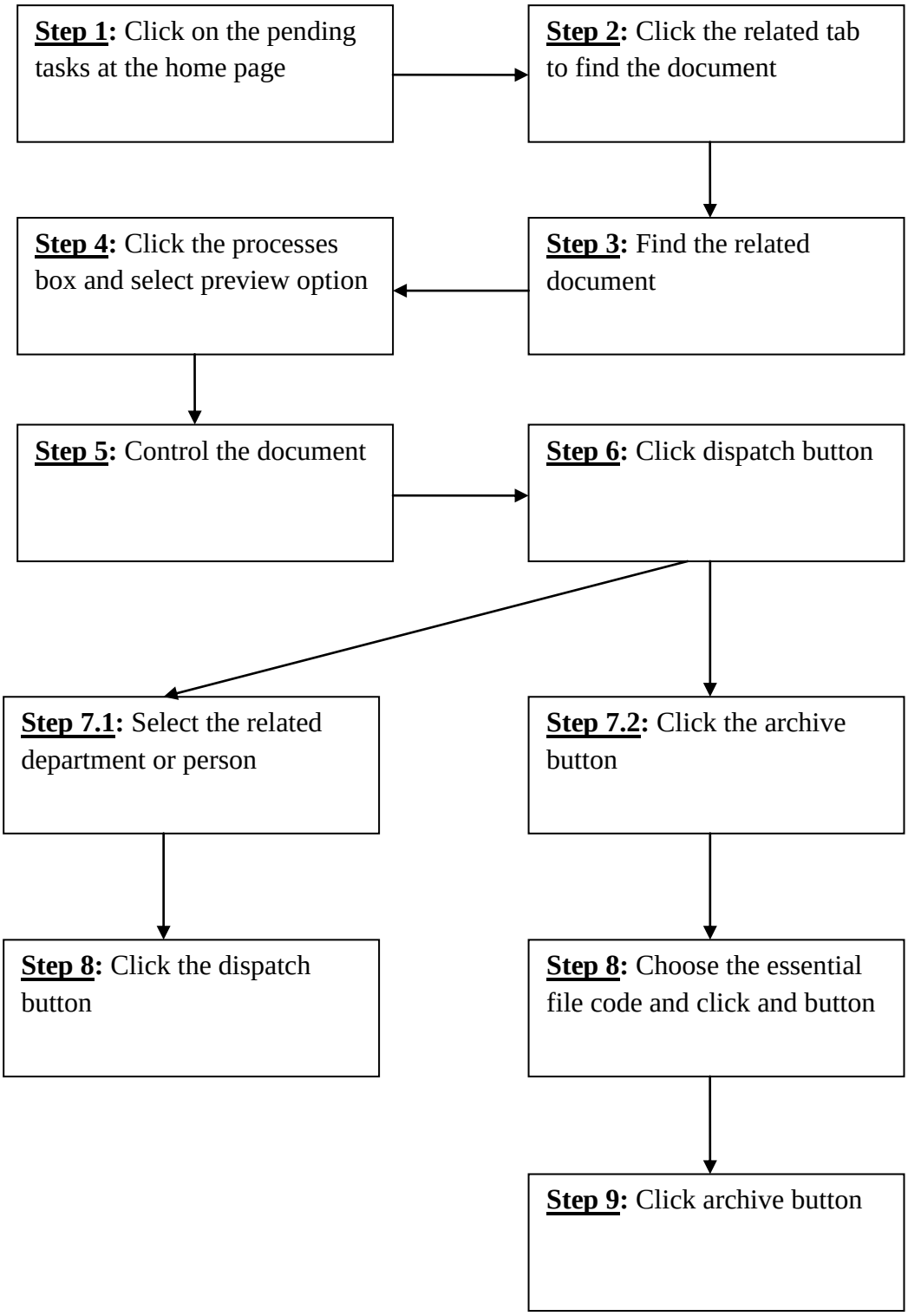

Figure C.0.5: Steps of Completing Task 4

Task 5: You want to make some changes on a repair and maintenance form's text. However, you do not know how to make these changes and direct it to the related personnel. Find the help menus inside the system so as to get help and get information about the related situation from these menus.

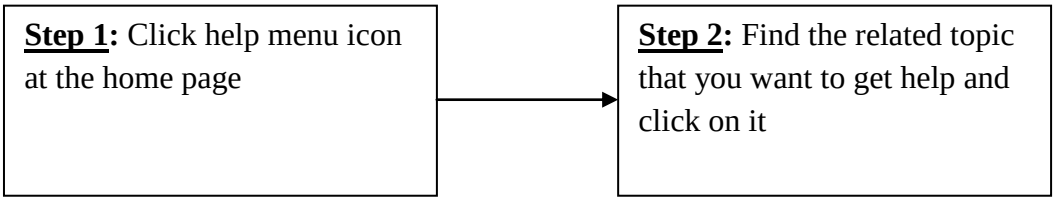

Figure C.0.6: Steps of Completing Task 5 (First way)

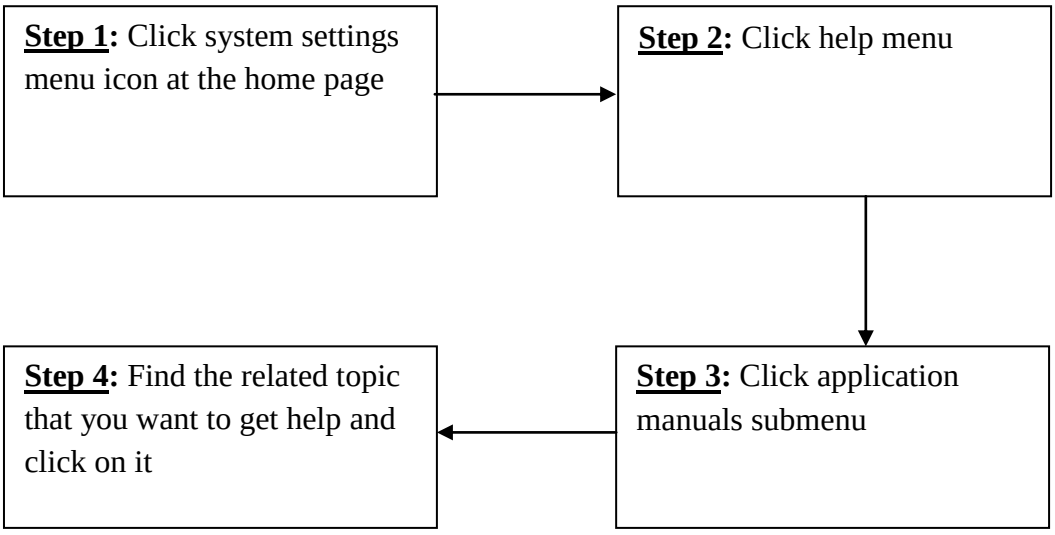

Figure C.0.7: Steps of Completing Task 5 (Second way)

Tasks for Personnel / Workers

Task 2: You need some information related with a maintenance and repair form that you had filled before. Find this form whose subcejt is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information.

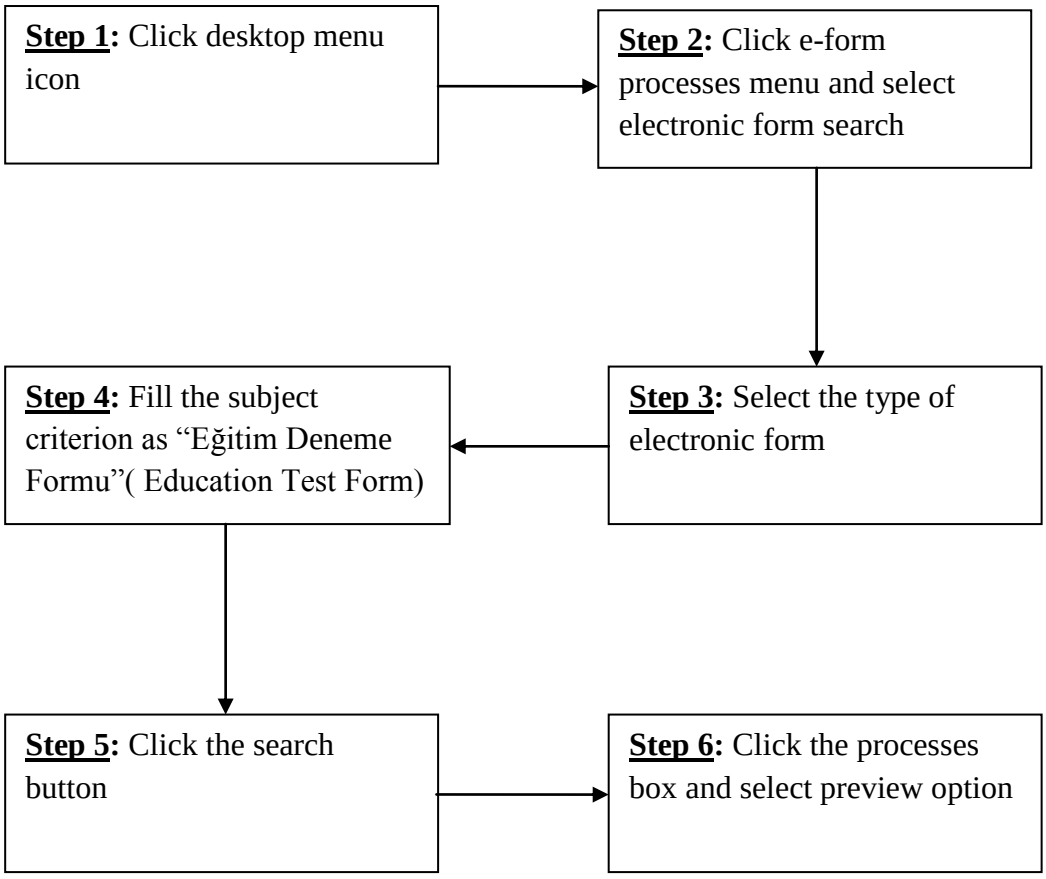

Figure C.0.8: Steps of Completing Task 2

Task 3: Since you had another work to do, you left a repair and maintenance form that you were filling incomplete. You want to continue filling your form after you completed the other work. Hence, find the shortcomings of the document whose subject is "Eksik Bilgileri Giriniz" (Enter Incomplete Information) in My New Records and send it to the related personnel by completing it.

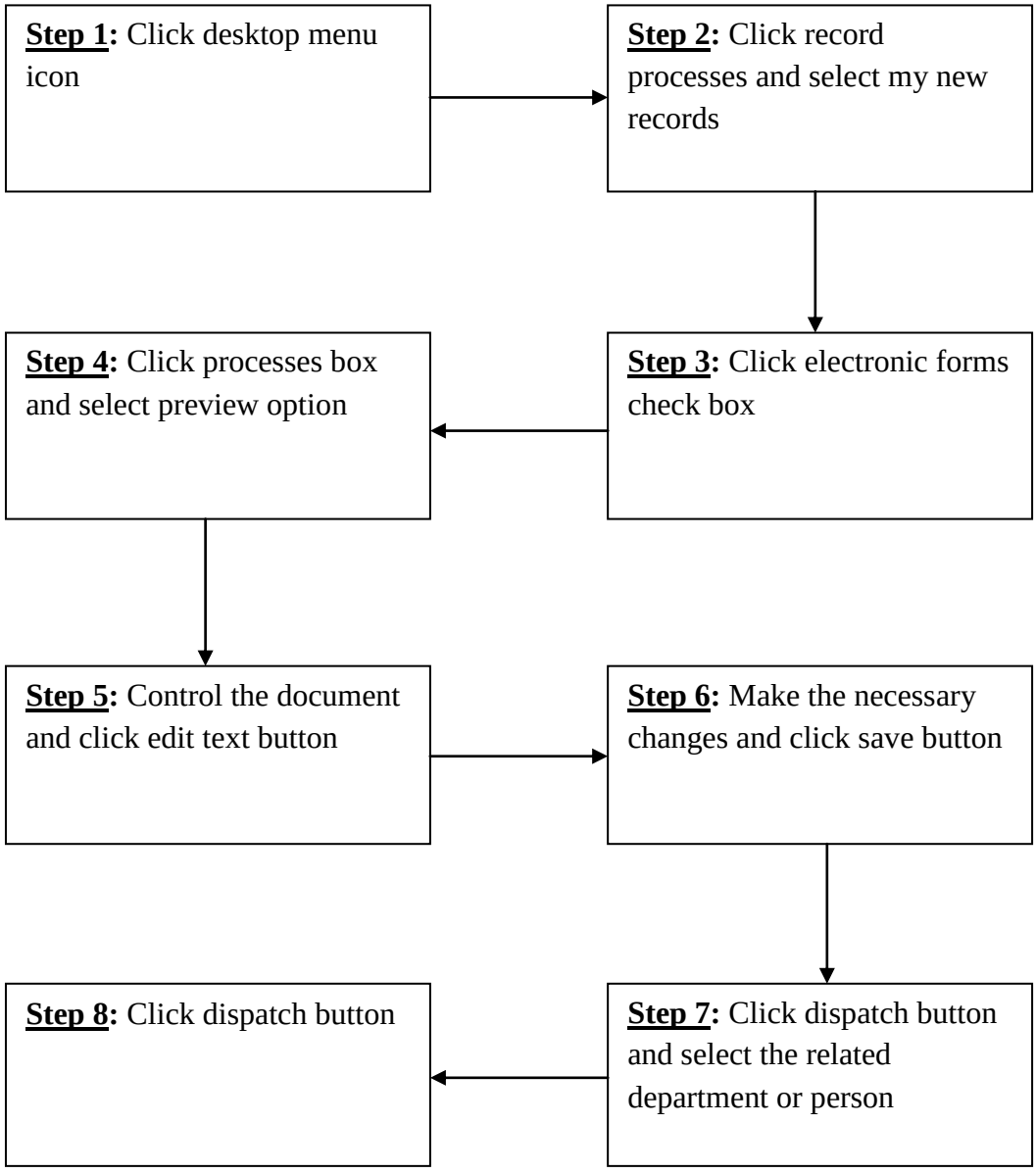

Figure C.0.9: Steps of Completing Task 3

Task 4: A malfunction has occured for a room's heating system in your department or agency. Your head of department or manager demanded you to fill a repair and maintenance form related with this situation. Complete the repair and maintenance form by filling the essential information and dispatch it to the appropriate personnel.

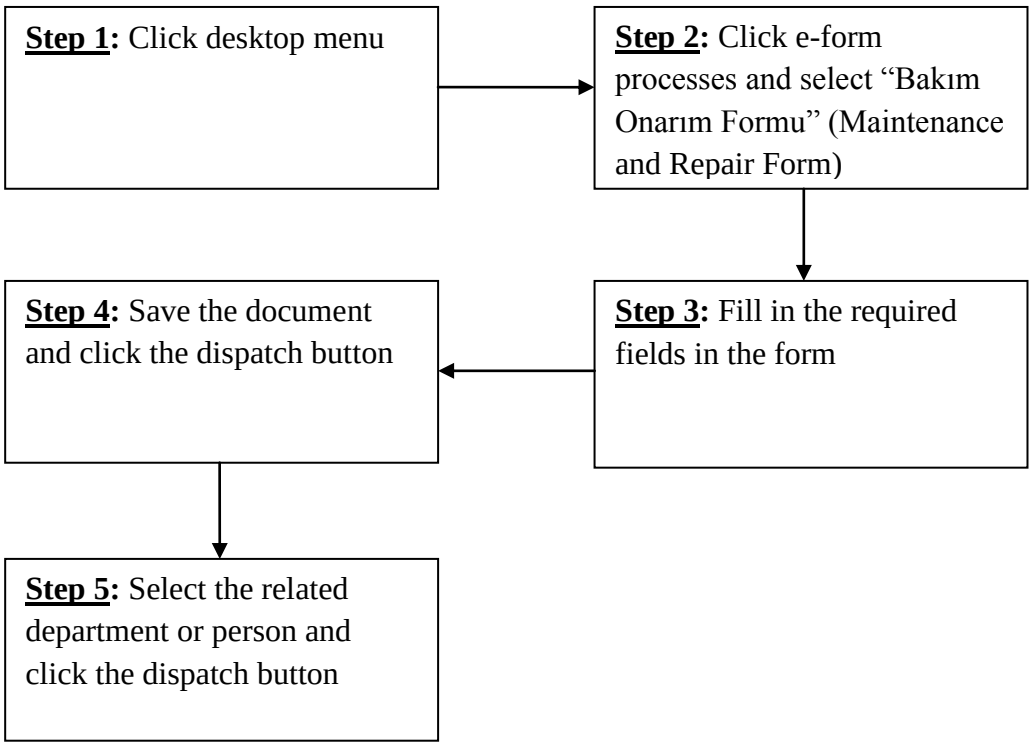

Figure C.0.10: Steps of Completing Task 4

Your head of department or manager wanted information about where and on which phase the repair and maintenance form that you had dispatched is after some time. For this reason, learn where and on which phase the repair and maintenance form that you had dispatched is by finding your document.

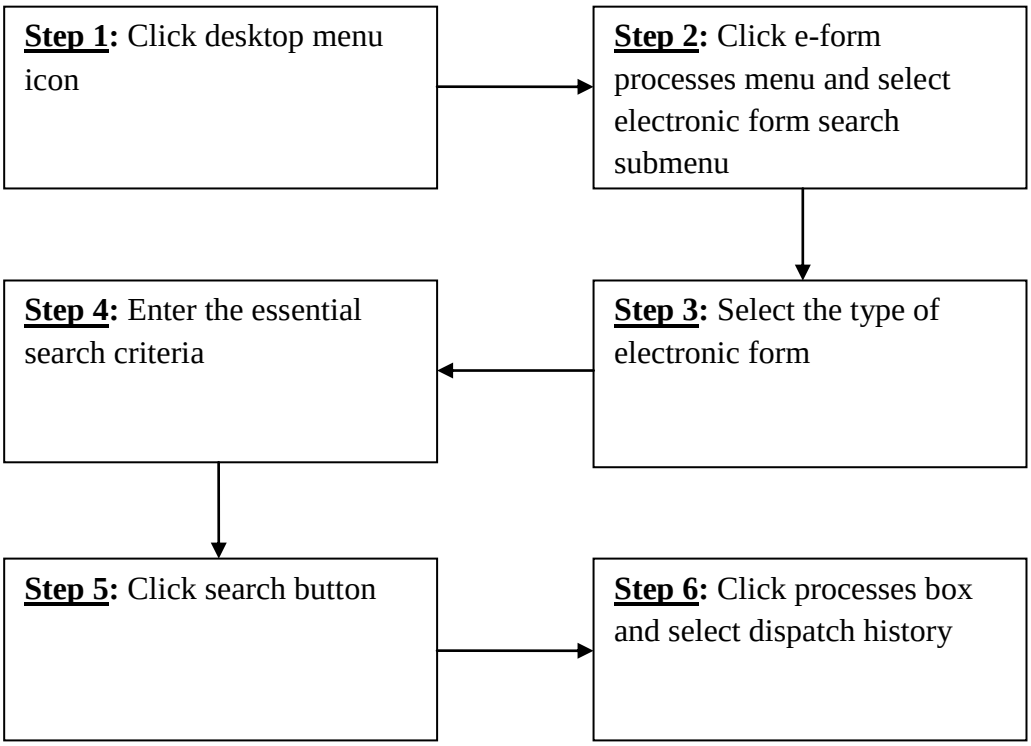

Figure C.0.11: Steps of Completing Task 5

Task 6: You realized that you had sent the Repair and Maintenance form that you had filled based on your head of department or manager demand to a wrong personnel. Take your document back before the personnel that you had sent wrongly makes a change on your document.

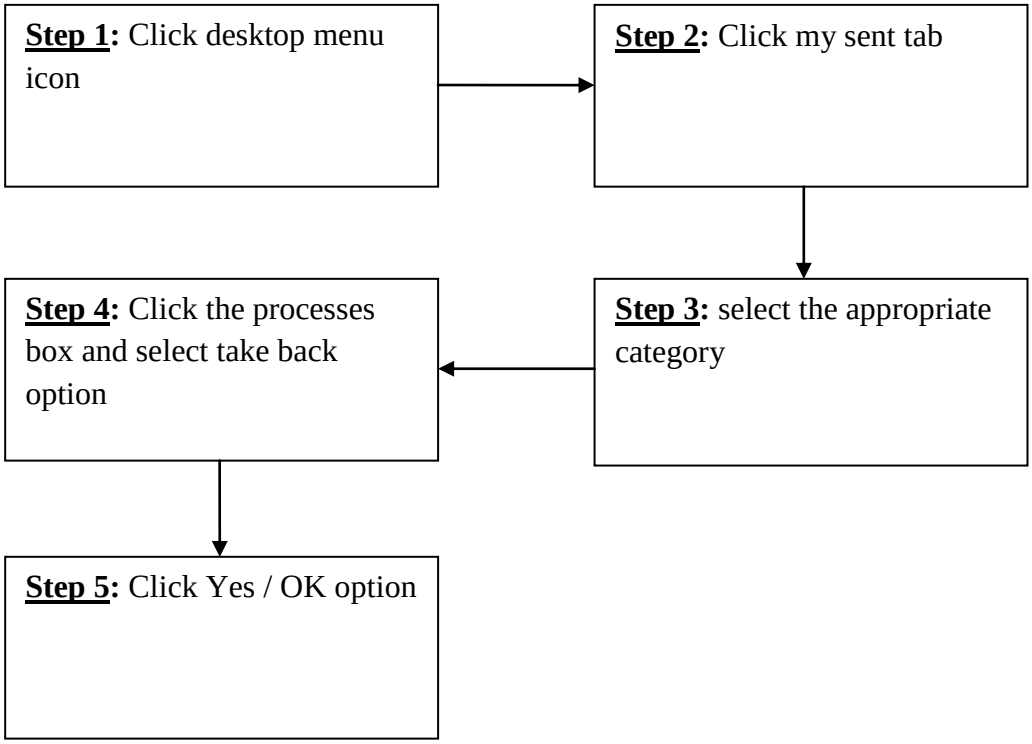

Figure C.0.12: Steps of Completing Task 6

APPENDIX D

TASKS FOR MANAGERS

1. You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works by procuration on behalf of you. For this reason, give your procuration to the worker that will perform your works by filling the related date and time information. After giving procuration, assume that your annual leave has ended and cancel your procuration.

2. You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information. After previewing the document, learn where and on which phase this document is.

3. Preview the maintenance and repair form whose subject is "Eğitim Deneme" (Education Test) sent by the related personnel and make the essential changes by using Edit Text option. Send the document to the related personnel after you make the desired changes.

4. Review the maintenance and repair form, which was filled and sent to you, related with central heating problem of a department and process it to the next phase (Sending it to the next department / manager or archieve it).

5. You want to make some changes on a repair and maintenance form's text. However, you do not know how to make these changes and direct it to the related personnel. Find the help menus inside the system so as to get help and get information about the related situation from these menus.

APPENDIX E

TASKS FOR WORKERS / PERSONNEL

1. You will take an annual leave between august 8, 2013 and august 16, 2013. Therefore, another worker in your department will be doing your works by procuration on behalf of you. For this reason, give your procuration to the worker that will perform your works by filling the related date and time information. After giving procuration, assume that your annual leave has ended and cancel your procuration.

2. You need some information related with a maintenance and repair form that you had filled before. Find this form whose subject is "Eğitim Deneme Formu" (Education Test Form) by using Electronic Form Search option and preview it in order to get essential information.

3. Since you had another work to do, you left a repair and maintenance form that you were filling incomplete. You want to continue filling your form after you completed the other work. Hence, find the shortcomings of the document whose subject is "Eksik Bilgileri Giriniz" (Enter Incomplete Information) in My New Records and send it to the related personnel by completing it.

4. A malfunction has occurred for a room's heating system in your department or agency. Your head of department or manager demanded you to fill a repair and maintenance form related with this situation. Complete the repair and maintenance form by filling the essential information and dispatch it to the appropriate personnel after you.

5. Your head of department or manager wanted information about where and on which phase the repair and maintenance form that you had dispatched is after some time. For this reason, learn where and on which phase the repair and maintenance form that you had dispatched is by finding your document.

6. You realized that you had sent the Repair and Maintenance form that you had filled based on your head of department or manager demand to a wrong personnel. Take your document back before the personnel that you had sent wrongly makes a change on your document.

7. You could not guess what to write to some text fields that exist in Maintenance and Repair Form and you have difficulty in filling the form. Find the help menus inside the system so as to get help and get information about the related situation from these menus.