USABILITY TESTING OF A FAMILY MEDICINE INFORMATION SYSTEM

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USABILITY TESTING OF A FAMILY MEDICINE INFORMATION SYSTEM

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ABSTRACT

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Healthcare is an important part of life in most societies that attract a significant amount of public investment. Primary healthcare is a fundamental branch of the healthcare system where patients and doctors initially meet. Family Medicine Information Systems are developed in an effort to ease the daily work of family doctors with the help of information technology. Such systems are generally used for handling critical tasks such as managing health records of patients, monitoring

pregnancy and keeping track of children's vaccination. Like any medical information technology, the usability of such systems is a vital concern for enabling efficient and effective primary healthcare operations. Family Medicine is a recently established practice in Turkey and there are a number of systems in service to aid the daily work of family doctors. However, none of these systems have been subjected to a systematic usability analysis. In this study, a usability analysis of a popular Family Medicine Information System used in Turkey is conducted. By combining several usability evaluation techniques, the study identified several important usability issues and provided recommendations for further improving the system. The main usability issue observed in the system was the overall complexity of the information presented at the main interface that often confused and misled the users. In order to address this problem, it is suggested that features related to the most frequent family medicine operations should be placed on the main screen, whereas remaining features should be organized under auxiliary pages with clear navigation aids.

Keywords: Family Medicine Information System, Usability Testing, Usability Evaluation, Human-Computer Interaction, Eye-Tracking

ÖZ

AİLE HEKİMLİĞİ BİLGİ SİSTEMİNİN
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Sağlık hizmeti birçok toplumda ciddi yatırımların yapıldığı ve insan hayatında önem teşkil eden bir alandır. Birinci basamak sağlık hizmeti hastaların ve doktorların ilk buluştuğu yerdir ve sağlık sisteminin temel bir alt dalıdır. Aile hekimliği bilgi sistemleri aile hekimlerinin günlük iş yükünü bilgi teknolojilerinin yardımı ile birlikte azaltmayı hedefleyerek üretilmektedir. Bu tip sistemler gebe izlemi, çocuk aşı takibi ve hastaların sağlık kayıtlarını yönetmek gibi kritik işlemleri yapmak için

kullanılırlar. Diğer tıbbi bilgi teknolojileri gibi bu sistemlerin de kullanılabilirliği etkili ve verimli birinci basamak sağlık hizmeti sunmak açısından önem teşkil etmektedir. Aile hekimliği Türkiye'de son zamanlarda uygulanmaya başlanan bir alandır ve aile hekimlerinin günlük işlerini kolaylaştırmaya yönelik bir çok yazılım bulunmaktadır. Fakat bu sistemlerden hiçbiri sistematik bir kullanılabilirlik değerlendirmesine konu olmamıştır. Bu çalışmada Türkiye'de popüler olarak kullanılan aile hekimliği bilgi sisteminin kullanılabilirlik değerlendirmesi yapılmıştır. Bu kapsamda çeşitli kullanılabilirlik değerlendirme teknikleri bir arada kullanılarak bazı önemli kullanılabilirlik problemleri tanımlanmış ve sistemi geliştirmek için önerilerde bulunulmuştur. Sistemde gözlenen temel kullanılabilirlik problemi ana ekrandaki bilgilerin karmaşık bir şekilde sunulması ve bundan dolayı kullanıcıların sıklıkla yanlış yönlendirilmesi ve kafalarının karışmasıdır. Bu problemi ortadan kaldırmak için, en sık kullanılan aile hekimliği işlemlerinin ana ekrana yerleştirilmesi ve geri kalan işlemlerin açıkça belirtilmiş gezinim yardımları ile yedek sayfalarda düzenlenmesi önerilebilir.

Anahtar Kelimeler: Aile Hekimliği Bilgi Sistemi, Kullanılabilirlik Testi, Kullanılabilirlik Değerlendirmesi, İnsan Bilgisayar Etkileşimi, Göz İzleme

To My Family

and

Yegâh Classical Turkish Music Association

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LIST OF ABBREVIATIONS AND ACRONYMS

FMIS : Family Medicine Information System

FHC : Family Health Center

SUS : System Usability Scale

HCI : Human Computer Interaction

METU : Middle East Technical University

PARC : Palo Alto Research Center

ISO : International Standard of Organizations

UEMs : Usability Evaluation Methods

CWT, CW : Cognitive Walkthrough

WT : Walkthrough

HE : Heuristics Evaluation

HTA : Hierarchical Task Analysis

GOMS : Goals, Operations, Methods and Selection rules

UI : User Interface

CM : Cognitive Modeling

KLM : Keystroke-Level Models

ACT-R   **:** Adaptive Control of Thought-Rationale

AOI   **:** Area of Interest

NAOI   **:** Not Area of Interest

HF   **:** Human Factors

CPOE   **:** Computerized Physician Order Entry

EHR   **:** Electronic Health Records

MEDS   **:** Mobile Emergency Department Software

GUI   **:** Graphical User Interface

IT   **:** Information Technology

MD   **:** Medical Doctor

CHAPTER 1

INTRODUCTION

In the health domain, technology plays a significant role to ease daily tasks. Almost each subfield of medicine has its own special purpose technological devices and software. When patients visit a doctor for the first time, their individual records are usually managed by computers using special software known as Clinical Information Systems (CIS) or Hospital Information Systems (HIS). In most countries it is obligatory to visit a family doctor first before visiting any secondary health department such as internal medicine, obstetrics, gynecology etc. Since the same restriction does not currently apply in Turkey, patients are free to visit any hospital from the first level (e.g. family medicine centers) up to the third level (e.g. research hospital or faculty of medicine). However, this situation will change in the near future as the Ministry of Health is getting prepared to make it mandatory to visit the local family medicine center first to get access to basic healthcare services in Turkey. The impact of this policy change can be observed in the increasing number of degree programs for family medicine at medical schools. In addition to increasing number of newly graduates, there has been an increase in the number of experienced doctors who have decided to switch their practice to family medicine.

As the family medicine centers are projected to be the main gateways for basic health care services, several kinds of Family Medicine Information Systems (FMIS) have been recently released in an effort to help family doctors manage local patient

information through a centralized national database. Since the development of family medicine information systems were contracted by the Ministry to private software companies, there are currently several competing systems such as elements, Server AHBS and SisoFamily AHBS in the market that specifically target the family medicine practice. Family doctors in Turkey are free to select which FMIS they like to use in their practice. Although all these systems are required to implement the specifications set by the Ministry, to the best of our knowledge none of these systems have been subjected to a systematic usability evaluation. Due to the critical role that will be fulfilled by FHCs in the near future in our healthcare system, it is important that such systems are designed over user-centered principles to enable efficient and error-free use. This study aims to address this gap by conducting a usability analysis of a widely used FMIS system called Neuroogle.

Among several competing options, Neuroogle is the most preferred software by family medicine practitioners in the Ankara region. There are currently 1280 family doctors located in Ankara (personal correspondence, City Directorate of Public Health, August 28, 2012) and 1000[1] of them are reported to be using the Neuroogle FMIS. Despite this software's popularity among family doctors, there is no systematic study that evaluates the usability of Neuroogle in terms of user-centered design principles. Thus, the main and perhaps the most significant purpose of this study is to conduct a usability evaluation of the Neuroogle Family Medicine Information System (FMIS). Through a triangulation of multiple usability analysis techniques, the thesis aims to provide a constructive critique of this system by identifying important usability issues and offering recommendations to remedy those issues based on user-centered design principles.

1.1. Purpose of the Study and Research Questions

The main purpose of this study is to conduct a usability evaluation of the Neuroogle system by employing multiple usability methods such as eye-tracking experiments, semi-structured interviews, questionnaires, cognitive modeling and heuristic

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[1] personal correspondence with the financial manager of the company that designed Neuroogle, August 28, 2012

evaluation. Each method aims to uncover complementary aspects regarding the use of Neuroogle. The following list provides the main research questions that have been pursued in this study:

- (RQ1) What are the most important tasks carried out by family doctors on a FMIS like Neuroogle?
- (RQ2) What usability issues are there on the existing Neuroogle interface in relation to the important tasks?
- (RQ3) How can the Neuroogle interface be improved based on the usability issues identified?

Question 1 is related to the properties of the work setting in which Neuroogle is being used. The main tasks that are important for the daily lives of family doctors are identified via semi-structured interviews conducted with family doctors during site visits. Flowchart models of the main tasks are devised based on screen recordings obtained from the doctors' interface while they were carrying out those tasks as part of their daily routine.

Question 2 is further decomposed into 3 main sub-components based on standardized dimensions of usability; namely effectiveness, efficiency and satisfaction. Further explanations of these terms are provided in Chapter 2. Neuroogle is evaluated in terms of effectiveness and efficiency through heuristic evaluation, cognitive modeling and a usability experiment conducted with an eye tracker. During the usability experiment participants (IT experts and medical professionals) who have no prior experience with Neuroogle attempted to perform a selection of important tasks. The following sub-questions are considered to evaluate the effectiveness of the system, which aims to probe for the accuracy and completeness with which users achieve the goals of each task:

- (RQ 2.1) What percentage of the tasks are accurately completed by the users?
- (RQ 2.2) Which tasks are the most difficult for the users to complete? What kinds of obstacles/errors do they face when they failed to complete a task?

The following sub-questions aim to evaluate the efficiency of the system, which is related to the attentional and physical resources expended for achieving each task:

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- (RQ 2.3) How long does it take users to perform each task?
- (RQ 2.4) How many mouse clicks do users perform to complete each task?
- (RQ 2.5) How long do users fixate on task-related vs non-task-related objects?
- (RQ 2.6) What are the main design issues of Neuroogle interface in terms of established usability heuristics?

These questions are answered based on the data obtained from the eye tracker during the usability experiment. The empirical data is also compared with the performance of a hypothetical expert user that is modeled with the help of a cognitive modeling tool.

The following sub-questions aim to probe the user satisfaction dimension of usability:

- (RQ 2.7) How do the users rate the perceived usefulness of the system and their satisfaction by using the system?
- (RQ 2.8) What kinds of comments do the users make about the interface while they are engaged in the tasks?

User satisfaction analysis is based on user comments recorded during the think-aloud session and user ratings obtained from the post-survey administered after the experiment.

1.2. Significance of the Study

Commercial FMIS systems have a wide-spread use among family doctors in Turkey due to the advantages such systems offer for managing daily operations at family health centers (FHCs). Paper-based operations have turned into computer-based operations in almost every FHC (there are still some FHCs not using computer-based systems in some cities). Despite their wide-spread use, FMIS systems have not subjected to a usability evaluation. This is not surprising since conducting usability studies in the medical context is not common practice in Turkey. In the literature there is only a single study conducted by Karahoca et al. (2010) about the usability

evaluation of health domain systems services for palliative care and intensive care. These two systems were evaluated by using cognitive walkthrough and heuristics evaluation methods. (Karahoca et al., 2010). Therefore, given the increasing importance of family medicine practice in Turkey, this study aims to contribute to the efforts for improving the overall usability of systems developed for managing primary healthcare services.

1.3. Organization of the Thesis

The next chapter provides definitions of main usability concepts and a review of related literature in medical informatics. This chapter aims to give a brief information about the terms used throughout the thesis based on the literature in the field of Human-Computer Interaction (HCI). In particular, the chapter includes a short history of HCI, definitions of fundamental terms associated with HCI and usability, phases of usability evaluation, summaries of some of the mostly used usability evaluation methods (UEMs) and a review of similar studies conducted in the medical informatics context. Information about the design of the study, the participants, and materials and methods involved in the study is given in Chapter 3. The results obtained from all usability evaluation methods involved in the study are reported in Chapter 4. The chapter starts with the subject demographics then goes on with interview results, heuristics evaluation results, cognitive modeling results, eye-tracking study results, heat maps and gaze plots, system usability scale (SUS) results, think-aloud results and the overall success rates of the tasks performed by subjects of the study. Chapter 5 provides a discussion of the results reported in chapter 4 in the light of research questions of the study. Finally, chapter 6 offers recommendations for improving the system evaluated in the study, and discusses some of the limitations of the study and recommendations for future work.

CHAPTER 2

LITERATURE REVIEW

Within this chapter, overall information about Human Computer Interaction (HCI) and its concepts were covered. This chapter starts with the definition of the HCI and its brief history. Then explanation of HCI system architecture types supports brief information about HCI systems or interfaces. Afterwards, the most general HCI concepts are explained in order to gain deep insight about the terms used in HCI and usability studies. Lastly, some of the usability evaluations methods (UEMs) and remarkable usability studies in medical context provided.

Usability studies have increasing importance in almost every field in which there is an interaction between human and an interface. For the purpose of evaluating the usability of an interface, several methods are available in the literature. Making an interview is one of the best ways for collecting important information about the system based on evaluations of real users of that system.In this study, an interview was made with some family doctors at the beginning of the study to gain important information about the Neuroogle FMIS, especially for defining the most frequently used tasks or operations that will be the main focus of the study. Another mostly used method in the literature is heuristics evaluation that provides quick and cost effective evaluations of systems. Within this study, two heuristics guidelines were used to evaluate Neuroogle interface, which are explained in this section and the methodology section of the study. Cognitive modeling is another method which is

preferred when there is a need for estimating expert users' completion times of specific tasks defined for the study. In this study, cognitive modeling is mainly used to estimate task completion times of expert users of Neuroogle system. Eye-tracking and think aloud methods are other important methods for the usability evaluations as they provide quantitative and qualitative data for the analysis phase of the study. In this study, eye-tracking method was used for observing and obtaining quantitative data from end-users dealing with basic tasks over Neurgoole system. Think-aloud method was used as a supplementary method to the eye-tracking method to gain verbal expressions of the end-users.

Usability evaluations have a great importance in medical context since there might be loss of a life as a result of even the most simple error with respect to usability issue of the system. Systems designed for the use of medical personnel should be more carefully manufactured in order to minimize errors that might lead to these types of critical results. Systems may include design errors that are not easily noticed and may cause humans to make mistakes. Liljegren and Osvalder (2004) define these types of errors as latent errors that trigger a human error. Generally, latent errors are accepted as usability errors and diminish the usability of a medical technology or an interface (Liljegren & Osvalder, 2004). In medical context usability evaluations are mostly made to reveal usability problems of a system and present these errors to the design team of the system in order to help them to address those issues. Some studies are also available in the literature that compare two or more systems' usability to aid the purchasing decision of end-users. However, systematic usability evaluations offer further insights about how a medical technology should fulfill its design goals, and thus is more than a simple method for making a comparison among competing systems.

2.1. Human Computer Interaction

2.1.1. Definition of Human-Computer Interaction

Human-computer interaction (HCI) can be defined as a discipline that engages in design, implementation and evaluation of interfaces and interactive systems for

human use. HCI also concerns with the effectiveness, efficiency and pleasure of these systems after they are released for human use. HCI has emerged within computer science as an area of research and practice in the early 1980s (Carrol, 2009). Since then, HCI has become an integral part of almost all stages of software development, starting with requirements gathering, prototype design, implementation and evaluation.

The central concept in Human Computer Interaction is the notion of interaction. Humans in every field of specialty or work in various kinds of fields interact with a technology particularly with software that serves their field of work and is designed to ease their work. At this point, critical question is that how do people interact with software? Answering this question in a disciplined way defines the field of Human Computer Interaction, shortly HCI. According to Carrol (1997, p. 62) *"HCI is the visible part of the computer science"*. This statement explains the concept of HCI briefly and clearly.

Human-computer interaction remains to be an improving field since it continues to develop, and it is applied to the fields of social and behavioral sciences (Carrol, 1997). As a result of this, HCI specialists have become well integrated in system or software development phase in industry and also they have been explicitly involved in project management. In addition, human-computer interaction has been a rapidly and steadily spread out area for three decades and it attracts professionals from various disciplines and incorporating diverse concepts and approaches (Carrol, 2009).

2.1.2. History of Computers and Human-Computer Interaction

Human-computer interaction has been an emerging area for some decades which involves studying how users interact with computer systems. As Carrol (1997) states HCI is the visible part of the computer science; human-computer interaction aims to discover what happens when specific target users starts to use a system or a software that was developed to provide specific functionality. It is more valuable to refer to

the history of computer use before mentioning the history of human-computer interaction. Carrol (2009) states that computers were used by only information technology professionals and dedicated hobbyists until the late 1970s. Then this situation changed rapidly with the increasing use of personal computers. This rapid change on computer usage expansion and increasing quantity of computer users highlighted deficiencies of computers and contributed to the emergence of a new area briefly named as usability (Carrol, 2009).

Table 2.1 Growth of digital computers and user issues (Shackel, 2009, p. 355)

Computer type	Approx growth era	Main users	User issues
Research machines	1950s	Mathematicians, scientists	Machine reliability; users must learn to do the programming
Mainframes	1960s & 1970s	Data-processing professionals supplying a service	Users of the output (business managers) grow disenchanted with delays, costs, lack of flexibility
Minicomputers	1970s	Engineering and other noncomputer professionals	Users must still do much programming; usability becomes a problem
Microcomputers	1980s	Almost anyone	Therefore usability is the major problem
Laptops, Notebooks, PDAs	1990s	Anyone and often in mobile situations	Complexity in trying to achieve usability, especially with new input/output modalities

Shackel (2009, p. 354) describes the reason why computers attracted the attention of its first users as "*…the power and speed of this new machine was so useful that some scientists found it worth the cost of time and effort to learn how to use it*". Computers took their place in human life for the first time in late 1950s as the first business machines that were designed by computer specialists for data processing

professionals' use. With the invention of microcomputers around 1978 and smaller portable machines around 1990, computers were started to be used by everyone, including specialists and non-specialists.

Shackel (2009) states that some preliminary work was done primarily on military systems with respect to human factors and usability aspects in late 1950s, and ergonomics designs were not developed for commercial computers until 1960s. Then two foundations or centers named Palo Alto Research Center (PARC) and HUSAT research group were established in 1970s and they made considerable contributions to the field of Human-Computer Interaction. The field of human-computer interaction developed has established itself as a scientific discipline with the contributions of authors by releasing journals and books from early 1980s till now.

2.2. Human-Computer Interaction Concepts

2.2.1. User Interface

An interface is the platform by which the users interact with the product to achieve their goals . It is the place where the system reveals itself to the users and responds according to the users' actions. Interfaces can be in various forms including (Hackos & Redish, 1998):

- The controls on a hardware product
- The labels and signs on the hardware
- Small liquid crystal displays on machines of all sorts
- The screens for software applications on mainframe terminals
- The screen for software applications on personal computers running operating systems such as Windows, OS/2, DOS, Macintosh, UNIX, and others
- The pages of a website
- Help systems and online paper manuals
- Embedded tutorials and other types of performance support
- The page layouts of paper forms or other documents

The user interface that can be defined as a part of a computer and its software that people can see, hear, touch and talk to consists of two essential components: input and output (Galitz, 2002). Input is people's way of transmitting their needs or desires to the computer and output is the computers' way of conveying the results of computations/operations to the user.

2.2.2. Usability

Usability is a term that has gained increasing importance in software and product design community in the past few decades. Nielsen & Loranger (2006) describes usability as "…a quality attribute relating to how easy something is to use. More specifically, it refers to how quickly people can learn to use something, how efficient they are while using it, how memorable it is, how error-prone it is, and how much users like using it. If people can't or won't use a feature, it might as well not exist." (Nielsen & Loranger, 2006). Designing more usable systems have emerged as an important necessity in the industry due to its important benefits such as increased productivity, reduced errors, reduced need of user training and user support and improved acceptance by the users (Jaspers, 2009).

The International Standard of Organizations (ISO) defines the usability in the standard of ISO 9421-11 as;

> "*Usability is the effectiveness, efficiency, and satisfaction with which specified users achieve specified goals in particular environments*" (ISO, 1998, as cited in Kushniruk & Patel, 2004, p. 56)

As it is highlighted by ISO'sdefinition, the concept of usability consists of three attributes; efficiency, effectiveness and satisfaction. These attributes are defined by Liljegren (2006) as follow;

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"Effectiveness is the accuracy and completeness with which specified users can achieve specified goals in particular environments. Efficiency is the resources expended in relation to the accuracy and completeness of goals achieved. Satisfaction is the comfort and acceptability of the work system to its users and other people affected by its use" (Liljegren, 2006, p. 346).

Usability has some attributes that should be supported by the systems. Nielsen (1993) defines five attributes of usability as follows (as cited in Liljegren, 2006, p. 346):

- *Learnability*: The system or an interface should be easy to learn so that end-users can rapidly overcome some work by using the system.
- *Efficiency*: The system should be efficient to use, so that when the system is learned by the users, it can also be used with a high proportion of productivity.
- *Memorability*: The system should be easy to remember, so that the users should be able to remember everything with the system even they did not used the system for some period and they should not have to learn everything all over again.
- *Errors*: The system should have a low error rate, so that users encounter with few errors during the use of the system and they should get rid of errors easily.
- *Satisfaction*: The system should be pleasant to use, so users are subjectively satisfied when using it.

2.2.3. Usability Testing

Usability testing is a "…a process that employs participants who are representative of a particular target population to evaluate the degree to which a product or a system satisfies basic usability criteria" (Kaufman et al., 2003, p. 47). Usability testing can also be defined as the evaluation of interactive systems by involving representative target group of users. During usability testing, usability evaluators watch and record users' interaction with the system while they perform real or simulated tasks based on clearly defined scenarios (Beuscart-Zéphir et. al., 2004). It is important that users should be selected

from the target group of users of a system and they should be minimally intervened by the evaluator during the test phase in order to ensure the validity of the evaluations.

2.3. Usability Evaluation Phases

Usability evaluation requires careful planning. Conducting usability evaluations for user interfaces needs some phases to be considered as follows; (Kushniruk & Patel, 2004)

2.3.1. Phase 1. Identification of Evaluation Objectives

Firstly, evaluation objectives should be defined by the evaluators in order to shape and keep evaluation towards these aims. Some possible objectives are listed below as;

- Assessment of system functionality and usability
- Input into refinement of emerging prototypes
- Identifying problems in human computer interaction
- Evaluating the effects of a system on physician decision making processes
- Assessing the impact of a new information technology

2.3.2. Phase 2. Sample Selection and Study Design

Second phase of usability evaluation includes the selection of a sample of end-users or subjects for the study from a target population. When selecting subjects for the evaluation of a system, some criteria should be applied depending on the aim of the study, such as;

- Expertise of subjects in using computers
- The roles of subjects in the workplace
- Subjects' expertise in the domain of work the information system is targeted for.

Number of subjects: It is enough to involve at least 8-10 subjects for carefully planned and conducted usability studies that reveal most of the fundamental usability problems in a system. On the other hand, more subjects (e.g, 15- 20 or more subjects) should be involved in the study to make more generalizable claims regarding less salient usability issues.

Study design: Study designs may consist of within group studies or between group studies according to aim of the study.

2.3.3. Phase 3. Selection of Representative Experimental Tasks and Contexts

This phase involves selecting representative experimental tasks for the study. Tasks that will be used for the evaluation of a system should be carefully selected so that they represent real uses of a system by the end-users in a real working environment. The task selected for the study should also reveal high quality data about interactions of users with the system. In order to define and select tasks, interviews can be made with target group users during planned site visits.

2.3.4. Phase 4. Selection of Background Questionnaires

A background questionnaire may be given before or after actual testing of a subject's interaction with a system for obtaining background information of participants that helps the evaluators understand participants' behavior and performance during the test. Questionnaire may include some items to reveal the level of subjects' prior experience with computer systems or an interface that is being evaluated in order to classify them according to aims of the evaluation.

2.3.5. Phase 5. Selection of Evaluation Environment

The physical location selection for the evaluation can change depending on the study; however, conducting usability evaluations in real environments is usually more preferable to obtain more ecologically valid evaluations. On the other hand,

some systems may not be suitable for conducting usability evaluations in the real working environment such as medical software, since these types of software are used in more risky and busy environments. These systems can be evaluated in commercial usability laboratories that consist of test rooms and observation rooms separated by a one-way mirror, which allow experimenters to observe subjects in a controlled setting. Controlled usability labs provide increased precision in obtaining usability measures at the expense of a reduction in ecological validity.

2.3.6. Phase 6. Data Collection Video Recording and Recording of Thought Process

Data can be collected either by a video recording or a voice recording of the participants during the test sessions. Audio recordings are particularly preferred for think-aloud protocols, which allow evaluators to get some insights about participants' reasoning process while they interact with the system. Moreover, audio recordings of test subjects often enhance the video recordings by presenting subjects' comments on everything related with their interaction with the system.

2.3.7. Phase 7. Analysis of the Process Data

Analysis of data collected from usability evaluations can vary according to each method used for the evaluation. Depending on aims of the study, usability evaluation of a system can involve a single method or mixed methods. Usability evaluation methods may involve both qualitative or quantitative techniques. For instance interviews, questionnaires and heuristics evaluation support qualitative data, whereas cognitive modeling, system usability scale (Brooke, 1986) and eye-tracking experiments provide quantitative data related to usability.

2.3.8. Phase8. Interpretation of Findings

The data collected from usability testing can be compiled and summarized in various ways, depending on the aims of the evaluation. The results reveal some aspects of

system use including task accuracy, user preference data, users' comments on items related to the interface, time to completion of task, frequency and classes of problems encountered, etc. These results are then transformed into recommendations list for the designers of the interface.

2.3.9. Phase 9. Iterative Input into Design

This phase is applied for the evaluation of the systems that are currently under development. After implementations of changes to the developing system, usability evaluation may be repeated to determine how the changes affect the system's usability. In this way, systems are continuously improved through iterative design phases informaed by usability evaluations.

2.4. Usability Evaluation Methods (UEMs)

Usability evaluation methods are grouped under various headlines in the literature. For instance, Liljegren (2006) grouped usability evaluation methods into two categories; analytical and empirical. Analytical UEMs depend on the reasoning of one or more evaluators and there is no need to involve actual users whereas empirical UEMs depend on data collected from actual users. According to Liljegren (2006) four UEMs are common and current in either analytical or empirical UEMs. These common methods can be stated as hierarchical task analysis (HTA), cognitive walkthroughs (CWT or CW), heuristic evaluation (HE) and usability tests.

In addition to categorization of UEMs by Liljegren (2006), UEMs are also grouped into three categories as testing, inspection and inquiry by J. Hom (cited in Karahoca et al., 2010). Usability testing approach involves experiments where a sample of representative users deal with typical tasks by using the system in a controlled usability lab setting. The usability inspection approach needs usability specialists to examine and judge the degree of a system that accompanies usability principles. On the other hand the usability inquiry approach needs usability evaluators to collect

information from the end-users (e.g, target group users) about the system that is being evaluated via surveys, site visits and interviews.

Another categorization of usability evaluation methods is made by Jaspers (2009) as expert-based and user-based. Expert-based evaluation methods include guideline review, heuristic evaluation (HE), consistency inspection, usability inspection and walkthroughs (WT) while user-based evaluation methods include user performance measurements, log-file and key-stroke analyses, cognitive workload assessments, satisfaction questionnaires, interviews and participatory evaluation (Jaspers, 2009, p. 341).

In this study usability evaluation methods were introduced without grouping into categories as follow;

2.4.1. Interviews

Interview is probably the most commonly used approach for gathering information (cited in Kirwan & Ainsworth, 1992, p. 66) about the target user group. The evaluator designs an interview in order to make "…a conversation with participants through a purpose" (Sharp, Preece & Rogers, 2007, p. 298). This purpose can vary according to the study being conducted, but in general interviews aim to collect some cues regarding how the target group uses the system under evaluation and to gather their opinions about the system. Kvale and Brinkmann (2009) defined seven stages of interviewing: thermalizing an interview project, designing, interviewing, transcribing, analyzing, verifying and reporting.

In the literature, it is possible to find so many types of interviews but the most common and frequently used interview types are open-ended (unstructured), structured, semi-structured and group interviews. The most appropriate type of interview depends on the purpose of the interview and the questions to be asked respectively.

Open-ended or unstructured interview consists of open questions meaning that there is no expectation about the format or content of answers as its name implies. This interview type can be defined as a conversation around a specific topic (Sharp, Preece & Rogers, 2007). The most important part of this type of interview is to make sure that answers to relevant questions are obtained. Such a question for this type of interview can be "What do you think about software you used?" and "Can you give your positive and negative opinions about software you used?" With these types of questions target group's opinions and some cues about the software or hardware can be obtained.

Structured interview on the other hand consists of predetermined questions that are usually short and clearly specified. Generally these questions are closed, which means that their answers are selected from a predetermined group of alternatives. This type of interview is most suitable when the goals are clearly understood and specific questions can be identified.

Semi-structured interview combines the properties of both structured and unstructured interview by including closed and open questions. The semi-structured interview starts with preplanned questions, but the interviewee is allowed to continue elaborating his/her opinions regarding the topic of interest set by the question.

Group interviews, unlike other interview types, are based on interviewing with a group of people. One form of group interview that is frequently used is the focus group (Sharp, Preece & Rogers, 2007). Usually it is enough to involve 3 to 10 people in an interviewing session that is led by an expert facilitator. Moreover, it is important to select participants of focus groups from the representative sample of the target group population.

2.4.2. Task Analysis

Task analysis involves identification of the nature and the sequence of steps required to successfully fulfill operations on a user interface. In particular, task analysis "…is used mainly to analyze the underlying rationale and purpose of what people are doing: what are they trying to achieve, why are they trying to achieve it, and how are they going about it? The information gleaned from task analysis establishes a foundation of existing practices on which to build new requirements or to design new tasks. Task analysis is an umbrella term that covers techniques for investigating cognitive processes and physical actions at a high level of abstraction and in minute detail." (Sharp, Preece & Rogers, 2007, p. 515)

In the literature it is possible to find some task analysis models but mostly used task analysis models or techniques are Hierarchical Task Analysis (HTA) and GOMS (Goals, Operations, Methods and Selection rules) (Sharp, Preece & Rogers, 2007).

Hierarchical Task Analysis (HTA): HTA can be defined as the process of developing task models of operations of users by using an interface to achieve come goals. The result of HTA is a hierarchy of sub-goals and operations needed to perform a task successfully. HTA can be preferred for the analysis of existing systems, and it can be used to describe tasks for comparison of operations and task content (Liljegren, 2006).

GOMS (Goals, Operations, Methods and Selection rules): GOMS model can be defined as the knowledge and cognitive processes that are involved when users interact with systems or interfaces, perform a task or solve a problem. GOMS refers to Goal, Operations, Methods and Selection rules and these terms are explained by Sharp, Preece & Rogers (2007) as follows:

- *Goals* refer to particular state the user wants to achieve.

- *Operators* refer to the cognitive process and physical actions that need to be performed in order to attain those goals.
- *Methods* are learned procedures for accomplishing the goals and consist of the exact sequence of steps required.
- *Selection rules* are used to determine which method to select when there is more than one available for a given stage of task.

2.4.3. Heuristics Evaluation

Heuristics evaluation can be broadly defined as evaluating software or more generally user interfaces according to some guidelines (i.e. principles) by the usability evaluator. There are some different types of guidelines compiled by authors. Nielsen (1994) developed heuristics evaluation technique with 10 major heuristics that should be followed by good user interfaces and Shneiderman (1998) described eight golden rules that all good user interface designs should follow (Zhang, Johnson, Patel, Paige & Kubose, 2003). Another heuristics evaluation guidelines is described by Xerox Company which includes 13 main criteria and 293 sub items for these criteria (see Appendix L).

Usability evaluators are able to observe any part of the interface or a system but it is more significant that they should follow the guidelines of usability heuristics when they conduct heuristics evaluation. In the literature the most preferred heuristics evaluation guideline belongs to Nielsen (1994) and 10 heuristics of this guidelines are described below;

Visibility of System Status: This heuristic is based on whether the system gives information about what the user is doing at a specific time or what is going on.

Match between System and Real World: This heuristic checks whether the system contains words or phrases which are familiar to the target user group of the system. It emphasizes that the system should not contain technical words or phrases from software terminology, especially if the system is catering to a broad user group.

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User Control and Freedom: This heuristic implies that users always have a sense of control over the system they use. For instance, when users click on the wrong option or do something wrong they should be able to recover from that situation by using the undo feature of the system.

Consistency and standards: All the functions or properties of the system should be consistent with each other. There should not be any duplicate functions that do the same thing. So, the end-user should not be confused with two different words, actions or functions that are doing the same thing.

Error Prevention: Error messages should be carefully designed in order not to make end-users get confused about the situation. The system should prevent problems to occur at the first place. Besides, the system should always prompt the user with a confirmation message when they perform a critical task or an action.

Recognition Rather than Recall: The system should minimize end-users' memory load by presenting information, objects, actions or options visible and reachable each time the user demands. Users should not have to remember information from a previous screen to carry out a function in the current screen.

Flexibility and Efficiency of use: Users are different from each other so, the system should allow users to make their own shortcuts for their frequently used actions, functions or properties.

Aesthetics and minimalist design: This heuristics implies that the user interface and the dialogues in the system should not contain extra or irrelevant information since it slows users down by making them spend time to read unnecessarily detailed information.

Help Users Recognize, Diagnose and Recover from Errors: Error messages should contain information that consists of words or phrases that are familiar to the end-users. They should not contain expression from software language such as references to code lines or exception messages. The error messages should accurately state the problem and suggest a solution for recovery.

Help and Documentation: The system should contain a help and documentation part in order to serve relevant information when users want to learn about something they do not know or when they need detailed information about a feature.

It is proposed to evaluate the system with these heuristics by more than one usability evaluator since error finding rate increases when the numbe of evaluators increases. In addition to this, having evaluators with different levels of expertise greatly affects the results of heuristic evaluation since the success rate of finding usability problems and the variety of the detected problems increase (Jaspers, 2009).

The chart below shows usability problems found by heuristic evaluation as a function of the number of evaluators (Nielsen, 1993).
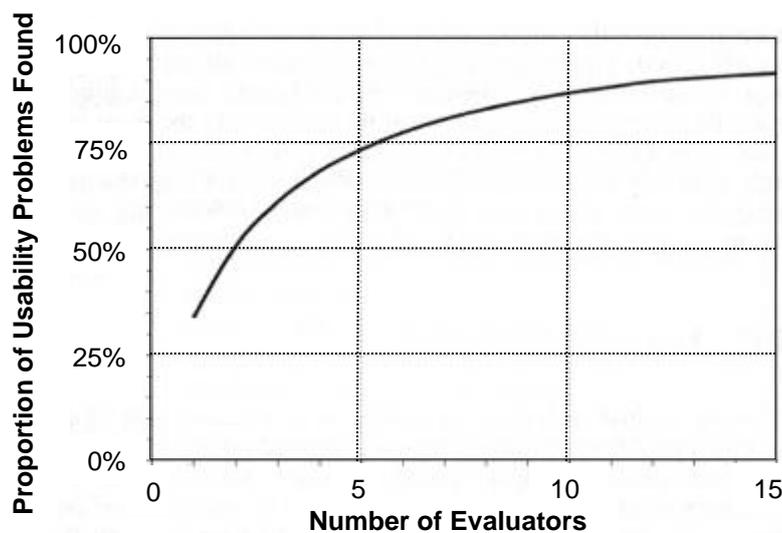
Figure 2.1 Usability problems found by heuristic evaluation as a function of the number of evaluators (Nielsen, 1993, p. 156)

An advantage of heuristic evaluation is stated as *"an efficient usability evaluation method with a high benefit-cost ratio"* (cited in Jaspers, 2009, p. 342). If the time and resources are limited, it is more preferable to use heuristics evaluation since it gives an opportunity of making quick and cheap evaluation. Another advantage of heuristic evaluation is that there is no need to involve a targeted group of users (i.e. end users) in the evaluation process.

2.4.4. Think-Aloud Method

Think-aloud method can be defined shortly as externalizing thoughts during performing a task or solving a problem. Jaspers, Steen, Bos & Geenen, (2004, p. 783) define think–aloud method as "*...a method that requires subjects to talk aloud while solving a problem or performing task*".

Since think-aloud method gives direct data on the current thought processes during task performance or problem solving of users, it can be accepted as a unique source of information on cognitive processes. The think-aloud method can be summarized in two steps: collecting think aloud protocols in a systematic way and analyzing the protocols to obtain a model of the cognitive processes that take place while tackling problems (Jaspers, Steen, Bos & Geenen, 2004). Think-aloud protocols can be defined as verbal protocols and can be collected by guiding subjects to solve a problem or to perform a task by verbalizing their thought processes. These verbal protocols obtained from users are used as raw data to gain deep insight in the way subjects perform tasks with substantial analysis and interpretation.

Rubin and Chisnell (2008) suggest that while implementing the think-aloud method, the participants should be asked to provide a running commentary of their thought process and express their confusion, frustration, and perhaps even their delight by thinking aloud while they are performing the task of the test. If think-aloud method is successfully implemented by usability evaluators, it is possible to reveal information about what participants think during task performance and what kinds of comments they make about a system or an interface.

2.4.5. Cognitive Modeling

> *"Predictive human performance modeling has been an HCI "holy grail"*
> *for decades. If the field had a computational model of a human that could*

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perform like a human (including perception, cognition and motor action),
make errors like a human, learn like a human, and experience emotions
like a human, then we could test our design ideas as they emerge in the
design process, quickly and inexpensively" (John & Suziki, 2009).

In the cognitive modeling approach researchers can predict time of execution of specified tasks by using some modeling tools. Cog-tool is one of these useful tools to predict completion time of tasks. Cog-tool gives user interface designers an opportunity of creating quickly and easily valid Keystroke-Level Models (KLM) that enables researchers to model a task as a sequence of cognitive and motor operators each of which has duration, based on prior empirical research and run them using Adaptive Control of Thought-Rationale (ACT-R) cognitive architecture to compute task completion time for expert users (cited in Richards, Bellamy, John, Swart & Thomas, 2010). Keystroke level Models (KLM) are defined as follow:

"*The basic idea of KLM is to list the sequence of keystroke-level actions*
that the user must perform to accomplish a task, and sum the time
required by each action. The KLM describes the task execution in terms
*of four physical-motor operators: **K** (key-stroking), **P** (pointing), **H***
*(homing), and **D** (drawing), one user mental operator **M**, and a system*
*response operator **R**(t). K, P, H and D are determined by the actions*
necessary to accomplish the task. The KLM assumes that the first five
operators take constant time for each occurrence, and provides a set of
heuristic rules for placing M's in the sequence of Ks, Ps, Hs and Ds, set
by prior psychology and HCI research. Response times must be estimated
by the analyst and only include the time that the user must wait for the
system after any M operator has completed." (Luo & John, 2005).

When user interface (UI) designers model tasks, cog-tool turns these models into ACT-R code that imitates the KLM, runs the code and finally returns a prediction of skilled performance time for the task on that UI (John, Blackmon, Polson, Fennell & Teo, 2009).

2.4.6. Eye-Tracking Methodology

Eye tracking is a method that allows evaluators to record and observe eye movement and eye-fixation patterns of users (Namahn, 2001). Eye-tracking is one of the best ways of collecting quantitative data from users for usability evaluation. Eye-tracking method is used to obtain some quantitative information such as which objects users focus on during task performance and how much time they focus on these objects. Such observations provide evaluators insights into what the user found interesting, what drew their attention, and how he/she perceived the information presented on the user interface (Duchowski, 2007).

Goldberg and Kotval (1999) state that eye movements can significantly enhance the observation of users' strategies while using computer interfaces (cited in Duchowski, 2007, p. 283). Eye-tracking method allows evaluators to obtain some significant information such as patterns of fixations (scan paths), time spent for looking at different display elements and deployment of visual attention (Namahn, 2001). More precisely, eye-tracking studies can be conducted for usability testing for several reasons, such as (Namahn, 2001)

- Support other types of data
- Help discriminate "dead time"
- Measure how long a user looked at an area of interest
- Capture a sequential scan path
- Evaluate a specific interface
- Extract general design principles
- Demonstrate scanning efficiency
- Understand expert performance for training
- Help to sell usability testing
- Provide a quantitative comparison of UI designs
- Provide domain specific benefits (web pages, cockpits, text design)
- Help explain individual differences

Eye-tracking method involves so many terms and metrics that should be known by evaluators. Some of the important terms and metrics can be defined as follows:

Area of Interest: Area of interest (AOI) is an analysis method used in eye tracking (Poole & Ball, 2005) Evaluators of an interface define a rectangular, circular or octagonal shaped area on a particular screen of the interface under evaluation and analyze eye movements that fall within these areas.

Gaze: An eye tracking metric, usually the sum of all fixation durations within a prescribed area and called as dwell, fixation cluster or fixation cycle. (Poole & Ball, 2005). This metric can be best used for comparing attention distributed between targets.

Saccade: "An eye movement occurring between fixations, typically lasting for 20 to 35 milliseconds." (Poole & Ball, 2005). Saccades are also defined as quick movement of the eyes from one fixation to the next (Nielsen & Pernice, 2010). Moving the eyes to next viewing position is the aim of most saccades (Poole & Ball, 2005).

Scan path: An eye-tracking metric, usually a complete and spatial arrangement of sequence of fixations and interconnecting saccades (Jacob & Karn, 2003; Poole & Ball, 2005).

Fixation: Eye movements that stabilize the fovea over a stationary object of interest (Duchowski, 2007). "*Fixations are moments the eyes are relatively stationary, taking in or encoding information*" (Poole & Ball, 2005). Fixation is resting of an eye on something on the screen (Nielsen & Pernice, 2010)

Fixation Duration: Measure of difficulty of information extraction and interpretation, and the pattern of fixation transitions between displays (Jacob & Karn, 2003).

First Fixation Duration: This metric estimates the duration (in seconds) of first fixation over area of interest (AOI) defined by the evaluator for eye movement analysis.

Time to First Fixation: This metric measures how long it takes before a participant fixates on an AOI for the first time (Tobii Studio Software Manual).

Fixation Before: This metric measures the number of times the participant fixates on the media before fixating on an AOI for the first time (Tobii Studio Software Manual).

Fixation count: This metric measures the number of times the participant fixates on an AOI (Tobii Studio Software Manual).

Time to first Mouse Click: This metric measures how long it takes before a participant left-clicks with the mouse on an AOI for the first time (Tobii Studio Software Manual).

Time from First Fixation to Next Mouse Click: This metric measure how long it takes before a participant left-clicks with the mouse on an AOI once he/she has fixated on it (Tobii Studio Software Manual).

Mouse Click Count: This metric measures the number of times the participant left-clicks with the mouse on an AOI (Tobii Studio Software Manual)

2.5. Usability Studies in Turkey

Usability is a topic that is still in its infancy in Turkey. Despite recent academic studies and the efforts of the state (e.g. KAKIS guidelines), usability methods and techniques are not generally incorporated in software development practice in Turkey. Nevertheless, usability is attracting increasing interest as it is indicated by the growing literature on the subject matter.

In Turkey, usability studies are usually conducted for academic purposes. Institutions and professional companies such as METU-HCI lab, SimSoft and UTRLab that provide consultancy services for improving usability of existing interfaces have recently been established. For instance, METU Human-Computer Interaction research group (METU-HCI) is an institution that was established in 2005 that aim to

study the nature of interaction between people and computers in order to enhance the design and utilization of more usable and humanly acceptable systems[2]. The group has been conducting 3 main types of studies with respect to usability concerns up to now;

- Eye tracking based dynamic real-time evaluation of cognitive activities in computer supported learning environments and effects of different human-computer interface designs on these activities
- Eye-tracking use for evaluating the effectiveness of advertisements
- Standards and guidelines for government institutions web-sites (KAKIS)

There are some other commercial companies established in Turkey to make usability evaluations of systems or interfaces such as Simsoft and UTRlab.

In the literature, there are some usability studies conducted in Turkey. One of these studies was an eye-tracking study to inspect how color coding affects multimedia learning (Ozcelik et. al., 2009). The study aimed to investigate the underlying cause of a color-coding effect by utilizing eye movement data. According to result of this study, it was revealed that color coding increases retention and transfer performance, and enhancement of learning by color coding was due to efficiency of locating corresponding information between illustration and text (Ozcelik et. al., 2009).

Another usability study was conducted by Karacan, Cagiltay and Tekman (2010) to focus on the effect of environment familiarity on gaze direction. Findings of the study revealed that the factor of familiarity with one's surroundings in virtual reality environments exerts a significant influence on peoples' ability to detect a variety of specific changes that occur within scenes under their observation (Karacan, Cagiltay, & Tekman, 2010).

Ozcelik, Arslan-Ari and Cagiltay (2010) conducted a study that inspects why signaling enhances multimedia learning by tracking eye movements of participants. The main goal of this study was to examine the effects of signaling on learning outcomes and to reveal the underlying reasons for this effect by using eye movement

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[2] METU – HCI research group website, http://hci.metu.edu.tr/

measurements (Ozcelik, Arslan-Ari, & Cagiltay, 2010). This study revealed that signaling guided attention to relevant information and improved the efficiency and effectiveness of finding necessary information (Ozcelik, Arslan-Ari, & Cagiltay, 2010).

Alkan (2006) conducted a study to analyze computer game learning experience by using eye-tracking data. The main purpose of Alkan's (2006) study was to explore how novices leanr computer games. The mentioned study was administered by the participation of some undergraduate university students. Participants of Alkan's (2006) study were recorded by the eye-tracking device while they were interacting with a computer by playing a game selected for the study. The main finding of the study was that eye-tracking could be used as measure to study learning experience of games.

A study conducted by Kavaklı (2004) to develop and investigate usability of a course content management system. In Kavaklı's (2004) study, a course content management system was designed and developed first, and then its usability was inspected by heuristics evaluation with the participation of some experts.

Another study conducted by Cansız (2012) inspected the effects of different way finding affordances on the usability of METU virtual campus, which was built in Second Life virtual world, in terms of user's satisfaction, performance and mental workload. In Cansız's (2012) study, some METU students completed a series of navigational tasks in the METU virtual campus. Participants' eye movements were recorded by an eye-tracking device and examined to determine which areas were mostly engaged by the participants (Cansız, 2012). The results of the Cansız's (2012) study provided guidance for the design of way finding affordances in METU virtual campus.

Usability studies, especially eye-tracking experiments, are also conducted in some other disciplines like cognitive sciences. In cognitive sciences usability studies take place in visualizing cognitive process of people when they perform a task or solve a problem. A study conducted by Bahadır (2012), for example, includes an eye-tracking experiment to inspect structural priming in the comprehension of Turkish

GEN-POSS (genitive-possessive) constructions. Moreover, Aydın (2012) conducted a study to inspect differences in usability and security of a graphical password scheme that depends on the coherence of a displayed image. Participants of Aydın's (2012) study created a graphical password and three days after the first session they tried to remember it so as to authenticate to the system. To reveal cognitive process of participants' making and remembering of graphical password, eye-tracking experiments were conducted in the study (Aydın, 2012).

To sum up, it can be claimed that conducting usability studies is a new research field in Turkey and it gains importance for many disciplines every passing day. Usability studies should take a place in every phase of software development life cycle but it is more important to integrate usability evaluations especially in early stages of software development in order to reveal the most significant and critical design errors before the product is released.

2.6. Usability Studies in Medical Context

Usability studies have great importance in medical context since a usability error that might even be accepted as a minor problem can cause critical and life-threatening problems. So, usability issues of a system designed for medical context should be seriously taken into account by the desgin team of software. When designing medical software, considering usability principles will increase the likelihood to catch problems the end-users may face with the interface and promote more effective use of the software. Thus, it is important to use and apply usability methods in each phase of software development lifecycle.

In the literature, several usability studies have been conducted in the medical context for various purposes. Some of these studies compare two or more medical software to aid purchasing decisions while others evaluate medical software or devices to improve their usability for end-users. There are also methodological studies that evaluate the usability evaluation methods themselves by considering their

effectiveness in terms of identifying and addressing usability issues in medical software.

Liljegren (2006) evaluated four common usability evaluation methods (UEMs) named hierarchical task analysis (HTA), cognitive walkthrough (CW), heuristics evaluation (HE) and usability tests according to some criteria of UEMs such as thoroughness, validity, reliability, cost effectiveness and clarity. According to Liljegren (2006) usability tests can be recommended to be the primary method in usability evaluations of interfaces at hospitals since they address the 'difficult to make errors' aspect of usability. This study mainly aimed to decide most beneficial usability evaluation methods for the evaluation of medical software.

Jaspers et al. (2004) aimed to design a user interface for a pediatric oncologists' computerized patient record by observing and thinking oncologists' work behavior in order to fulfill higher degree of usability principles. For the study, Jaspers et al. (2004) used think aloud method with the combination of video recording to get better understanding of the way in which pediatric oncologists' searched through the paper-based patient record in preparing patient visits. A cognitive task model reflecting pediatric oncologists' task behavior was developed with the contribution of video and protocol analyses (Jaspers et al., 2004). The result of the study is a product named computerized medical record system that meets pediatric oncologists' information needs and task behavior patterns (Jaspers et al., 2004).

Another study was conducted by Beuscart-Zéphir et al. (2005) to support the choice and acquisition process of Clinical Information Systems. Beuscart-Zéphir et al. (2005) evaluate two different clinical information systems by using quality management, usability assessment and performance evaluation. For the usability assessment of these systems, heuristic evaluation and usability test with which audio and video recordings of users were taken and observed were used (Beuscart-Zéphir et al., 2005). With the help of the evaluations Beuscart-Zéphir et al. (2005) recommended hospital managers to acquire second system offered by bidders. This

study mainly conducted for selecting the best usable product that will be purchased for the hospital usage.

Tan, Liu and Bishu (2009) evaluated two usability evaluation methods named heuristic evaluation and user testing with respect to their effectiveness and efficiency. As a result of the study Tan, Liu and Bishu (2009) claimed that both user testing and heuristic analysis are effective as they addressed different usability problems. It is also argued that user testing works better when a cognitive walkthrough is done and certain trials have been performed (Tan, Liu & Bishu, 2009). Jeffries et al. (1991) had found that with the heuristic evaluation it is possible to find approximately three times more usability problems than user testing but user testing discovers more severe usability problems compared to heuristic analysis (cited in Tan, Liu and Bishu, 2009).

Banna et al. (2009) conducted a study that aimed to focus on improving the effectiveness of public web-based health information services in addressing the information needs of family members or relatives or critically and chronically ill patients. Banna et al. (2009) chose two public health websites, one of which was a palliative care website and the other an intensive care website, to observe their existing benefits and suggest ways to improve them. This study of Banna et al. (2009) used several usability evaluation methods like pre-test and post- test questionnaire, think aloud method and an interview. With the study of Banna et al. (2009) some positive and negative aspects of two public health websites and recommendations were revealed with the contribution of participant responses analyzed from data collected with think aloud method. The result of the study also revealed how significant the aim of the public health web-based information systems was (Banna et al., 2009). This study was improtant for improving the usability of these two websites.

Rose et al. (2005) conducted a study that aims to improve the usability of a results management module of a widely deployed web-based electronic medical record (EMR) by conducting two qualitative studies including multiple focus group and

field study sessions. Findings of the study conducted by Rose et al. (2005) revealed issues such as the amount and organization of information in the display, interference with workflow patterns of primary care physicians and the availability of visual cues and feedback. Then Rose et al. (2005) used these findings to recommend design changes to the user interface of the result management module.

Niés and Pelayo (2010) conducted a study that presents case study reporting the collaborative work between Human Factors (HF) experts and a company developing and commercializing computerized physician order entry (CPOE). Within the study, regular meetings were convened between software development team and users' representatives in order to get users' feedbacks on the existing products for further developments (Niés & Pelayo, 2010). In addition usability inspection and usability test methods used for the study to further realize deficiencies of the software were evaluated. As a result of the Niés and Pelayo's (2010) study, it is claimed that the integration of users' representatives in the software lifecycle is a good point for the end users but sometimes it remains insufficient to resolve the complex usability problems of the system. At this point Niés and Pelayo (2010) suggested that integration of human factors experts required to enlighten this issue and involvement of human factors experts may generate benefits in terms of reduction of the number of iterative developments and users' training costs. Thus, this study mainly evaluated whether the involvement of representative end-users and human factor experts in software development is significant or not.

Kaufman et al. (2003) conducted a study that presents an approach to usability evaluation of computer-based health care systems designed for patient use in their homes. The study incorporates a cognitive walkthrough (CW) usability evaluation and some other methods for usability testing that can be applied in patients' homes. The method was applied to the IDEATel intervention, a multi-institution randomized controlled trial of the feasibility, acceptability and clinical utility of home-based telemedicine system for diabetic Medicare population (Kaufman et al., 2003). The main purpose of using usability evaluation for this study is to assess barriers to optimal use of the system and focus were both on dimensions of the interface and on

dimensions of patient skills and competency (Kaufman et al., 2003). Findings of the study revealed important insight regarding use of technology by an elderly chronic-care patient population and more generally understanding how home health initiatives can more effectively use such technology. Study of Kaufman et al. (2003) also led to software changes, development and subsequent revision of a patient tutorial and the creation of a field training program.

Karahoca et al. (2010) conducted a study that intended to evaluate the usability of emergency department software prototypes developed for Tablet personal computers (Tablet PCs) in order to keep electronic health records (EHRs) of patients errorless and accessible through mobile technologies. In order to serve the purpose of the study two alternative prototypes were developed for Tablet PCs: Mobile Emergency Department Software (MEDS) and Mobile Emergency Department Software Iconic (MEDSI) by Karahoca et al. (2010). For the study two usability evaluation methods were selected as heuristics evaluation and cognitive walkthrough. Result of the study revealed that usability evaluation of iconic GUIs has better success rate than non-iconic GUIs (Karahoca et al., 2010). So, this study was helpful in medical context that it evaluates the usability of two interfaces for selecting one of them as more usable.

Surabattula et al. (2009) conducted a study with the aim of comparing two cholesterol test kits named Accuchek Instant Plus and Home Access Instant Cholesterol Test on the basis of user performance, accuracy and the patient's future medical decisions on the test results. Questionnaires, user task performance comparison with the clinical evaluation were applied for the usability evaluation of these test kits (Surabattula et al., 2009). Result of the study revealed that first kit named Accuchek Instant Plus was founded to be a more usable kit by the participants of the study and evaluation methods results justified this situation (Surabattula et al., 2009).

CHAPTER 3

METHODOLOGY

In this study several methods have been employed to investigate the usability of the FMIS system selected for evaluation. Ethnographic field study was used to understand how actual users of the system perform their daily operations on the system and whether the system serves its aims. Semi-structured interviews and video capturing were conducted to reveal insights regarding the way the system is used by actual users. Task analysis was conducted to visualize the main tasks involved in this study and to schematize the steps needed to complete each task. Cognitive modeling was conducted in order to estimate how much time would be needed to complete the schematized tasks by a simulated expert user. The Cog-Tool user modeling environment was used to estimate the completion times of expert users. Heuristic evaluation techniques – Jacob Nielsen's Heuristics (1993) and Xerox Heuristics – were used to inspect general usability issues in the system in terms of ratings provided by expert usability evaluators along a list of heuristics. Finally an eye-tracking study was conducted with a group of medical and IT professionals who were not previously familiar with Neuroogle to explore how much time they consumed for each task, which tasks they found difficult or easy and whether they focused on objects relevant to the tasks or not. During the eye tracking experiment a think-aloud protocol was also administered to encourage participants externalize their thoughts

while they were performing the tasks. With this method participants' opinions, complaints, comments and recommendations concerning the system were obtained.

3.1. Design of the Study

This study consists of several phases. The first phase involves searching and selection of the Family Medicine Information System that will be used for the usability evaluation. For this critical phase initially several family health centers were visited and information was collected via short interviews with the staff. According to the information collected from short interviews Neuroogle Family Medicine Information System is selected for the study. One of the main reasons why this particular FMIS is selected for study is due to its widespread use among Family Health Centers, particularly in Ankara. Detailed information about Neuroogle is stated in the materials section. Following the first phase, an ethnographic field study was conducted at the Beşevler Family Medicine Center to gather information about how the system is used in practice. Then Task Analysis, Cognitive Modeling, Heuristics and Eye-Tracking studies were conducted. These phases are further explained in the procedure part below.

3.2. Materials

For the selection of family medicine information system site visits to family health centers in Ankara was conducted, and Neuroogle FMIS is selected due to its popularity among family doctors. Then, semi-structured interviews were conducted with volunteered family doctors to get an overall view of their attitudes towards using Neuroogle FMIS in their daily practice and to determine which aspects of this software should be evaluated in this study. Interview questions included both open-ended and closed questions (see Appendix A)

3.2.1. Eye-Tracking System

In this study TOBII T120 eye-tracker device located at the METU Human Computer Interaction Lab is used. This device collects eye-gaze data from subjects at a sampling rate of 120 Hz. An eye-tracker device allows researchers to record and observe where subjects look on the screen or how many times they look at certain areas of interest on the screen. In addition to this, it gives some statistical knowledge such as mouse click count and percentage clicked on objects. Below picture shows the METU Human-Computer Interaction Lab and the eye-tracking device TOBII T120.

Figure 3.1 Human-Computer Interaction Lab and TOBII T120 Device

3.2.2. TOBII Studio Software

Tobii Studio (version 3.0.3) software was used for the analysis of data collected from the eye-tracker device. The software enables evaluators to analyze raw data collected during eye-tracking test session in many ways. Evaluators can observe visualized data at the replay section of the software and obtain logs of events like mouse clicks, beginning/ending of screen recordings, the position of instructional elements used to introduce task definitions to users throughout the entire record of the session. The replay section also allows evaluators to listen to participants' utterances if voice recording is enabled during the test session (known as think-aloud). The Tobii studio software also has a visualization module that produces heat maps (shows the diversity of fixations on the screen with a colored map) and gaze plots (shows all fixations and saccades of participants) from gaze recordings. Heat maps and gaze plots are generally used to produce an overall summary of gaze data across participants. Statistics part of the software gives some statistical summaries such as fixation durations, first fixation time, and fixation count among objects defined by the evaluator during analysis of raw data. Lastly, the data export section allows researchers to export raw gaze data to an excel file to conduct more detailed analysis of recordings.
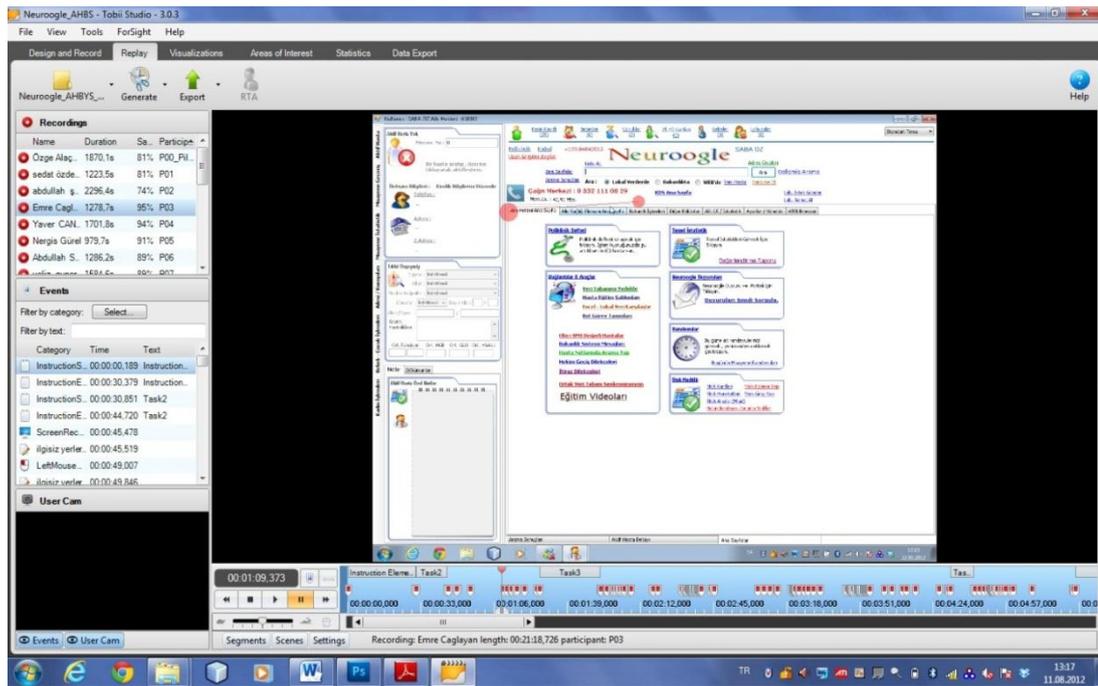
Figure 3.2 Tobii Studio (Version 3.0.3.) Interface

3.2.3. Neuroogle Family Medicine Information System (FMIS)

Neuroogle is designed for carrying out many processes/duties which have been assigned to family doctors with the beginning of family medicine practice in Turkey on July 15th 2010. So, Neuroogle has been used by family doctors for approximately two years. The system is designed to manage various types of operations related to the daily practices of family physicians, such as:

- patient care and examination,
- prescribing,
- entering medical attention,
- patient statistics,
- entering inventory information,
- giving health report for driving license,
- entering information of patient whose age is between 15 – 49 (age period of fertility),
- database backup,

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- entering patient identity information,
- entering data of polyclinic,
- follow-up vaccination, follow-up pregnancy,
- follow-up maternity and child-birth
- looking up patient's family doctor information,
- looking up operations previously done,
- checking reports previously given to patient,
- follow-up obesity.

Besides these main operations Neuroogle also gives opportunity to do some additional operations such as looking up family doctors' performance, monthly operation list, date of appointment entry, making a search from the Ministry of Health such as patient information, and displaying patients who have the same illness.

3.2.4. Questionnaire

A questionnaire was given to subjects after they completed the experiment in order to collect information regarding demographics, computer usage and their opinions about the Neuroogle system as well as the tasks they performed. The questionnaire consists of 16 items that start with participants' demographical information (age, specialty, education status etc.), continues with computer usage information (computer usage period, participants' aim of computer usage etc.) and ends with questions about Neuroogle FMIS (awareness of Neuroogle etc.). All items are reported in Appendix D.

3.2.5. System Usability Scale (SUS)

System Usability Scale consists of 10 Likert scale items and was administered after the subjects completed the experiment. This instrument collects subjective ratings of participants about the system being evaluated (Brooke, 1986). Participants rated each item on a scale from 1 to 5. A rating of 1 means that subjects strongly disagree with

the condition specified in the item, and a rating of 5 means that subjects strongly agree with the condition specified in the corresponding item (see Appendix E).

3.3. Procedure

3.3.1. Ethnographic Field Study

An ethnographic field study was conducted to understand how Neuroogle is used by actual users and whether the system serves its aims. This method was conducted at the real working environment by the researcher, where actual users were observed by taking notes with minimal intervention while they were using the system. Within this context, semi structured interview and video capturing were conducted.

3.3.1.1. Semi-Structured Interview

Semi-structured interviews were conducted with 5 volunteered family doctors for the needs analysis and determining which aspects of the selected FMIS should be evaluated with usability inspection methods. For this phase, an interview script was prepared which consists of 13 questions (see Appendix A also);

1. Which Family Medicine Information System (FMIS) do you use?
2. How long have you been using this FMIS?
3. Have you ever used any other FMIS before?
4. Who is authorized to use this FMIS?
5. What are the fundamental operations you perform by using this FMIS?
6. Do you easily reach the information you want by using this system?
7. When using this FMIS have you encountered any error(s)?
8. When you encounter an error what do you do? Does the FMIS assist you in order to solve this problem or error?
9. If you have an opportunity to make changes to this FMIS, what do you want to change or add?

10. Did you go through any training or attend to a seminar before you start using this FMIS?

11. When you first began to use the system did you experience any difficulties?

12. In your opinion, does using FMIS increase or decrease your daily work load?

13. Are you happy with using this FMIS? Could you tell us about your opinions?

At the beginning of the interview, general information was collected with the first four questions listed above. Then detailed information about the ways participants engage with FMIS systems was gained with the remaining questions. These questions aimed to solicit family doctors' opinions about usability issues or design errors they have witnessed.

3.3.1.2. Video Capturing

Screen recording of family doctors' computers were obtained to capture how the target group of users carry out their daily tasks. In order to minimize interruption, video capturing programs such as Adobe Captivate and Webinaria were used at the background of users' computer. With the help of these programs family doctors' daily task was captured for detailed analysis. An important advantage of this method is that everything related with a particular task can be observed in the video. Information that will be important in further task analysis was captured in the videos such as;

- Where user clicks on the screen,
- What types of errors occur during regular use,
- When users encounter error(s) what do they do
- If the system displays an information message what it says and what the users do with it
- Discovering the main steps of the task being captured
- Capturing the utterances of target group users while they are carrying out their tasks

- Gaining some information about which tasks are mostly used by the target user group and during their completion how many steps are need to complete them.

3.3.2. Task Analysis

Task analysis method was used in order to model the flow of actions involved with the execution of most frequently used tasks over the system. Task analysis is a helpful method for visualizing the task steps in order to understand how the tasks are completed and how many steps are needed to complete them. In the light of interview results stated at the results section of the study, 9 most frequently used tasks were chosen for the task analysis. These tasks are explained below.

3.3.2.1. Task 1. Check whether a patient named Ahmet Ozturk is registered in the Neuroogle Family Medicine Information System

There are 3 ways to complete this task in Neuroogle, as described below:

3.3.2.1.1. Using 'Arama' (search) Function on the Main Screen

When Neuroogle FMIS is run and the main screen comes to the view, a section called Arama (search) is displayed on the top middle portion of the page. In order to check whether that patient is registered or not in the system, one should click on the Arama box at the top and then type in the first 2 or 3 characters in this box to display the names that match these characters. These 2 or 3 characters should be enough to see matching results fetched from the patient database. However, if the number of matching names are large, these characters can be increased or even the full name of patient can be typed into the "Arama" box to get more accurate search results. The software has an auto-completion search property that when one types first 2 or 3 characters of the patient into the box, and then the system lists matching results below so that the user can select the patient if there is a hit. Steps of this way of completion task1 are visualized in Appendix H.

3.3.2.1.2. Using 'Kesin Kayıtlı' (Registered Patients) Button on Main Screen

Another way to complete task 1 is using "Kesin Kayıtlı" button on the upper left of the screen. In order to see whether a patient is registered in the system or not one should click "Kesin Kayıtlı" button to see all patients registered in the system. When this button is clicked the system shows all the patients registered in the system. By navigating over pages using the navigation buttons on the result section, a patient being searched can be found if patient is registered in the system. Steps of this way can be seen more clearly with flaw chart Appendix H.

3.3.2.1.3. Using 'Poliklinik Defteri' (Polyclinic Book) Section

The last way to complete task 1 is using Poliklinik Defteri section. One should find a patient in Poliklinik Defteri by clicking on the poliklinik defteri button or poliklinik (polyclinic) text on the main screen. When this button or text is clicked poliklinik defteri is opened. After opening poliklinik defteri, users can search for the patient on the Arama (Search) box on the top of the poliklinik defteri screen and then select the correct patient from the search results displayed below the box. The flow chart of this method is shown in Appendix H.

3.3.2.2. Task 2: Open the registration information of the patient named Şükrü Yılmaz and do some changes on his registration information. Enter his e-mail address as 'sukruyilmaz@yahoo.com', select blood type as A-Rh+ and select social security type as 'Emekli Sandığı'.

To complete this task, users should find the patient first and then reach that patient's registration information. Users can select one way over 4 ways for this task to complete it successfully. These ways explained below in a more detailed fashion;

3.3.2.2.1. Using 'Arama' (Search) function and 'Kimlik Bilgileri düzenle' (Arrange Identity Information) link on main screen

Users can find a patient by using the Arama function stated above and then access his registration information. Firstly Arama box is clicked and then patient name is typed into the box. After clicking Ara button near the Arama box, search results come and then patient whose registration information will be changed is selected from the results. Then Kimlik bilgileri Düzenle link will be clicked to see registration information. Flow chart of this way of completion stated in Appendix H.

3.3.2.2.2. Using 'Arama' (Search) function on main screen and 'Hasta Detayını Aç' (Open Patient Registration Information) option on right click menu of the patient name

Users can also reach registration information of the patient by right clicking on the patient name and selecting 'Hasta Detayını Aç' option on the emerging menu. To do this, one should search and find the patient first.

3.3.2.2.3. Using 'Kesin Kayıtlı' (Registered Patients) button and 'Kimlik Bilgileri düzenle' (Arrange Identity Information) link on main screen

The third way of completing task 2 is to search the patient on "kesin kayıtlı list" and then locate the patient's name in this list. After selecting the patient from search results list, "kimlik bilgileri düzenle" link should be clicked on the main screen. Then the user may change the registration information. Flow chart of this way is given in Appendix H.

3.3.2.2.4. Using 'Kesin Kayıtlı' (Registered Patients) button on the main screen and 'Hasta Detayını Aç' (Open Patient Identity Information) option on the right click menu of the patient name

The last way of the completing task 2 is to use kesin kayıtlı button to search patient whose registration information will be changed and then open menu with right clicking on the patient name. When user finds the patient and right clicks on his/her

name menu appears and user can select hasta detayını aç option in order to see registration information and do some changes on it.

3.3.2.3. Task 3: Assign patient named Kemal Çakır to 'Poliklinik Defteri' (Polyclinic Book)

Poliklinik Defteri module of the Neuroogle Family Medicine Information System is mainly designed for examining patients and giving prescriptions to them. This module can also provide some additional operations. In order to do these operations the user should assign a patient to the poliklinik defteri module. There are 3 ways to do this;

3.3.2.3.1. Using 'Arama' (Search) function on main screen and 'Poliklinik Defterine At' (Assign to Polyclinic Book) option on right click menu of the patient name

The user should find the patient first in order to assign him/her to poliklinik defteri. One way of doing this is using 'Arama' function on the main screen. After patient is found by the user, right click menu should be opened in order to select the "poliklinik defterine at" option. When this option is selected with a mouse click, the patient is assigned into "poliklinik defteri". Flow chart in the Appendix H show the steps.

3.3.2.3.2. Using 'Kesin Kayıtlı' (Registered Patients) button on main screen and 'Poliklinik Defterine At' (Assign to Polyclinic Book) option on the right click menu of the patient name

User can also search patient by using kesin kayıtlı button on the main screen and then assign the patient to Poliklinik Defteri (polyclinic book) by selecting 'poliklinik defterine at' option on the right click menu over the patient's name.

3.3.2.3.3. Open Poliklinik Defteri (Polyclinic Book) and use 'Arama' (Search) function

The last way of assigning a patient to poliklinik defteri is to open poliklinik defteri on the main screen by clicking on the "poliklinik" (polyclinic) link or the "poliklinik defteri" button. The user then searches for the patient by using arama function of poliklinik defteri module. In this way patient is searched in poliklinik defteri and clicking on the patient name will add that patient to the polyclinic book. The flow chart in Appendix H shows the steps in a more detailed way.

3.3.2.4. Task 4: Diagnose Gastro-Esofagial Reflux disease for the patient named Kemal Çakır and dose Gaviscon Advance 200 ml suspension with dosage 2x3x1 and Lansor 30 mg 28 Capsule with dosage 1x1x1.

When patient is assigned into Poliklinik Defteri (Polyclinic Book), the diagnose screen automatically appears on the poliklinik defteri screen. On the Diagnose screen the user should select the diagnosis tab to assign a diagnosis to the patient. When the patient to be diagnosed is selected, a list of diseases is displayed. The user can either select a disease from the list by scrolling down or, as a shortcut, use the arama (search) function above the list. After selecting a diagnosis the user should select the prescription tab near the diagnosis tab on the screen. When this tab is selected the drug list appears below and the user again selects the drug by scrolling down on the list or shortly typing some initial characters of the drug's name into the arama box above the list. When a drug is selected from the list, the dosage screen appears on the top level. On this screen the user can enter the drug usage dose into the related box. For this task gaviscon drug dose is set to 2x3x1. This means that the patient should obtain 2 bottles of the drug and take a single dose 3 times per day. After dose information entered to this screen the user should click on Kaydet (Save) button to save the dose information. This procedure should be done for 2 drugs in order to complete this task. The detailed flow chart is displayed in Appendix H.

3.3.2.5.   Task 5: Change the drug named Lansor with Nexium

In order to change a drug that has been given to a patient one should select the drug that will be changed from the prescription information section on the left bottom of the diagnose screen. After selecting a drug 'seçili kaydı sil' (Delete Selected Item) link or text located at the right bottom of the prescription information section should be clicked. Clicking on this link will delete the selected drug from both prescription information and examination information sections. Then a new drug should be added by following the same steps on task 4. Since there has been no change button or link on the screen, users should first delete the drug they want to change and then add a new drug. The flow chart in Appendix H shows the drug change procedure.

3.3.2.6.   Task 6: Give prescription of the drugs prescribed to Kemal Çakır on previous tasks.

To complete this task the user should click on the 'Reçete yazdır (F5)' (Print-out Prescription) link on the top and bottom of the diagnosis page. On the same screen there are two links that perform the same operation. Also the user can click the same link on the poliklinik defteri (polyclinic book) screen by exiting from the diagnosis screen. So, there are 3 alternatives to do this task, and the user should select one of them. The F5 in paranthesis on the link means that users can do same process by pressing the F5 key on the keyboard. Flow chart of this task stated in Appendix H.

3.3.2.7.   Task 7: Diagnose Acute Bronchiolitis for the patient named Jale Hüzün and give her a three day medical report.

This task can be completed in two ways as explained below;

3.3.2.7.1. Using 'Raporlar'   (Reports) button on the Poliklinik Defteri (Polyclinic Book) Screen

The user should first enter the diagnosis as Acute Bronchiolitis for the patient, and then continue by assigning a three day medical report. On the poliklinik defteri

screen user should first click on the 'Arama' (search) box at the top of the screen and then type some characters or the full name of the patient in order to search the patient database. When the user sees the patient name among the search results listed just below the arama box, he should click on the patient's name to assign the patient to the poliklinik defter, so that a diagnosis can be assigned to that patient. After the patient is assigned to poliklinik defter, the diagnosis screen automatically appears on the screen. On this screen, the user should click on the "tanı seçimi" (diagnosis selection) tab (normally it is selected as default when diagnosis screen appears) then select the disease named acute bronchiolitis from the diagnosis list. When the disease selection process is done, the user should exit from the diagnosis page to assign a three-day medical report on the poliklinik defteri screen. On the poliklinik defteri screen users should click on the Raporlar button placed at the upper-right of the screen. When this button is clicked by the user, a sub menu is displayed which contains report types. From this menu the user should select the medical report option. After this selection a small pop-up screen appears at the top level of the screen where the user can enter the duration (in days) for the report. On this small screen or message, the user should click on the day input box and type 3, and then click OK to confirm. After the confirmation the system will automatically display a report for the patient on the screen. The flow chart of this way stated in Appendix H.

3.3.2.7.2. Using 'İstirahat Raporu' (Medical Report) button from 'Hızlı İşlev Butonları' (Quick Lunch Buttons) section on the Poliklinik Defteri (Polyclinic Book)Screen

To complete task 7 in another way, the user should first diagnose the disease named Acute Bronchiolitis like before, and then give a three-day medical report. Only difference for this way is to use İstirahat Raporu from the "Hızlı İşlev Butonları" section instead of "Raporlar" button on the poliklinik defteri screen. The flow chart in Appendix H shows the procedure step by step.

3.3.2.8. **Task 8: a patient named Polat Çelik says that he has an appointment on current day. Check whether he has an appointment on current day or not. If he has not an appointment on current day, give an appointment to him two days after current date.**

Users can do this task in two different ways as explained below;

3.3.2.8.1. **Using 'Arama' (Search) box on main screen to search patient and sub menu appears below the patient name**

When the user double clicks on the name of a patient in the list returned by the Arama box, a sub menu below the patient name appears that list some operations like examinations and radiology results. From this menu users should select 'Randevuları' (Appointments) option in order to see appointment information for each patient. If there is no appointment listed for the patient on the current day, the user should click on the 'yeni' (new) button to make a new appointment. On the new appointment window the user should enter information about the appointment such as date, time and patient name. Firstly, the user should select the date of the given appointment and then select the patient name above the date part. When he clicks on the 'ilgili kişiyi seçin' (Select Relevant Person) link, a new screen that consists of name entry box will be dislayed. The user types the patient's name into this box and selects the patient among the search results displayed below the box by clicking the 'Seç' (Select) button below to finish the selection process. Then the appointment type should be selected by using the 'Randevu Türü' (Appointment Type) drop down menu. From this menu one of the appointment types is selected such as examination. Lastly, appointment time shoule be arranged by clicking on the arrow buttons near the time section. After these steps users click 'Kaydet' (Save) button to complete the appointment process. The flow chart in Appendix H summarizes these steps.

3.3.2.8.2. Using 'Kesin Kayıtlı' (Registered Patients) button on main screen to search patient and sub menu appears below the patient name

In this way, the user should search the patient first by using 'Kesin Kayıtlı' button on the left top of the main page, then follow the same steps to complete the appointment process as in the previous method. The flow chart summarizes the steps in Appendix H.

3.3.2.9. Task 9: Examine medical history of the patient named Şakir Sönmez and check his cigarette and alcohol consumption and obesity condition. In addition to this, check whether he has chronic disease or not. If not, define essential (primer) hypertension as chronic disease for him.

User of the Neuroogle FMIS can handle this task in two ways also. The first way is to search the patient on the main page using Arama (search) box again. Second way is to click on Kesin Kayıtlı (registered patient) button at the top of the page and search the patient by using the navigation buttons. After the patient is found, the user should find the medical history part on the main page to view the information about that patient.

3.3.2.9.1. Using 'Arama' (Search) box on main screen to search patient and examining medical history

User first searches for the patient thorough arama box and then selects the patient whose medical history will be examined. When users find the patient in search results, they should click on the patient's name in order to activate the patient monitor section on the upper left side of the screen. Without activating the patient monitor section, one cannot see the medical history of the specific patient on the main screen. After selecting the patient, the medical history part below the patient monitor section turns into active mode and shows the selected patient's medical history. On this section users can view information such as cigarette and alcohol

consumption or chronic disease information. The flow chart in Appendix H shows the process of task 9;

3.3.2.9.2. Using 'Kesin Kayıtlı' (Registered Patients) button on main screen to search patient and examining medical history

Second way of completing task 9 is to search the patient in the kesin kayıtlı list and then examine the patient's medical history. The flow chart in Appendix H shows the procedure step by step.

3.3.3. Cognitive Modeling

The tasks explained in the task analysis section above were modeled with Cog-Tool program in order to estimate how much time these tasks take to be completed by expert users. Cog-tool gives user interface designers an opportunity of creating quickly and easily valid Keystroke-Level Models (KLM) and run them using Adaptive Control of Thought-Rational (ACT-R) cognitive architecture to compute task completion time for expert users (Richards, Bellamy, John, Swart & Thomas, 2010). It is possible to use Cog-Tool to compare the efficiency of two alternative prototypes in terms of estimated completion times of specified tasks. In addition to this, Cog-Tool can be used to estimate the completion time of specified tasks just like expert users perform them. The latter purpose of using Cog-Tool program is valid for this study.

Cog-Tool's user model runs over the ACT-R cognitive architecture to compute the duration of each action performed by a simulated expert user such as keystrokes, mouse clicks, eye movements or cognitive process like thinking time (e.g. for encoding visual information to decide where to move the cursor, etc.) for specific actions. All of these actions can be defined as Keystroke-Level Models (KLM) that enables researchers to model a task as a sequence of cognitive and motor operators each of which has an estimated duration, based on prior empirical research.

Estimated durations for each operator is then added up by Cog-tool to obtain an overall estimate of task completion time for an expert user (Richards, Bellamy, John, Swart & Thomas, 2010).

The tasks described above are modeled in the Cog-tool environment to estimate their completion times. First, screen-shots from Neuroogle that correspond to each stage of the flow-charts provided in the previous section were obtained. Then, action elements such as buttons or textboxes that are relevant to perform that task were marked. Finally, the sequence of actions described by the flow chart was implemented by linking the action elements. Cog-tool used this input to estimate the time it would take an expert user to visually encode each screen, decide where to move the mouse, decide to click on an action item, visually encode the response (e.g. screen change), decide the next area to attend to, etc. Each of these actions are associated with a specific duration. The output obtained from Cog-tool summarizes the total duration and the number of clicks to perform each task in the ideal case (i.e. when the user exactly knows what to do next). The picture below shows the Cog-Tool program in design view;
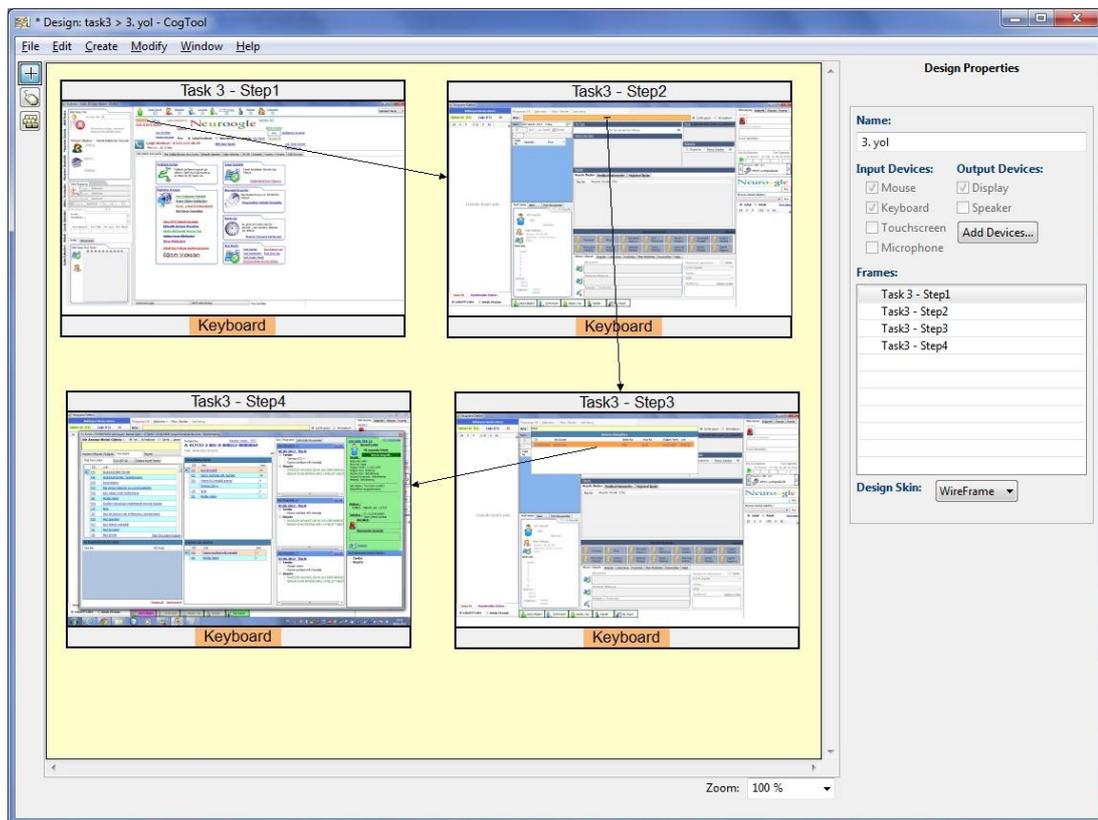
Figure 3.3 Cog-Tool Program Interface (Design View)

As seen on the picture frames show the steps of task. These steps can include a mouse click or a key press on keyboard. All thse actions may not necessarily imply a screen change at each step of the task. For the task model displayed in Figure 3.3, it can be said that the task consists of four steps including both mouse clicks and key press actions. Cog-Tool program estimates the time cost of each step considering the type of action performed. Arrows in the picture show the transitions between each step. The figure below shows a visualization of the underlyin ACT-R model over which cog-tool estimates these parameters.
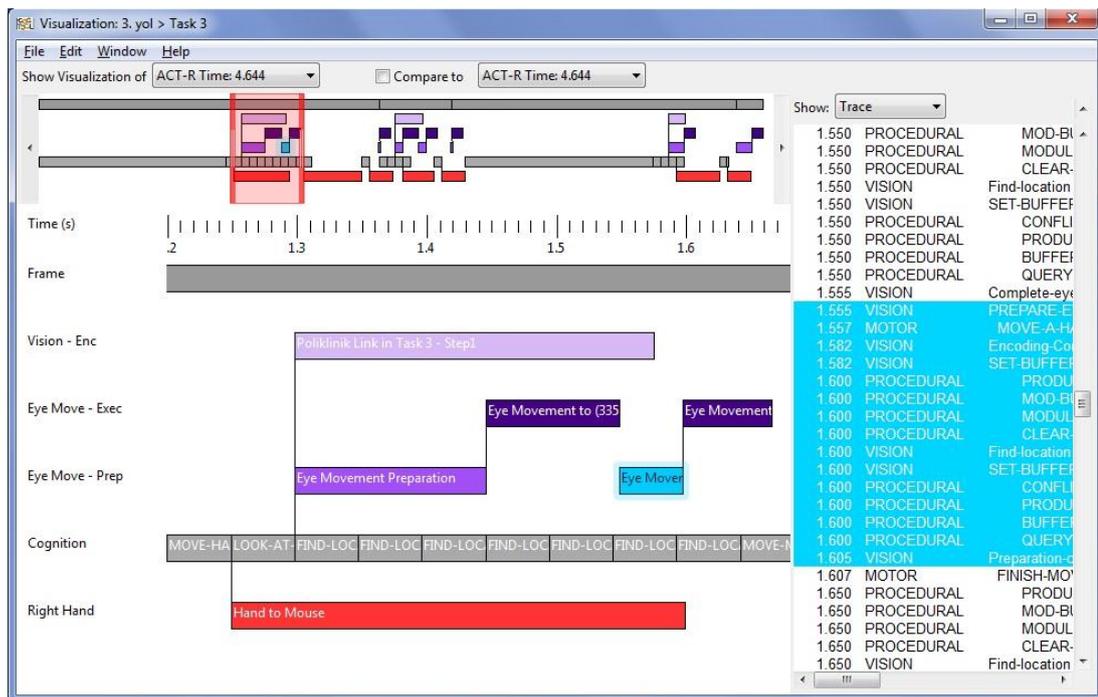
Figure 3.4 Cog-Tool Program Interface (Visualization View)

One can see from the picture above that Cog-Tool program uses ACT-R's cognitive, perceptual and motor modules for the estimation of task completion time. On the left side components of ACT-R cognitive architecture listed with corresponding time intervals. As seen on the picture above, Cog-Tool program computes approximate task completion time of expert users by dividing tasks into their cognitive components.

For the current study 9 tasks schematized in the task analysis part above modeled with their alternative ways of completion in the Cog-Tool environment in order to get approximate values of completion time by expert users. These tasks were turned into ACT-R code by Cog-Tool program to imitate KLM and program returned skilled performance time for each modeled task (John, Blackmon, Polson, Fennell & Teo, 2009)

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3.3.4. Heuristics Evaluation

3.3.4.1. Nielsen's Heuristics

For Heuristics Analysis Jackob Nielsen's (1993) 10 heuristics was used first for testing the usability of the Neuroogle. These Heuristics are i) Visibility of system status, ii) Match between system and the real world, iii) User control and freedom, Consistency and standards, iv) Error prevention, v) Recognition rather than recall, vi) Flexibility and efficiency of use, vii) Aesthetic and minimalist design, viii) Help users recognize, diagnose and recover from errors and lastly ix) Help and documentation,which are all explained at the literature review part of the study.

Jacob Nielsen's heuristics evaluation method involves the evaluation of a system by usability evaluators or experts according to the 10 heuristics stated above. Given the heuristics and their definitions, the evaluator observes the system and rates each heuristics with according to the severity rating scale stated below;

0. Not a usability problem at all
1. Cosmetic problem only. Need not be fixed unless extra time is available
2. Minor usability problem. Fixing this should be given low priority.
3. Major usability problem. Important to fix. Should be given high priority.
4. Usability catastrophe. Imperative to fix this before the product is released.

For the heuristics evaluation, three usability evaluators were recruited since the probability of error detection increases as the number of evaluators increases (Nielsen, 1993).

3.3.4.2. Xerox Heuristics

Xerox Heuristics evaluation (Appendix L) presents a system checklist for a comprehensive expert evaluation with 13 main titles consisting of 289 criteria totally (Pierotti, 2012). In this heuristics evaluation instrument each criteria has 3 options for evaluators to select. These options are named as 'Yes', 'No' and 'N/A'. If a criterion is not met by the system; the evaluator checks 'No' and if a criterion is met by the system; the evaluator checks the option 'Yes'. If a criterion is not acceptable or suitable for the system being evaluated; the evaluator checks the not applicable option 'N/A'. In addition to this, a comment box is provided for each criterion to accommodate additional comments by the evaluator. Within the conext of the study, Neuroogle FMIS evaluated by one evaluator by the help of these heuristics checklist and result stated at chapter 4.

3.3.5. Eye-Tracking Study

An Eye-Tracking study was conducted for the evaluation of Neuroogle FMIS quantitatively. Eye-Tracking study conducted at the METU human-computer interaction lab with the help of eye-tracker device (Tobii T120) connected to computer. This study was conducted with the participation of the target group users of the system being evaluated and users from information technology field. Users handle some tasks on computer by using system. The main purpose of the eye-tracking study is to record target group users' process of dealing with tasks in visual and audial format (think-aloud). Eye movements can significantly enhance the observation of users' strategies while using computer interfaces (cited in Duchowski, 2007, p. 283)

Eye-Tracking device records each participant' or target group users' screens, mouse clicks and more importantly their eye movements with bubbles named fixations in video format. This device also records sound of the participants when they perform their tasks if there is need for study. After records have been completed, they are

examined by the usability evaluator or expert to see which task is easy to complete and which one is challenging. Besides, usability experts extract some statistical information with examining records such as participants completion time of the tasks, mouse click counts, fixation count which estimates how many times participant fixates on relevant object to complete task, fixation duration, time to first fixation that shows the time of participant's first fixation to relevant objects defined by evaluator for analysis.

Usability evaluator can also extract heat maps or gaze plots that shows all participants fixations diversity among tasks. Heat maps shows fixation diversity with colored map in which red color represents highest fixation distribution, yellow represent more fewer fixations and green shows lowest fixation distribution among screen. Heat maps got their name because the choice of colors metaphorically indicates hot zones and cold zones on a screen (Nielsen & Pernice, 2010).

Gaze plot gives all participant fixations on screen with assigning a color and fixation numbers for each participant. With gaze plot graph evaluator can see fixation diversity on screen with colored fixation points represent participants. The size of each points on gaze plot graph represents the duration of that fixation; bigger points indicates longer looks and smaller points indicates shorter ones (Nielsen & Pernice, 2010). The thin lines between each points on the gaze plot graph shows the saccades of participants as eye moved from one location to the next (Nielsen & Pernice, 2010).

With audial analysis property of eye-tracking study; usability evaluator reach participants' opinions about system or their thought stated verbally known as think aloud. This analysis type is valuable for usability inspection studies in order to catch participants' objective evaluations of the system or to see where participants have difficulties in dealing with system and what comment they contribute among these difficulties.

3.3.5.1. Subjects

Subjects were recruited from both health services and information technology fields. Totally 20 subjects participated in the study and 8 of them were female and 12 were male. 3 of the subjects were family doctors and 4 subjects were doctors with various specialties, such as general practitioner, molecular biology and genetics etc. 13 of them were experts in information technology with different specialties such as software developer, usability expert, and computer specialist. Their age ranges from 21 to 56 and mean is 33,5 and standard deviation S.D. = 9,22 showed in table format below;

Table 3.1 Descriptive Statistics of Eye-Tracking Study Subjects

	N	Minimum	Maximum	Mean	Std. Deviation
Age	20	25	56	33,50	9,220

6 of the subjects have a B.S. degree, 7 of them have a Medical Doctor (M.D.) degree 5 of them have an M.S. degree and remaining 2 subjects have a PhD. Degree.

Each subject participated in the study voluntarily by signing informed consent forms. The experiment lasted approximately 25 minutes. During the experiments subjects were asked to complete a total of 9 tasks by using the Neuroogle FMIS. While participants were working on the tasks their eye gaze patterns were recorded by the Tobii T-120 eye tracking system at the METU Human Computer Interaction (HCI) laboratory.

3.3.6. Think-Aloud Method

Think-aloud method was used with the eye-tracking study simultaneously. With this method participants asked to verbalize their thoughts during task perform. This method was useful to analyze which tasks or parts of the tasks were difficult for the participants, what they commented when they see an error message, what they

commented on visual and organizational aspect of software, how they thought when they perform task (a clue for cognitive process of participants), what they recommended about display items or anything with respect to an interface and etc. When analyzing think-aloud data, sound records examined and participants' expression related to usability issues of the Neuroogle FMIS were categorized in 11 main titles and their expressions put in a written form with these categorization. These 11 main titles were useful to group expressions into categories (Kushniruk & Patel, 2004) and explained below;

Navigation: Coded when subject comments on basic navigations related to system or cannot move through a system or interface

Graphics: Coded if subject comments on graphical issue of the interface

Layout/Screen Organization: Coded if subject comments on the general layout or screen organization of the interface.

Color: Coded when subject comments on color aspects of the interface

Resolution: Coded when subjects comment on the resolution of the information presented through the interface.

Meaning of Labels: Coded when subject mentions meaning of labels in the interface such as confusing labels of buttons.

Understanding of System Instructions/Error Messages: Coded if subject comments on instructions or error messages in the interface.

Consistency of Operations: Coded when subject comments on consistency issues of the interface.

Overall Ease of Use: Coded if subject comments on overall ease of use of the interface.

Response Time: Coded if subject mentions response time of the interface.

Visibility of System Status: Coded when subject comments on visibility of system status such as information messages that state the system's status.

CHAPTER 4

RESULTS

4.1. Subjects' Demographics

Subject demographics is briefly specified in Methodology part. The average age of participants is 33,5 years (S.D.= 9,22 and range between 25 - 56).
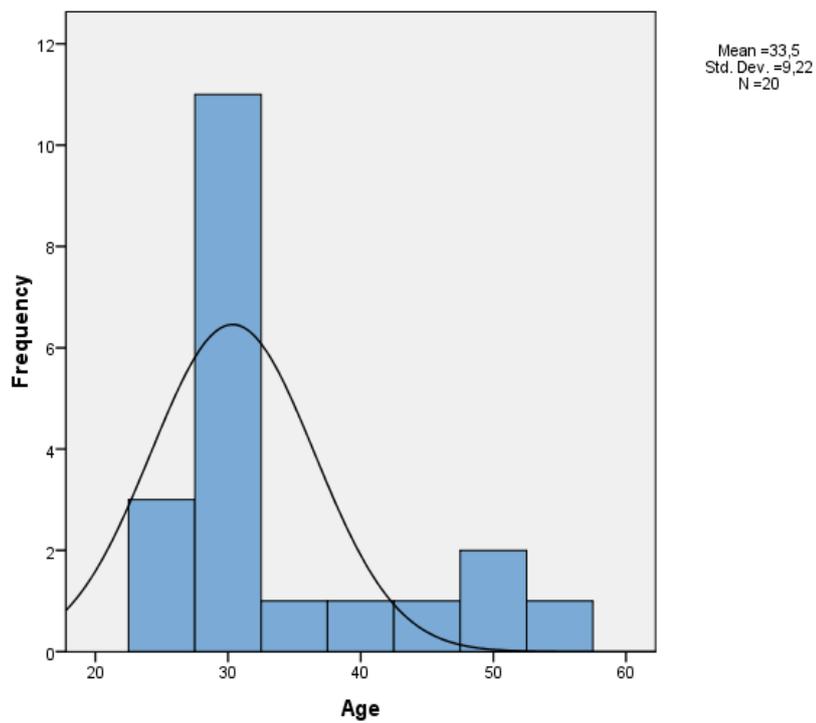
Figure 4.1 Age Distribution of Eye-Tracking Study Subjects

Majority of the participants were male (12 participants, 60%) and minority were female (8 participants, 40%).
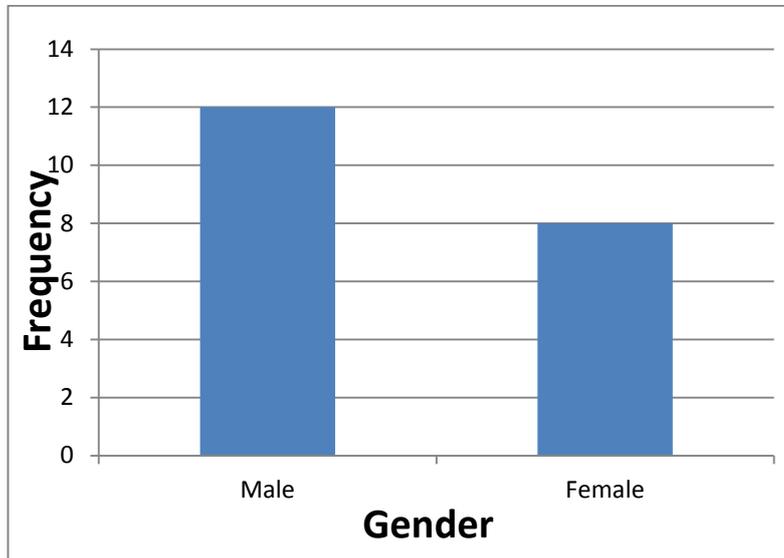
Figure 4.2 Gender Distribution of Eye-Tracking Study subjects

Education level of the participants varies between university (B.S. degree) and doctoral (PhD. degree). Majority of the participants has a Medical Doctoral (M.D.) degree (7 participant 35% respectively) and 5 participants (25%) have Master of Science (M.Sc.) degree from different fields related with information technologies. Other participants have Bachelor of Science (B.S.) degree (6 participants 30% respectively) and doctoral (PhD.) degree (2 participants 10% respectively).
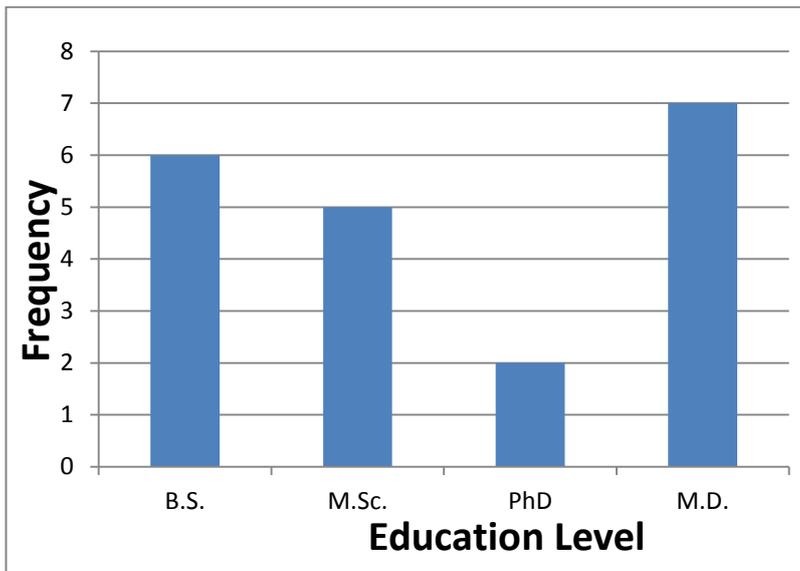
Figure 4.3 Educational Status of Eye-Tracking Study subjects

Subjects from several different specialty areas in medical field and information technologies (IT) field participated in the eye tracking experiment part of this study. There were 7 participants with a medical background. 3 of them were family doctors (15%) from various health institutes (hospitals, family health centers) and remaining 4 participants (20%) were specialists in different branches of medicine (molecular biology and genetics, medical biology, medical genetics and general practitioner). 13 participants from the IT field also had different backgrounds. In particular, 3 of the subjects (15%) were specialized in computer education and instructional technologies, 6 of them (30%) were software developers, 2 of them (10%) were from the medical informatics field and the remaining 2 of them were from the field of Information Systems (10%).
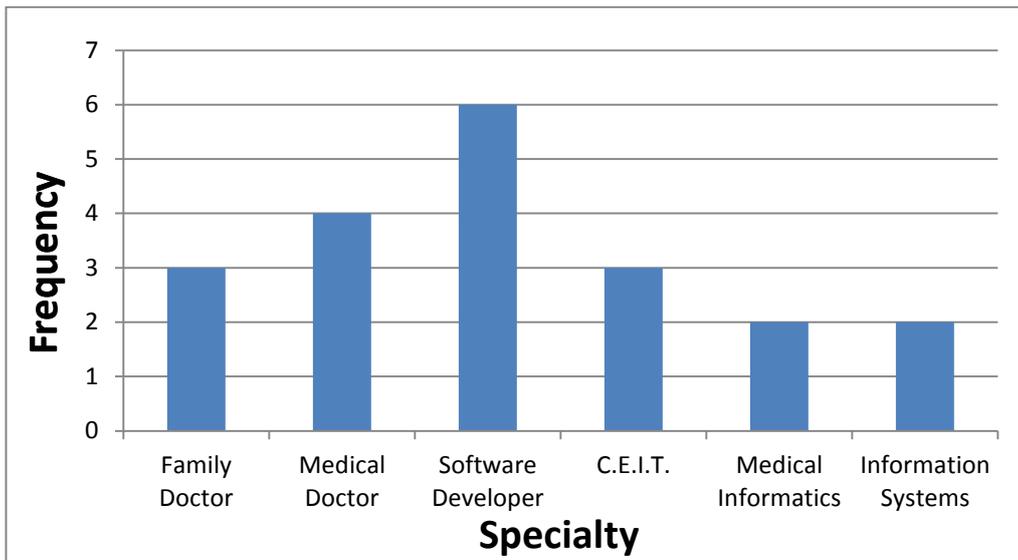
Figure 4.4 Specialties of Eye-Tracking Study subjects

Majority of the participants have their own computer at home (19 of total participants, 95% respectively). 11 of the participants (55%) specified that they use computer mostly at their office and 6 of participants (30%) use computer mostly at both home and office and the remaining 3 of participants (15%) use computer mostly at their home. All participants (100%) use computers for more than five years. Majority of the participants (15 participants, 75%) had not heard about the Neuroogle FMIS before participating in this study. The remaining 5 participants had heard about Neuroogle FMIS from their friends or by other ways (internet, FMIS representatives etc.) before they participated in the study. However, no one had any experience with using Neuroogle FMIS prior to the experiment. Table below (Table 4.1) shows a summary of the information provided by the subjects during the initial survey.

Table 4.1 Overall Views of Eye-Tracking Study Subjects' Demographics

Item	N=20
Age	33,5 ± 9,22
Gender	
Male	12 (60%)
Female	6 (40%)
Education Level	
University (B.S.) Degree	6 (30%)
Master of Science (M.Sc.) Degree	5 (25%)
Doctoral (PhD) Degree	2 (10%)
Medical Doctor (M.D.) Degree	7 (35%)
Specialty	
Family Doctor	3 (15%)
Medical Doctor	4 (20%)
Software Developer	6 (30%)
Computer Education and Instructional Technologies (CEIT)	3 (15%)
Medical Informatics	2 (10%)
Information Systems	2 (10%)
Computer Ownership Status	
Yes	19 (95%)
No	1 (5%)
Place of Mostly Computer Usage	
Home	3 (15%)
Office	11(55%)
Both Home and Office	6(30%)
Computer Usage	
1 year – 2 years	-
2 years – 3 years	-
3 years – 4 years	-
4 years – 5 years	-
More than 5 years	20 (100%)
Knowing Neuroogle FMIS	
Yes	5 (25%)
No	15 (75%)
Using Neuroogle FMIS	
Yes	-
No	20 (100%)

4.2. Interview Results

At the beginning of the study an interview was conducted with 5 family doctors at Beşevler Family Health Center (FHC) to collect general information about Neuroogle software, determine which tasks should be used in the study, obtain doctors' opinions about the system and take their advice if they want to contribute. The interview comprised of 13 items with open and closed questions (see Appendix A for full of questions). These items are stated below together with replies from the family doctors interviewed.

4.2.1. Which FMIS is used

When they were asked which family medicine information system (FMIS) they use, all participants reported that they were using the Neuroogle FMIS. They also stated that they selected this FMIS due to the advice of their friends or colleagues. They also reported that the choice of the FMIS is up to the family doctor. The ministry or the health center does not restrict doctors to use a specific FMIS. So, in the same institution there can be doctors who use different FMIS.

4.2.2. Time for Usage of FMIS

When doctors are asked how long they have been using the Neuroogle FMIS, replies changed from person to person. Almost all of them (4 doctors) have been using this software since the Family Medicine practice has begun in Ankara (June 15, 2010). One of the doctors stated that he has been using Neuroogle only for some months.

4.2.3. Experience with Different FMIS

When participants were asked whether they had been using another FMIS, some of them replied this question as yes and reported that they had used FMIS systems prepared by the government and by other companies. One of them reported that

before using Neuroogle FMIS he used a system called NBYS and he said that he was more satisfied with this system in contrast to Neuroogle. He justified this opinion by saying that NBYS is easier to use compared to Neuroogle.

4.2.4. Authorization of Neuroogle FMIS Usage

When family doctors asked that who are authorized to use Neuroogle FMIS, all of them replied this question as family doctors and nurses working closely with doctors.

4.2.5. What Type of Operations Can Be Performed by Using Neuroogle FMIS

This question aimed to identify the typical operations performed by family doctors on Neuroogle FMIS. The operations cited by the doctors in response are listed below;

- Patient registration
- Managing patient identity information
- Policlinic data entry
- Patient care
- To administer a drug
- To make a report
- Entering medical attention
- Making a report for driving license
- Dealing with patient statistics
- Entering Inventory information
- Follow-up vaccine
- Follow-up pregnancy
- Follow-up maternity and child
- Checking patient's family doctor information
- Entering registration information of patients between 15 – 49 ages

- Checking performance information of personnel such as vaccine information on KDS page in system
- To back up database
- To perform some operations on patient records, such as send to medical expert, send to protocol book, looking up for appointments and operations history, checking obesity and vaccine information, querying the Ministry of Health's database and making appointments.
- To extract patients with the same disease or along any other similarity criteria by using detailed search of system
- Follow up drugs previously given to a patient

4.2.6. Reaching Information Easily

When doctors were asked whether they reach information which they need easily or not, some doctors replied this question as positive some as negative. Doctors who replied the question positively reported that the Neuroogle FMIS is easy to use and one can reach information needed without having any difficulty as follows;

"*Bilgisayar bilmeyerek başladım bu sistemi kullanmaya. Program adım adım herşeyi gösteriyor. Erişmek istediğiniz yere kolaylıkla erişebiliyorsunuz.*"

"*I started using this system without knowing how to use the computer. The program indicates step-by-step everything that needs to be done. You can reach the place you want easily.*" (a family doctor interviewed)

"*Hiçbir sıkıntı yaşamıyorum. Günlük verilere kolaylıkla erişip çıktı alabiliyorum. Aşılama ve stok takibi vb.*"

"*I don't experience any difficulties. I can easily access daily data, such as vaccination and stock follow-ups and get print outs.*" (a family doctor interviewed)

However, some doctors replied with negative comments and said that this FMIS is not easy to use and it has a complex interface that makes it confusing. Below an excerpt from such a comment is provided;

"Neuroogle'ın çok fazla yetersizlikleri var. Daha önce NBYS kullanmıştım. Bu programın kullanımı daha kolaydı. Neuroogle karmaşık bir arayüze sahip."

"Neuroogle has too many deficiencies. Earlier I had used NBYS. This program was more user-friendly. Neuroogle has a confusing interface."

(a family doctor interviewed)

Participants also reported that when they need information that must be extracted from the Ministry of Health's database; they may experience connectivity problems from time to time. For instance, when a patient who registered to another family doctor comes to them, they need to query that patient's record from the Central Civil Register System known as MERNIS. If the family doctor has a problem at this query phase such as a connection problem with the MERNIS, then they have to give a temporary registration number to that patient and register him/her again to the system manually. They reported this situation as time consuming in their daily busy work. This situation summarized below in a quote from one of the family doctor's comments;

"Hasta geldiği doktora kayıtlı değilse bilgilerine Mernis sorgulaması yapılarak bakılabiliyor. Bu hastanın eski aile hekimine bakılması için mernis sorgulaması yapılması gerekiyor ve eğer mernis sorgulaması çalışmıyorsa kişiye geçici bir kimlik numarası verilip kaydı elle yapılıyor. Bu durum doktorların zamanını alıyor ve iş yükünü arttırıyor"

"If the patient is not registered to the doctor he/she went to, his/her details can be reached by using Mernis inquiry. In order to see the previous family doctor of the patient, the Mernis inquiry needs to be used, and if the Mernis inquiry is not working properly, the patient is given a tentative id card and his/her registration is done manually. This

takes up too much of the doctor's time and increases his/her work load."

(a family doctor interviewed)

4.2.7. Error Occurrence When Using Neuroogle FMIS

Doctors also asked if they have had a problem or an error with using Neuroogle FMIS. Almost all of them replied this question as yes and claimed that they may encounter unexpected errors from time to time, and need to report this error to the call center of the company that developed Neuroogle. They complained about this situation as they have difficulty reaching a person at the call center since the line is usually busy. Some of the participants also stated that when they enter a patient's information in the system incorrectly and send this information to Ministry of Health accidentally, the incorrect information is kept in the Ministry's database and it is impossible to fix the record even if they correct it. This situation was stated by one of the doctors in the follwoing way;

> *"Kullanıcı kaynaklı hatalar olabiliyor. Örneğin bebek izlenimi yanlış girildiyse ve bakanlığa gönderilmişse doğru bilgiler girilip gönderildiğinde eski bilgilerle değişmiyor. Eski ve yanlış bilgiler sistemde yüklü kalıyor."*
>
> *"There can be user-derived mistakes. For example, if the infant follow-up is entered wrongly and sent to the ministry, and when the correct information is entered and sent, the old information is not replaced. The previous wrong information remains within the system."* (a family doctor interviewed)

One significance contribution of them for this question is that they had a lot of problem at the beginning of the using Neuroogle FMIS since they were not familiar with the system and the system has a complex interface. One of doctors stated this situation as;

> *"Yadırgadık, sistemi yeni görüyorduk, komplike geldi sistem"*

> *"We found it unfamiliar, the system was new to us and we found it complicated."* (a family doctor interviewed)

4.2.8. What to Do When an Error Occurred

Doctors were asked what they do when they encounter with an error and whether Neuroogle FMIS gives them an opportunity to overcome this error. They reported that there is nothing to do when they have a problem or an error, and claimed that the system does not provide any opportunity for doing something to fix an error. They can only call a mobile number of the company's help desk, but they have a difficulty reaching out to an authorized person because of busy lines. One of the doctors reported this situation by saying;

> *"Çağrı merkezi aranıyor fakat bazen çok yoğun olduğu için ulaşmakta zorluk yaşıyoruz."*
> *"The call center can be accessed but during busy hours, we find it difficult to access."* (a family doctor being interviewed)

They also stated that the help desk can fix some errors via remote access.

4.2.9. Demand of Making any Changes on Neuroogle FMIS

Family doctors also asked what they wished to make any changes on the system if they had the opportunity. All of them replied to this question as since they did not have any authority to make changes on the system, they had not thought of this up to the time the interview was made. They added that only the Ministry of Health has the responsibility and the authorization to demand any changes on the system. In addition to this, one of the participants stated that when they type a drug name incorrectly on the search box at the prescription section and then delete it in order to replace it with the correct one, the drug list gets lost and turns into an empty list ,

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which they find annoying. This complaint stated below with quotation of the doctor's expression as;

> *"Bazen ilaç ismini yanlış girdiğimizde silip tekrar yazacağımız zaman ilaç listesi kayboluyor. Tekrar ilacın ismini yazmak gerekiyor. Bu durum çok rahatsız ediyor."*
>
> *"Sometimes when enter the name of the medicine wrongly and want to delete it and write it again, the medicine list disappears. The name of the medicine needs to be written again. This is disturbing."* (a family doctor interviewed)

One doctor also claimed that drug list contains some drugs that are out of date and not available in the market so, when they prescribe one of these drugs patients come back since they could not find the drug ath the drugstore. As a result, this situation is time consuming for both family doctors and patients. This situation stated below with the quotation of this doctor's expression as;

> *"Piyasada satılmayan ilaçlar ilaç listesinde mevcut. Bu listenin güncellenmesi gerekiyor. İlaç seçimi yaparken zorlanıyorum. Örneğin hastaya bir ilaç yazıyorum, yazdığım ilaç piyasada satılmadığı için eczane hastayı geri gönderiyor. Tekrar farklı bir ilaç yazıyorum ve bu durum benim ve hastanın vaktini almış oluyor."*
>
> *"The drugs that are not on the market are also on the medicine list. This list needs to be updated. I experience difficulty in choosing medicines. For example, I prescribe a medicine to a patient. Because the medicine I prescribe is not on the market, the pharmacy sends the patient back to us. I prescribe another medicine; this takes up the patient's and my time."* (a family doctor interviewed)

In addition another doctor stated that Neuroogle FMIS has so many features that are not used frequently and reported that it is enough me to learn these features rather

than recommending any changes to the system. This is stated below with an original expression of the doctor as;

> *"Programın çok fazla özelliği var ve bu özelliklerin çoğunu kullanmıyorum. Bu özellikleri öğrensem yeter."*
> *"The program has too many features and I don't use most of them. It is sufficient to learn these features."* (a family doctor interviewed)

4.2.10. Training Before Using Neuroogle FMIS

This question was about whether they have taken any training to get themselves introduced to Neuroogle FMIS and if yes how much time they had spent on training. All doctors replied this question as yes and said that they had taken a course before they started using the system and this course lasted about 2 hours. They also claimed that this course was not enough to use Neuroogle FMIS professionally. So, they have taken extra courses by communicating with the company that developed Nuroogle FMIS. They had taken these courses either by going to the company's office located at Gölbaşı, Ankara or by inviting help desk personnel to the family health center if more than one doctor needed help. They reported that these introductive courses or education is enough to handle basic tasks or operations on the system, but they used the system slowly at the beginning due to the fear of making an error or breaking down the system. They could not afford to be reckless since the data is stored at the Ministry of Health's servers. The statement provided below belongs to the family doctor who contributed the comment;

> *"Yanlış yapma korkusu ve veri depolandığı için tedirgin olma durumu vardı. İlk başlarda yavaştık daha dikkatli olma durumundaydık."*
> *"I had the fear of making mistakes and I was hesitant as data was stored. In the beginning, we were slow; we tried to be careful."* (a family doctor interviewed)

One of the doctors stated that the system has no help or any other supplementary documentation;

"Sistemde yazılımın nasıl kullanılacağına dair bir bölüm yok. Eğitim kısmı yok."
"There is no section in the system as to how to use the software. A section on training does not exist." (a family doctor interviewed)

4.2.11. Having Difficulty at the Beginning of the Neuroogle FMIS Usage

Doctors were asked whether they experienced any difficulty with using some of the properties when they first began using the system. Almost all of them replied this question as yes and reported that they had many difficulties at the beginning such as finding the place of buttons or properties that serves their processes. One doctor claimed that they initially got confused about what the right click or left click does on some of the properties. The same doctor also reported an anectode regarding what happened when they encountered an unregistered patient had visited them. According to the routine procedure they needed to register the patient to the system so as to obtain that person's record from the MERNIS database. The participant mentioned that they had a problem at the data inspection phase possibly due to an error in connection with the server at the Ministry of Health. Since no information was returned from the Ministry of Health, they had to declare this problematic case to the Ministry. However, the Ministry did not accept the data sent by the doctors and kept on returning an error message saying "send the patient's data set". This error message was so strange to them that they could only send the data to the Ministry with the help of company's help desk via remote access. This situation is reported by the doctor in the following way;

"Hasta girişi yapılıyor, hastanın aile hekimi görünmüyor. Kendi üzerinize kaydetmeye çalışıyrosunuz hasta ile ilgili hiçbir bilginin bulunmadığı geliyor Bakanlıktan. Bakanlığa bildirmek gerekiyor fakat Bakanlık kabul etmiyor. 'Hasta bilgi setini gönderin' gibi bir hata mesajı

alıyorduk. Çağrı merkezini arayıp uzaktan erişim ile bilgileri
gönderdiler."

"The information of the patient is entered, the family doctor of the
patient does not appear. You try to register the patient to yourself, but
from the Ministry comes a notification indicating that there is no
information belonging to the patient. The Ministry needs to be informed
but it doesn't accept it. We received an error message like 'Send the
data set of the patient'. They called the call center and sent the data via
distant access." (a family doctor interviewed)

Another doctor reported that the system negatively affected his work performance
due to incomplete information such as missing drug information as stated below;

"Bu sistem işlerimi ağırlaştırıyor ve beni yoruyor. Birçok ilacın bilgisi
yok."
"This system slows down by work and tires me. Information of many
medicines don't exist." (a family doctor interviewed)

In general all doctors stated that they had experienced some difficulties with using
Neuroogle FMIS because of their poor knowledge of using computers, but they have
got used to the system with practice.

4.2.12. Effects of Neuroogle FMIS on Daily Workload

This question was a critical question and asked doctors whether usage of Neuroogle
FMIS decreases their daily workload or not. They replied this question with giving
some complaints. One of the doctors being interviewed stated that Neuroogle FMIS
increased their daily workload since it is confusing to pass through use of FMIS and
computers in family health centers. One another doctor reported that before starting
to use Neuroogle FMIS operations were made with many of people but after passing
through use of Neuroogle FMIS many operations have been started to make by one
person. So, this increased their daily workload. In addition to this, basic operations

were taking short time to handle before using FMIS but it takes so much time to complete these operations with Neuroogle FMIS now. Same doctor also stated that this is software installed to a computer ultimately, so, the performance of the software depends on the performance of the computer also. This doctor's full of expression reported as follow;

> "*İş yükünü arttırdı. Eskiden birçok kişi ile yapılan işlemler şuan tek aile hekimi ve yardımcısı tarafından yapılıyor. Daha önce denetleme yokken bu iş yoğunluğuna rağmen denetleme yapılıyor. AHBS ile üzerimize düşen iş yükü arttı. AHBS yokken temel işlemler daha kısa sürüyordu. Bilgisayar performansıda süreyi etkiliyor.*"
>
> "*It increased the work load. The procedures that used to be done by numerous people are now done by one family doctor and his/her assistant. While there used to be no inspection, there is now inspection despite the work load. With AHBS, our work load increased. Prior to AHBS, the basic procedures used to take less time. The performance of the computer affects the duration as well.*" (a family doctor interviewed)

When family doctors have a problem with their computers such as slowness or virus infection their daily work is interrupted and patients have to wait more and more. One of the doctors reported that although using Neurgoole FMIS decreases paper consumption rate, it increases the workload of doctors since they have to register so much information on the system. Also, according to this doctor, Ministry of Health started to expect so many operations to make from family doctors after starting to use FMIS. This situation makes them to have a difficulty overtaking areas of work and reported below;

> "*İş yükünü arttırdı çok fazla kayıt giriyoruz. Kağıt tasarrufu açısından avantajlı. İş yükünü istekler bakımından arttırdı. Sağlık Bakanlığı çok fazla şey bekliyor bizden. Bizde bu beklentileri karşılamakta zorlanıyoruz. Bu binadaki 8 ayrı doktorun herbiri ayrı bir sağlık ocağı gibi çalışıyor.*"

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"It increased the work load; we enter too many records. It is advantageous in terms of paper saving. It increased work load from the aspect of demand. The Ministry of Health expects too much from us. And we find it difficult to meet these expectations. Each of the 8 doctors in this building works like a separate health center." (a family doctor interviewed)

Another doctor claimed that before using Neuroogle FMIS at Family Health Center they used to keep registration information of patients at the same place and send this information to the Ministry of Health together, but after they began to use FMIS every doctor keep their patient information on their own computer and send it to the Ministry independent from others. Same doctor also reported significant situation that examination time was increased with using Neuroogle FMIS and as a result of this patients started to wait out of doctors' room much more before. The comment made by this doctor is given below;

"Eskiden sağlık ocaklarında tüm hastaların bilgileri aynı yerde tutulurdu. Şimdi sadece bağlı olduğu aile hekiminde tutuluyor. Bu durumda her doktor ayrı ayrı hasta bilgileri gönderiyor. Toplu bir veri gönderme durumu yok. Bu durum da iş yükünü arttırıyor. Bazen yetişmekte zorlanıyoruz. AHBS kurulduktan sonra muayene süresi arttı. Hastalar içerde daha fazla duruyor. Eskiden hastayı muayene eder, ilaç yazar gönderirdik fakat şimdi tek tek sisteme girmek zorundayız."

"In the past, the data for all the patients in the health center used to be kept in the same place. Now, they are kept with the family doctor to whom he/she is registered. Thus, each doctor sends the patient's data separately. There is no such thing as sending the data collectively. This increases work load. Sometimes we have difficulty keeping up with the work. After the installation of AHBS, the duration of examination increased. Patients remain in the room longer. In the past, we used to examine the patient, prescribe a medicine and send him/her, but now we need to enter the system one by one." (a family doctor interviewed)

Lastly, one doctor stated that drug list on examination part of the software contains drugs that are not up-to-date and this increases drug list's size. This situation exhaust doctors and even with small loss of attention they can click wrong name of a drug or wrong form of a drug such as clicking suspension form instead of tablet form as a result of this over size of drug list as stated below;

> *"İlacı listeden seçiyoruz. İlaç listesi çok güncel değil. Piyasada olmayan jenerik isimleri ve ilaç formları var. Veya aynı jenerik ismi farklı farklı isimlerle sisteme tekrar girilmiş. Bu durum doktoru yoruyor. Hafif bir dikkat dağılmasıyla yanlış ilaca tıklayıp hastaya yanlış ilaç vermiş oluyoruz veya farklı bir ilaç formunu vermiş oluyoruz. Mesela bir ilacın tablet formu yerine süspansiyon formunu vermiş oluyoruz. Göz yorgunluğu oluyor bir süre sonra."*
>
> *"We choose the medicine from the list. The medicine list is not updated. There are gerenic names and medicine forms that are not on the market. Or the same generic name is entered to the list under different names. This exhausts the doctor. With a slight disturbance in concentration we can click on the wrong medicine and prescribe a wrong medicine or a medicine form to the patient. For example, instead of the tablet form of a medicine, we can prescribe the suspension form. Eye fatigue occurs after some time."* (a family doctor interviewed)

4.2.13. Pleasure of Neuroogle FMIS Usage

Last question asked the doctors whether they were pleased to use Neuroogle FMIS or not. Some of them stated that they were pleased with the Neuroogle FMIS despite some of the disadvantages of the system. One doctor stated her pleasure with the system in the following way;

> *"Kağıt kalem kullanılmıyor, 0 – 12 yaş grubu bilgileri isteniyor. Aile planlaması verileri gönderiliyor. Anında sistem listeliyor. Hangi gün*

kime ne hap verilmiş, ilaç verilmiş ve bu ay hangi aşılamalar yapılmış anında görüntülenebiliyor"

"*Pen and paper are not used. The data for 0-12 year-aged group are asked for. The family planning information is sent. The system lists it immediately. Which drug, medicine is given to whom on which day and which vaccines are done in the current month can all be observed instantly.*" (a family doctor being interviewed)

One doctor also stated her pleasure with the system by giving an example of an operation that decreases their workload;

"*Sistemde bebeğin ve gebelik sürecinin bilgileri var. Süreyi sistem hesaplıyor, düzenli olarak uyarı veriyor.*"
"*The data belonging to the baby and the pregnancy period exist in the system. The duration is calculated by the system and gives warnings regularly.*" (a family doctor being interviewed)

Some of them replied this question that they were not pleased to use this system and reported that they started to use this system due to their colleagues' advice. If they had a chance to explore the complexity of system or witness some disadvantages of the system before they acquired the system, they might have never started to use Neuroogle FMIS.

To sum up, some essential findings were collected from the interview phase at the beginning of the study. Most significantly, the interviews outlined which operations are frequently performed during daily work of family doctors with using Neuroogle. This was helpful for determining the tasks that will be used during task analysis period and the eye-tracking (with the think-aloud method) study. Moreover, some information about error occurrence during the Neuroogle FMIS usage was obtained from an interview. Whether they encounter an error message, how critical an error message is, what can be done after error occurrence and even how an error affects doctors' operations were examples of information obtained about error occurrence.

In addition to this, interview was the best way to gain deep insights about target group users of the system that will be evaluated by the current study. At this point, some essential information with respect to target group users obtained from an interview. Expectation of doctors from a system designed for family medicine field, pleasures and complaints about the system they used and their point of view about technology were only some example of overall information of target group users.

4.3. Heuristic Evaluation Results

Jacob Nielsen's and Xerox Heuristics were used for the heuristics evaluation of the study. Nielsen's (1993) 10 heuristics stated at review of literature part of the study. Xerox heuristics have 13 main headlines and 293 subtitles or criteria related to these main titles for the evaluation of user interfaces. A checklist prepared by the Xerox company that includes all of these criteria and each criterion has a 3 options as 'Yes' , 'No' and 'N/A'. The meaning of this terms and how they used by the evaluators have explained at methodology part. Full of Xerox Heuristics in checklist format can be seen at (Appendix L).

4.3.1. Nielsen's Heuristics Evaluation

Neuroogle was evaluated by using Jacob Nielsen's (1993) 10 heuristics and severity rating scale stated at methodology part with 3 usability evaluators. Each evaluator has an information technology background and has taken a course of Human-Computer Technology that enables them to know how to make a heuristics evaluation. Each evaluator observed system with their background knowledge of heuristics evaluation and made a rating to each heuristics with the range between 0 (not usability problem) and 4 (usability catastrophe). The results of these evaluations stated with table below;

Table 4.2 Nielsen's Heuristics Evaluation Results

Heuristics	Severity Ratings			
	Evaluator 1	Evaluator 2	Evaluator 3	Mean
Visibility of System Status	3	2	2	2,3
Match between System and Real World	2	1	1	1,3
User Control and Freedom	4	3	4	3,6
Consistency and standards	3	3	2	2,6
Error Prevention	3	3	3	3
Recognition Rather than Recall	2	2	3	2,3
Flexibility and Efficiency of use	4	4	4	4
Aesthetics and minimalist design	2	2	1	1,6
Help Users Recognize, Diagnose and Recover from Errors	3	3	3	3
Help and Documentation	4	4	4	4

The inter-rater agreement among the experts was assessed with Pearson's r correlation coefficient. The table below provides the r values.

Table 4.3 Pearson's r correlation coefficient of Heuristics evaluation results

Correlations

		Evaluator1 ratings	Evaluator2 ratings	Evaluator3 ratings
Evaluator1 ratings	Pearson Correlation	1	,861**	,822**
	Sig. (2-tailed)		,001	,004
	N	10	10	10
Evaluator2 ratings	Pearson Correlation	,861**	1	,818**
	Sig. (2-tailed)	,001		,004
	N	10	10	10
Evaluator3 ratings	Pearson Correlation	,822**	,818**	1
	Sig. (2-tailed)	,004	,004	
	N	10	10	10

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficients indicate that there are strong positive correlations between evaluators' ratings (0,861, 0,822 and 0,818 respectively). Therefore, the evaluators' ratings were consistent with each other.

4.3.1.1. Visibility of System Status

When Neuroogle was observed according to the heuristic visibility of system status, one can see that users are not informed by the system about some of the processes. Only some processes were informed by the system to target group users. Pictures on the below shows some of these processes;

Figure 4.5 Assigning a patient to Protokol Defteri (Protocol Book)

The screen above appears when the family doctor completes the registration form for a patient and assigns it to the protocol defteri.
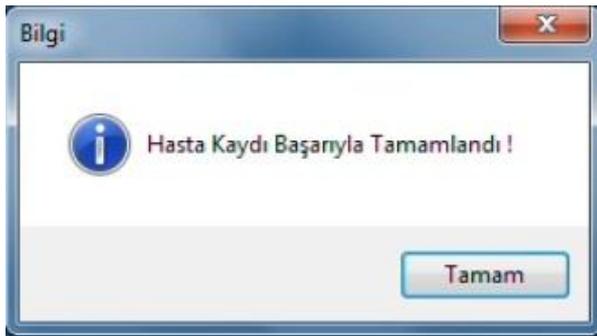
Figure 4.6 Information Message coming after Patient Registration

The snaphsot above shows the message that appears just after the registration of a patient is completed.

However the system should inform the user for every action that is taking place. When Neuroogle is observed it can be seen that the user is not necessarily informed about all the processes. For instance, when the user opens the Poliklinik Defteri there is no indication that the Poliklinik Defteri page is opened and this causes users to click again on either the same button or some other button/link due to the impression that the system is not doing anything. A similar issue is observed when users prescribe a drug or diagnose a patient by clicking on their names. on list there is no any information message that explains whether drug or disease defined to patient's current appointment information.

4.3.1.2. Match Between System and the Real World

When the system is evaluated accroding to the heuristic "match between system and real world", it can be seen that some interface elements contain phrases or words that are unfamiliar to the target group users. Pictures below exemplify this condition.
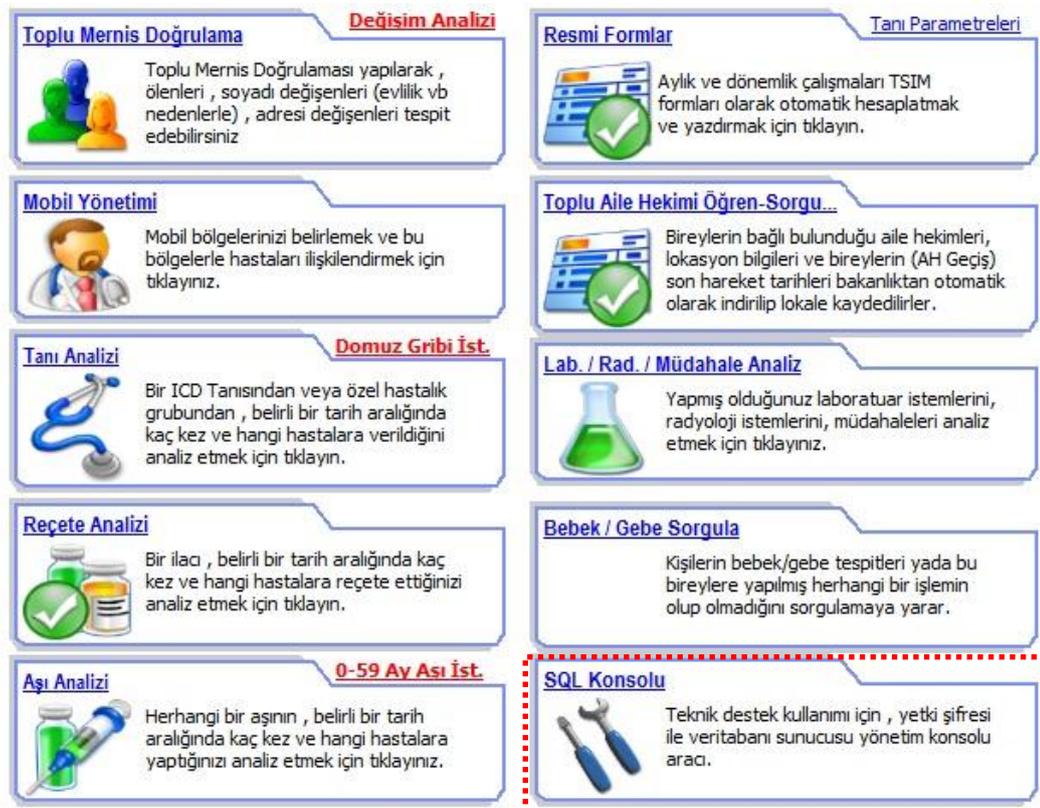
Figure 4.7 Screenshot from Main Screen of Neuroogle Interface

As seen on the picture there is a section named SQL Konsolu, this is an unfamiliar term for target group users. This is a technical term used by database experts which is probably not intelligible to doctors. This feature should either be removed from the system (if its only used for technical maintanence) or renamed into something more inttelligible for the doctors.

Figure 4.8 Right Mouse Click Menu of Patient Name (a small section)

Figure 4.8 shows a part of the right click menu on patient names. As seen in the picture, there is a property unfamiliar to the target group of users named 'Protokol Defterine At' (Assign to Protocol Book).This expression should be changed with a more medical term like 'Muayene Defterine Ata' (Assign to Examination Book) or 'Muayene Et' (Examine).
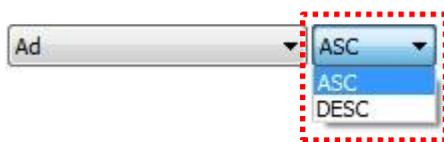
Figure 4.9 Screenshot from Kesin Kayıtlı (Registered Patients) Section

Figure 4.9 shows the search criteria selection menu for the list of registered patients in the system. When a search criteria such as name, surname, or age is selected; the box near the criteria says ASC and DESC. These options are used for sorting the list in ascending or descending order, which is intelligible to a database expert who is familiar with the SQL language. Such terms are unfamiliar to the target group of users, so they should be changed with simpler terms (e.g. büyükten küçüğe) or with arrows together with tooltip messgaes describing the intended functionality.

Figure 4.10 Screenshot from Poliklinik Defteri (Polyclinic Book) Section

This picture shows also two words that 'Bölüm Ekle' (add section) and 'Meta Veriler' (Meta Data) that are likley to be unfamiliar to the target group users. These words should be changed also.
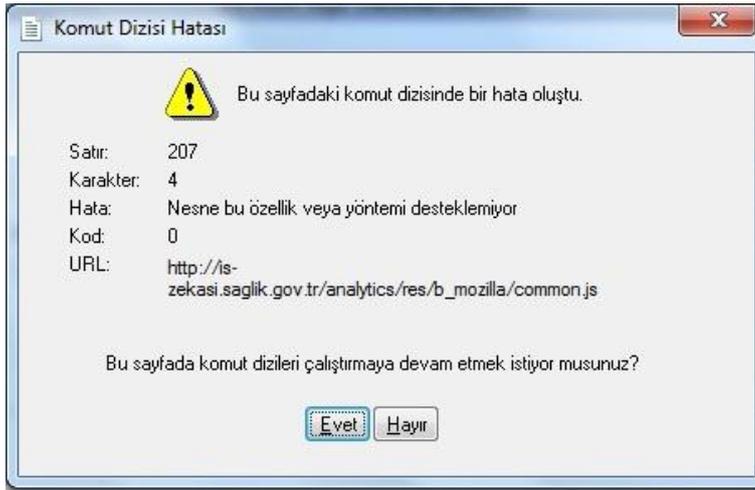
Figure 4.11 Example of error message

Picture above shows an error message that contains information unfamiliar to family doctors. This error message shows information about a script error which could only be understood by a person who deals with software development. Since this type of error message appears rarely in Neuroogle, this case is not thought as severe problem and rated as a cosmetic level problem. This picture also illustrates a violation of the heuristic of Help Users Recognize, Diagnose and Recover from Errors which implies

that error messages should contain information that consists of words or phrases that end-users can make sense of.

System contains some sections that are familiar to the target group of users such as arama section on main page, which resemblers Google's search interface, as illustrated below;

Figure 4.12 Screenshot from main screen of Neuroogle FMIS

As seen in Figure 4.12 the arama section resembles the 'google' search engine's interface which communicates to users that this section is intended to be used for keyword based search. However, some of the participants may be misled that when they type in some keywords in the box, the search hits will come from the Internet rather than Neuroogle (which is a possible option). Using familiar interface metaphors is usually effective for providing guidance regarding the intended use an interface element. However, in this case the known metaphor and the actual functionality does not match, especially in the default search setting where the search results return matching patient records in Neuroogle.

4.3.1.3. User Control and Freedom

This heuristic is also violated in some respect For instance, there is no way to undo an actions, which is especially useful when users do something wrong like clicking on the wrong drug name at the examination part of the system. When users click on the wrong drug name they can only correct this by deleting the drug name from the patient's examination information and then adding a new one. So, they need to do extra 3 steps in order to correct this situation. However there should be a redo/undo function to change actions to the previous condition with one step. At this point it

can be said that there is limited control given to users in this system. Users have to do operations with the way of system's permission.

4.3.1.4. Consistency and Standards

Neuroogle FMIS contains some properties or functions that are in contradiction with the consistency and standards heuristic of Jacob Nielsen. One example of violation of this heuristic is there are two buttons doing the same operation on the poliklinik defteri page as illustrated in Figure 4.13. The picture below is a segment from the poliklinik defteri page and as it can be seen there are two buttons or links named 'Reçete Yazdır {F5}' on the same page and they make the same operation (preparing a prescription for printing out from printer).

Figure 4.13 Screenshot from diagnosis section

Another example of violation of this heuristics is that there are no consistent phrases for buttons that open poliklinik defteri page. Opening poliklinik defteri can be done with three alternative ways; with selecting protocol defterine at option from right-click menu on patient name, with clicking poliklinik link on main page or with clicking poliklinik defteri button on main page. As seen these three buttons and links make same operation but their naming is different from each other. In addition to their different names when poliklinik defteri is opened with one of these ways, poliklinik defteri has page title named Muayene Defteri instead of Poliklinik, Poliklinik Defteri or Protokol Defteri. So, these four terms are in contradiction with themselves.

4.3.1.5. Error Prevention

This heuristic is violated in some ways that there is no confirmation message for some operations in order to prevent errors in system. For example when a doctor wants to diagnose a disease or a drug from the list on related tabs in poliklinik defteri page, there is no confirmation message for this operation in order to prevent possible clicking wrong drug or disease name. If a confirmation message appears for prescribing a drug operation for example and says 'do you agree with adding this drug to prescription of current patient?' prescribing wrong drug to patient can be eliminated before patient goes to pharmacy with wrong prescribed drugs on prescription.

However there were some messages that ask participants' confirmation. When a patient deleted from 'poliklinik defteri' (polyclinic book)page, participants warned with a message saying "Are you sure to delete that patient from Poliklinik Defteri. This message also followed by a warning message that warns users about how critical this deleting operation is. Picture of this confirmation message showed below;
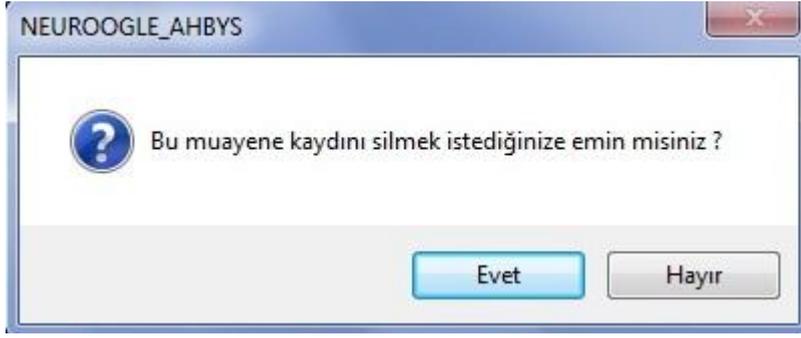
Figure 4.14 Confirmation message of deleting patient from poliklinik defteri (polyclinic book) section

4.3.1.6. Recognition Rather than Recall

Users of the system have to memorize something on system since it has a complex interface. On main screen and poliklinik defteri screen there are many buttons, links and sections stands crowded. This situation makes users get confused and have a difficulty to reach information they seek to. Although there are hızlı işlev -quick lunch- buttons on poliklinik defteri page, these quick lunch buttons are hard to see because of the complexity of the page.

4.3.1.7. Flexibility and Efficiency of Use

This heuristic violated also by the system. When Neuroogle screen was observed, one can see that there is no option for users to tailor their frequently used actions. When users want to create a shortcut to their most frequent used properties or actions among system there is no way to do this. This causes users to memorize the steps when they do their daily tasks. There should be option group for users to arrange some functions or operations of system with giving shortcuts just as they would like.

Although system does not offer users to make their own shortcuts, it provides some shortcuts defined by the developer team of software to users. This may good when a user wants to make operations quickly by just clicking combination of keys instead of using menus. One example of this situation showed below;
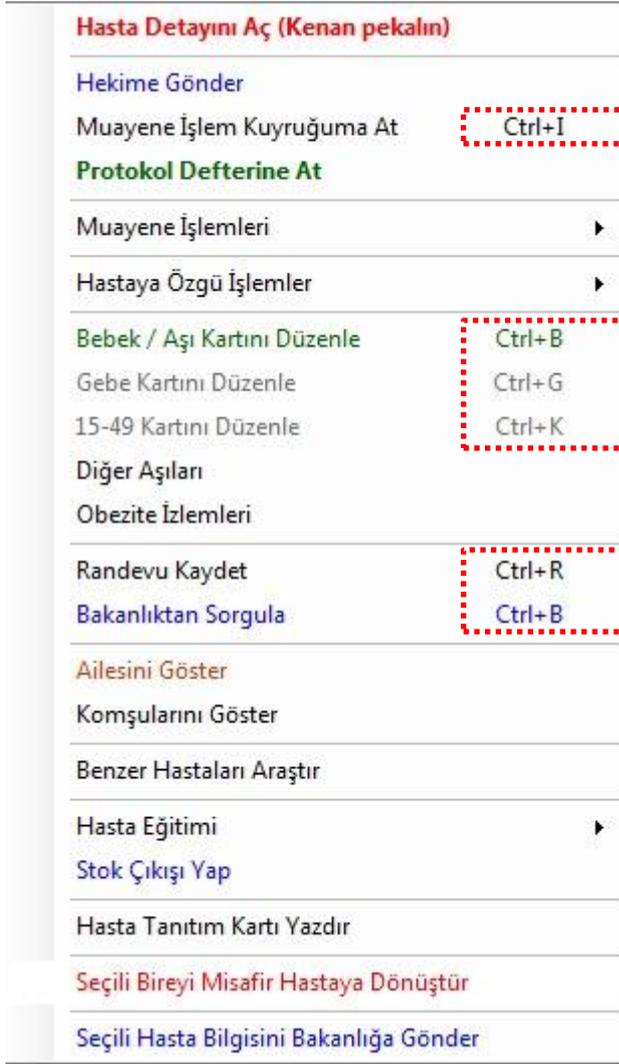
Figure 4.15 Right Mouse Click Menu of Patient Name

4.3.1.8. Aesthetics and Minimalist Design

This heuristic implies that system should not contain detailed, extra or irrelevant information on dialogues or messages that users need so much time to read on daily work. So, system should contain messages that are short and easy to read. When Neuroogle is observed in the light of this heuristic it can be seen that there are some warning/error messages that contains extra and irrelevant information which confuses system users about what is meant or intended. One example of these messages is illustrated with picture below;
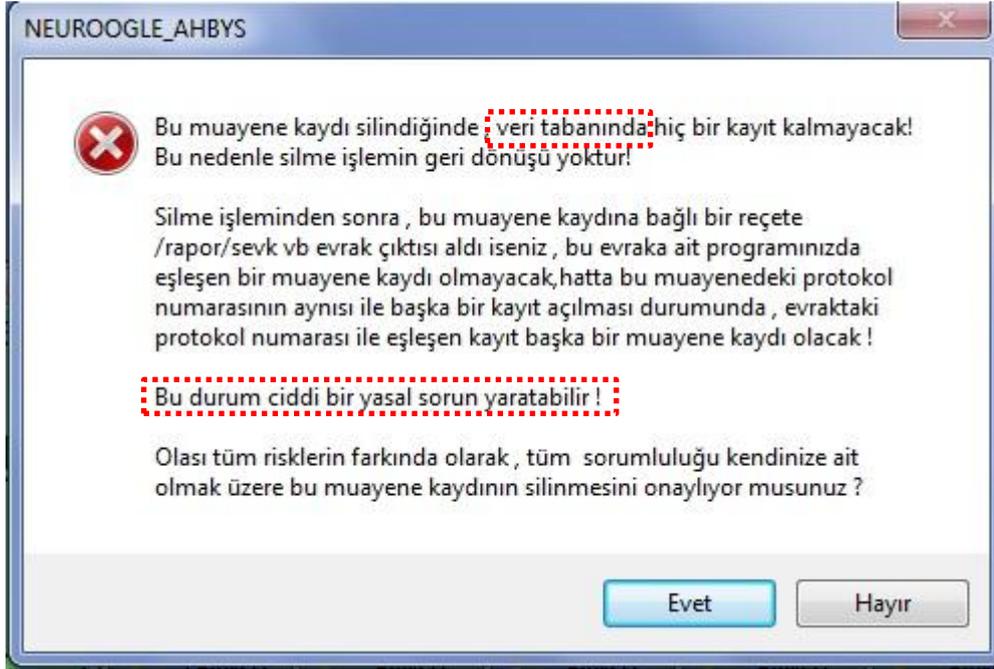
Figure 4.16 Confirmation message of deleting a patient from examination list

This warning message comes when a patient is wanted to remove from poliklinik defteri (polyclinic book) with clicking on muayeneyi sil (delete examination record) button placed on the top of the page. As seen on picture, besides warning message's being long to read on daily workload, it also contains some phrases irrelevant and strange to users such as 'veri tabanı' (database). Also on the title of the error message there should be a phrase defines the error message instead of NEUROOGLE_AHBYS.

In the system there are some messages that contain short information that makes users to understand a message more quickly en efficiently. One of them is illustrated below;

Figure 4.17 Information message coming after clicking on a diagnosis name second time

The message is short enough to read it quickly and understand efficiently but instead of using disease code (K21), using exact disease name would be more pleasant and preferable.

Figure 4.18 Confirmation message appearing when deleting a diagnosis name

The message showed above comes when a user delete a diagnosis from patient diagnosis information part. This message is clear enough to understand what it says. Stating both the disease name and ICD code is also makes message more comprehensible.

4.3.1.9. Help Users Recognize, Diagnose and Recover from Errors

This heuristics is violated by the Neuroogle FMIS since the users encounter with some unusual error messages that sense no meaning and confusing for them unless they are not interested in software development. Below picture shows one typical example of these error messages.
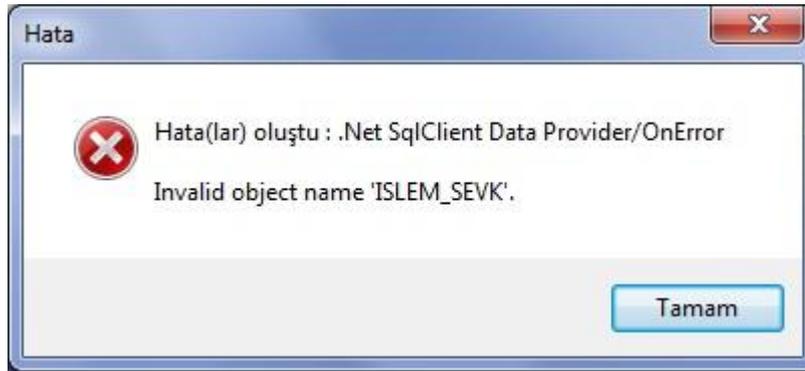
Figure 4.19 Error message coming after clicking 'Bölüm Ekle' (Add Section) on poliklinik defteri (polyclinic book) page

This error message comes when users click 'Bölüm Ekle' (add section) link on 'Poliklinik Defteri' (polyclinic book) screen and contains phrases strange to users of the system. So, this error message confuses the users when they see the message. In addition to its confusing property, it also does not give any opportunity to user except for clicking 'Tamam' (Ok) button. Whereas it should explains why that error occurs when user click that link in more familiar words among target users of the system and it should also give opportunity to handle this error such as report error message by using internet to specify message to developers of the system for making solution. When users click 'Tamam' button, another strange and confusing error message comes. This error message more complex and it is impossible to interpret unless being software specialist. Picture below shows this confusing error message.

Figure 4.20 Error message appears after clicking on 'bölüm ekle' section and clicking 'tamam' (Ok) button on coming message

When users see this error message they get confused and find it difficult to interpret. They have two options click continue for ignoring error message and attempting to continue and click quit button for quit from error message. When users click quit button they expect to exit from error message but software turns itself off when this button clicked unexpectedly. If another option is selected -continue button is clicked- by users software continues working but it shows unexpected function named 'sevk/konsültasyon' (dispatch/consultation) in new screen showed on picture below.
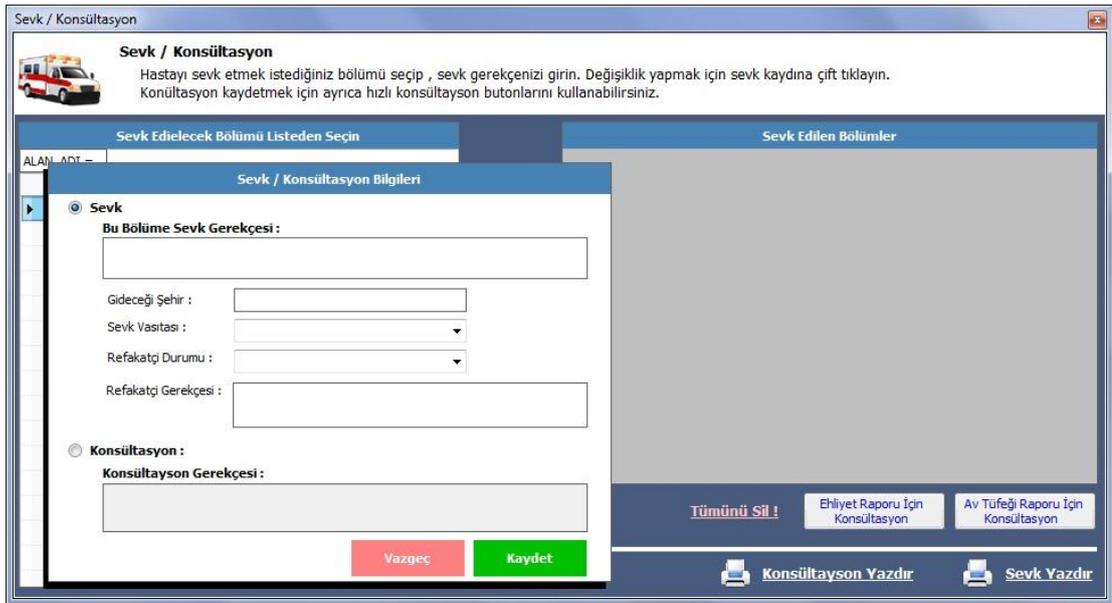
Figure 4.21 Dispatch/Consultation screen

4.3.1.10. Help and Documentation

When a heuristic of help and documentation was taken as criteria during the heuristic evaluation of the system, it can be seen that there is no help option or menu on the system. When user is confused about an operation or function and wants to get help there is no instructions available on Neuroogle. This is accepted as usability catastrophe and should be immediately fixed by the designers of the system.

4.3.2. Xerox Heuristics Evaluation

Xerox Heuristics evaluation is conducted via one evaluator since it takes more time compared to Nielsen Heuristics evaluation. The evaluator has enough knowledge in the human-computer interaction field and heuristics evaluation with the help of background in information technology and the completion of a course named human-computer interaction. As stated in the methodology part of the study, the evaluator examines the system for each main headline of Xerox heuristics (13 headlines) and 293 criteria totally. The evaluator checks 'Yes' for the system meets the criterion and 'No' when it does not meet the criterion, and 'N/A' for the criterion that is not applicable or suitable for the system. These 13 main criteria are as follows:

- Visibility of System Status
- Match Between System and the Real World
- User Control and Freedom
- Consistency and Standards
- Help Users Recognize, Diagnose, and Recover From Errors
- Error Prevention
- Recognition Rather Than Recall
- Flexibility and Minimalist Design
- Aesthetics and Minimalist Design
- Help and Documentation

- Skills

- Pleasurable and Respectful Interaction with the User

- Privacy

Results for each of these 13 main criteria with respect to Neuroogle FMIS has produced detailed graphs (see Appendix G). A section-by-section evaluation of Neuroogle FMIS with respect to each heuristics was performed. , The overall results are presented in the graph as follows (Figure 4.22).
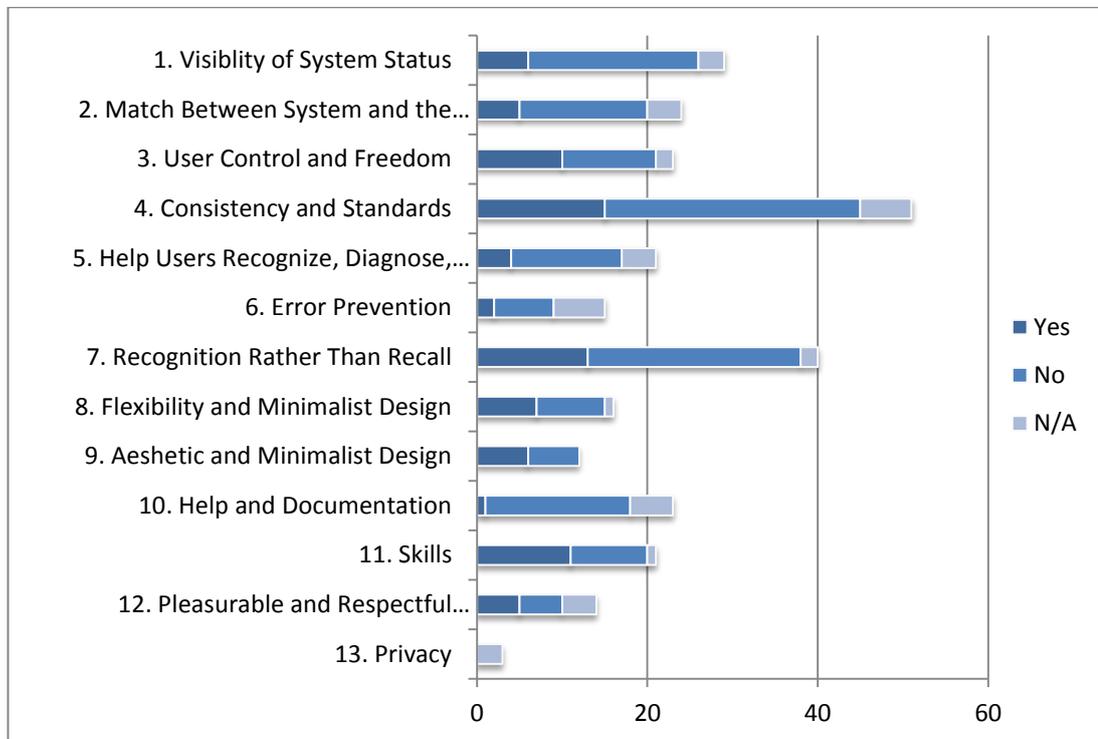
Figure 4.22 Xerox – Overall Results of Heuristics
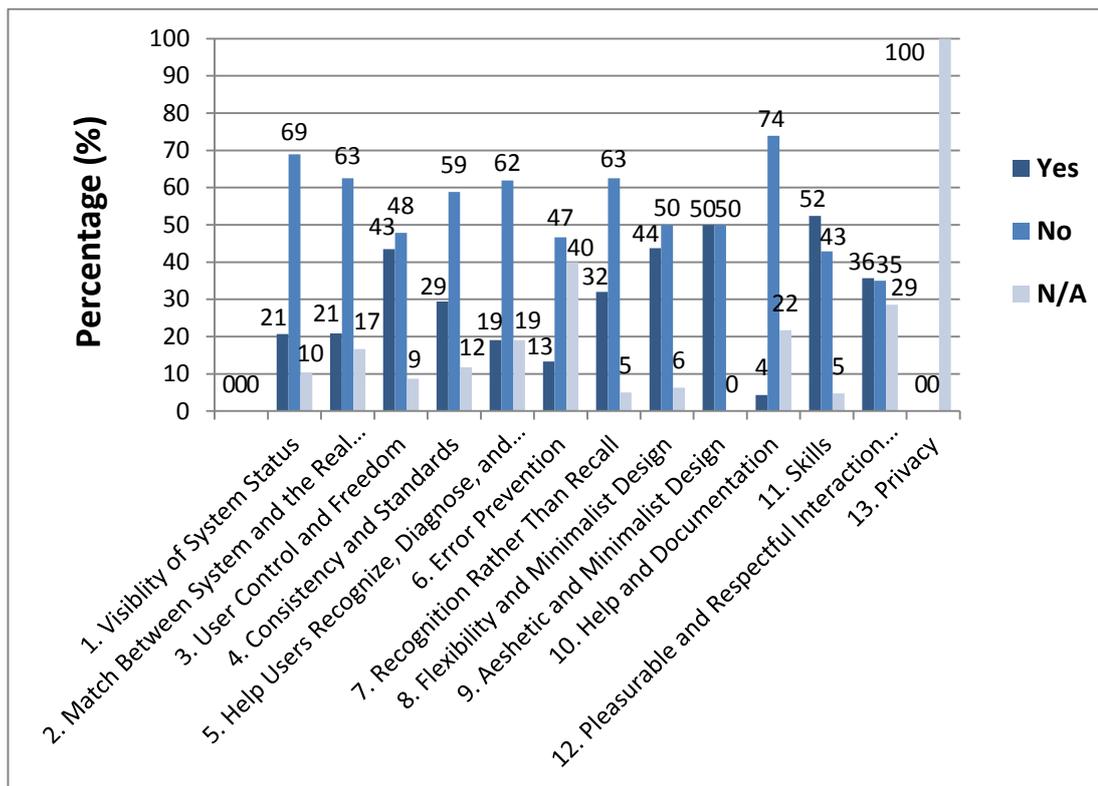
Figure 4.23 Xerox – Heuristics results (percentage)

A close examination of F 4.22, presenting the overall results of Xerox Heuristics, indicates that almost each heuristic has been violated,but the most severely violated heuristics are as follows:

- Help and Documentation (Yes: 4%, No: 74%, N/A: 22%)
- Visibility of System Status (Yes: 21%, No: 69%, N/A: 10%)
- Match Between System and the Real World (Yes: 21%, No: 63%, N/A: 17%)
- Recognition Rather Than Recall (Yes: 32%, No: 63%, N/A: 5%)
- Help Users Recognize, Diagnose, and Recover From Errors (Yes: 19%, No: 62%, N/A: 19%)

On the other hand, the heuristics below follow these critically violated heuristics with less critical or no violation.

- Consistency and Standards (Yes: 29%, No: 59%, N/A: 12%)
- Aesthetic and Minimalist Design (Yes: 50%, No: 50%, N/A: 0%)

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- Flexibility and Minimalist Design (Yes: 44%, No: 50%, N/A: 6%)
- User Control and Freedom (Yes: 43%, No: 48%, N/A: 9%)
- Error Prevention (Yes: 13%, No: 47%, N/A: 40%)
- Skills (Yes: 52%, No: 43%, N/A: 5%)
- Pleasurable and Respectful Interaction with the User (Yes: 36%, No: 35%, N/A: 29%)
- Privacy (Yes: 0%, No: 0%, N/A: 100%)

When the results are observed in relation to their percentage in meeting the heuristics (percentage of "Yes") and not meeting the heuristics (percentage of "No") by the Neuroogle FMIS, it can be said that only two heuristics are successfully met by the system, and these are:

- Skills (Yes: 52%, No: 43%)
- Pleasurable and Respectful Interaction with the User (Yes: 36%, No: 35%)

4.4. Cognitive Modeling Results

For the cognitive modeling phase of the study, 9 typical daily operations were selected in the light of the interview results stated above. These 9 operations were initially modeled using the task analysis method stated in the methodology section of the study in order to see their progression and how many steps one needs to complete.

For the cognitive modeling phase of the study, 9 typical daily operations were selected in the light of the interview results stated above. These 9 operations were initially modeled using the task analysis method stated in the methodology section of the study in order to see their progression and how many steps one needs to complete.

After these 9 tasks were visualized using the task analysis method, they were modeled in the cog-Tool program explained in the methodology section to estimate their completion time as if expert users were performing the tasks. The Cog-Tool program gives an opportunity to evaluators to estimate task completion times as if

expert users perform the task engaged in. In order to estimate task completion times by using the cog-Tool program, evaluator modeled tasks in this program. When task modeling is completed by the evaluator, the Cog-Tool program estimates the completion time of the task modeled. The table below displays the completion times for each 9 task selected and modeled for the study.

Table 4.4 Cognitive Modeling Results

Tasks modeled in cog-Tool	Time of Completion as an Expert User					
	Way 1	Way 2	Way 3	Way 4	Way 5	Mean
Task 1	6,36	7,03	12,82			**8,74**
Task 2	20,02	21,34	16,18	17,67	21,51	**19,35**
Task 3	16,80	12,93	11,44			**13,73**
Task 4	18,75					**18,75**
Task 5	11,69					**11,69**
Task 6	2,54					**2,54**
Task 7	14,96	13,26				**14,11**
Task 8	29,76	24,11				**26,93**
Task 9	27,26	23,30				**25,28**

4.5. Eye-Tracking Results

With an eye-tracking study 20 participants were administered a test in the human-computer interaction laboratory located at METU in the Computer Center building. The participants performed 9 typical daily tasks of family doctors using Neuroogle FMIS during the test. This section shows the results of the eye-tracking study extracted from the data analysis process after all participations were completed. Since the better analysis of the participants' test data, gaze samples collected by an eye-tracker device during the test should be more than 60%. With respect to this criterion, only 10 participants' data (P1- P10) were used for all statistical estimation. The remaining 10 participant's data (P11-P20) were evaluated for only some statistical estimations, such as time spent on completion of task and the number of mouse clicks during task performances. All estimations were done by using the software of an eye-tracking device called Tobii Studio (Version 3.0.3.).

These estimations are stated below. For the statistics of fixation duration and fixation count values of 10 participants (gaze samples are higher than 60%) were summed up according to each related Area of Interest (AOI), and they were presented in percentages. For example, in task 1 'kesin kayıtlı' (registered patients) was one of the AOIs. To calculate the percentage of the fixation durations and fixation counts for this AOI, all the participants' fixation durations and fixation count values of this AOI were summed up and divided by the total fixation durations and fixation counts of these 10 participants with respect to all AOIs. In this way, the proportion of each AOI were estimated among all the AOIs.

4.5.1. Task 1. Checking whether or not a patient registered in the Neuroogle system.

For the parameters of completion time of tasks and mouse click counts all participants' data were evaluated, but only 10 participants' data were evaluated for all other statistical estimations.

4.5.1.1. Completion time

For task 1, the ideal case of completion time was 8,74 seconds estimated on average using the cog-Tool program and stated in the cognitive modeling results section. The result of all the participants' completion time regarding task 1 and their comparisons with the ideal case are displayed in the graph below (Figure 4.24) .
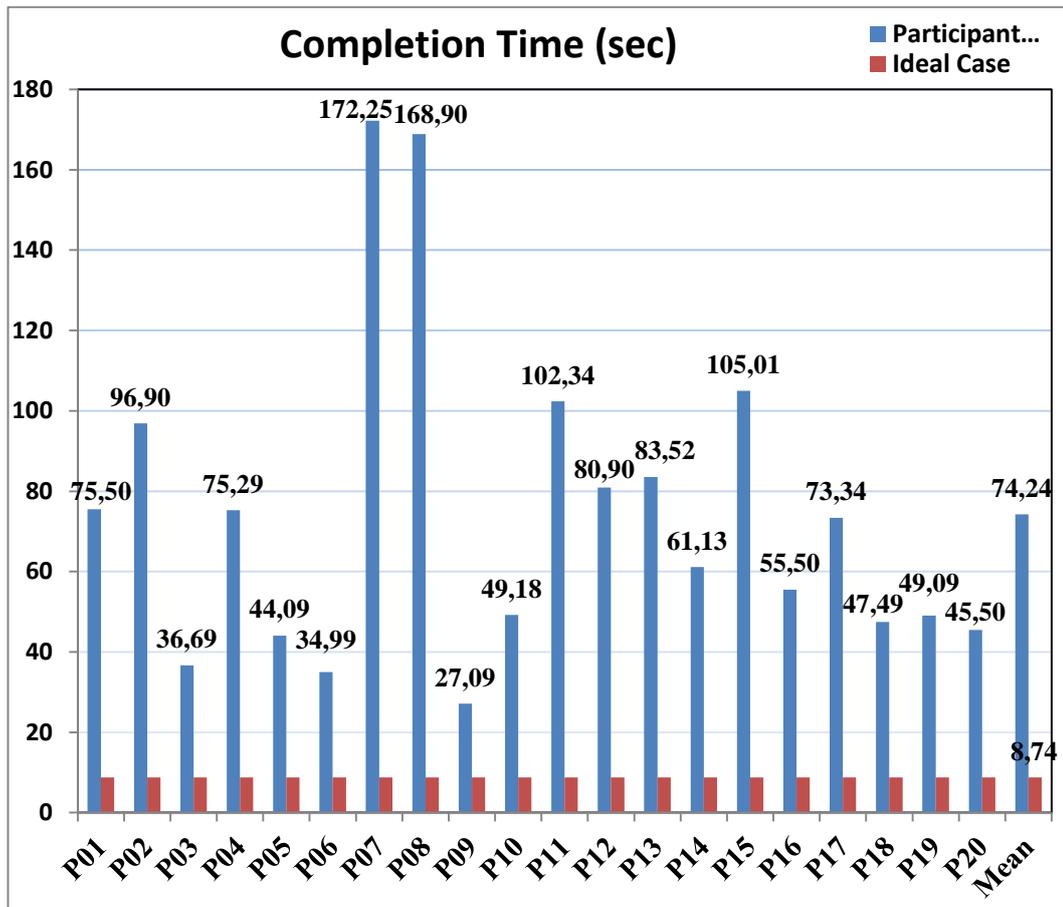
Figure 4.24 Task1 – Completion Time Graph

4.5.1.2. Mouse Clicks

For task 1, the ideal case of mouse clicks is 3 counts on average during the modeling of the task in the cog-Tool program. The graph below (Figure 4.25) shows the results of all the participants' mouse clicks estimations;
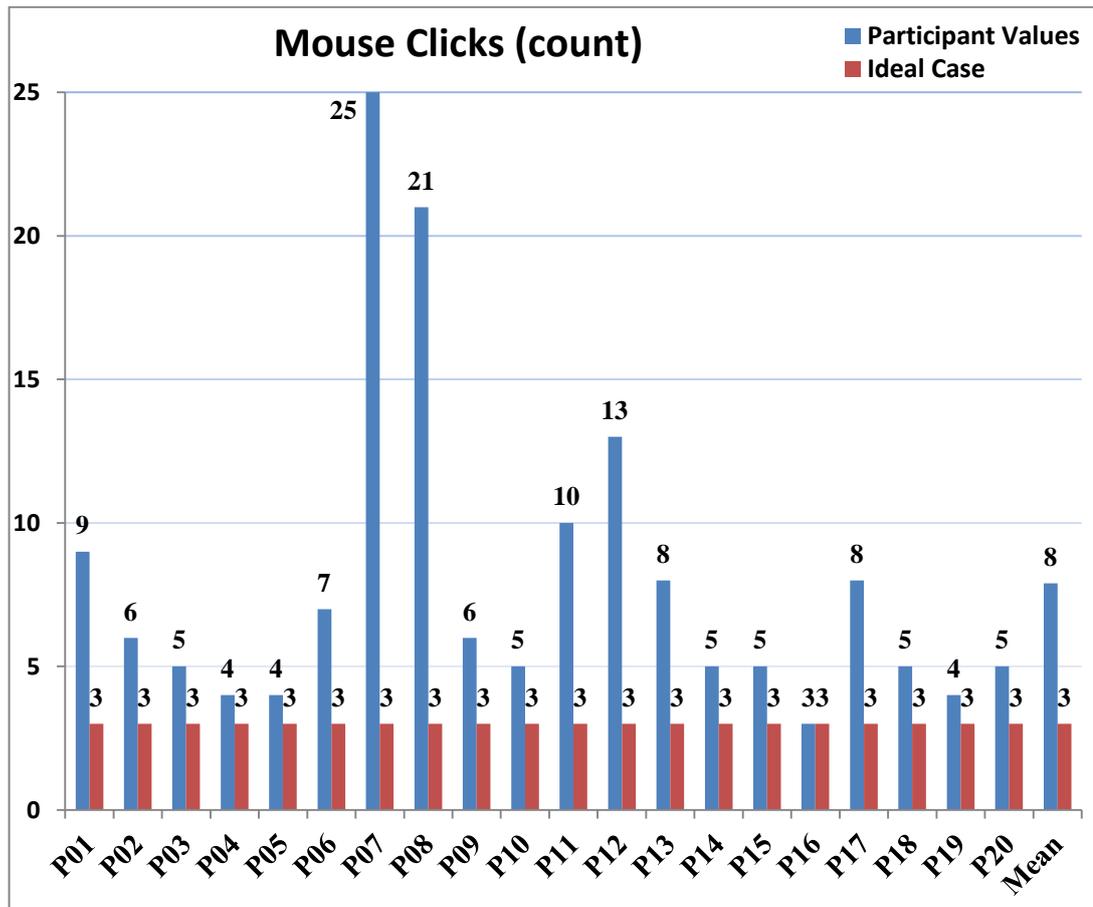
Figure 4.25 Task1 – Mouse Clicks Graph

4.5.1.3. Areas of Interest

Area of Interest (AOI) mostly represents the relevant sections that participants should focus on during task performances to complete the tasks. AOI, on the other hand, might represent an area of irrelevant objects of tasks and defined by evaluator in order to see some statistics of participants with these irrelevant objects and make comparisons with relevant ones. The evaluator defines AOIs when analyzing eye-tracking measurements data via the analysis software named Tobii Studio. The figure below (Figure 4.26) shows the AOIs of the beginning phase of task1.
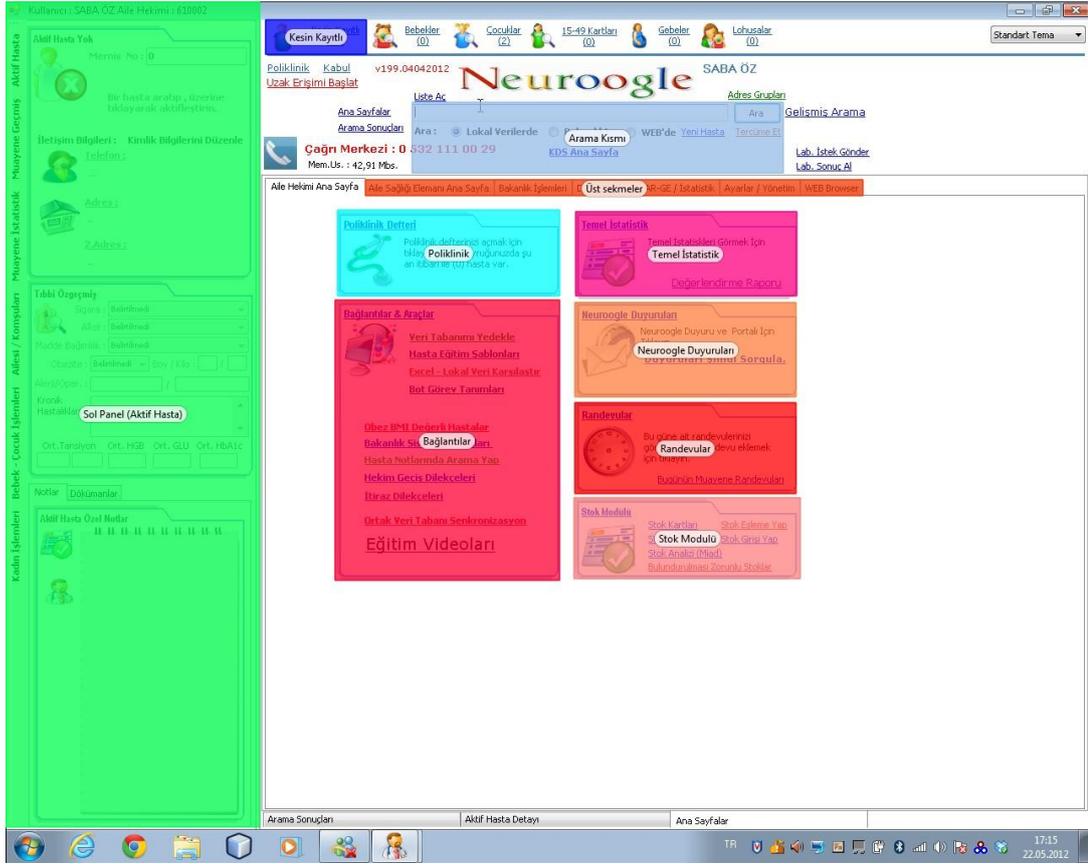
Figure 4.26 Areas of Interest (AOIs) for Task1

In Figure 4.26, there are 10 AOIs defined for the analysis; however, only 3 of them are relevant for task 1, namely 'Kesin Kayıtlı' (registered patients), 'Arama Kısmı' (Search Section) and 'Poliklinik' (Polyclinic). In the first phase of task 1, participants had to focus on these 3 items mostly and click on one of them to complete step 1 of task 1 successfully. In other words, the participants had to select one of these 3 items to complete task 1. In Figure 4.26, blue and turquoise green boxes represent relevant objects and red, green, orange and pink colored boxes represent irrelevant objects (Not Area of Interest). These objects were valid for only one segment of task 1, which is the start phase. When participants clicked on one of the three AOIs, some additional relevant objects and irrelevant objects were included in the analysis since the screen changes. The results of the data analyses for all AOIs and Not AOIs have been presented in a table and figures below.

4.5.1.4. Fixation Count and Fixation Duration Statistics

Fixation durations were calculated for 10 participants (P1- P10) since more than 60% of gaze samples were needed. This statistical estimation or metric shows how much time participants fixate on objects defined by the evaluator called Area of Interest (AOI) in the Tobii Studio program to illustrate time of fixating on related parts of the task. In the table below are presented the fixation durations calculated for these ten participants. The Area of Interests (AOIs) column shows how much time participants fixated on relevant objects with task 1 and the Not Area of Interest (NAOI) column shows how much time participants fixated on irrelevant objects regarding task 1.

Table 4.5 Task1 – Fixation Durations

Participant	Fixation Durations (sec)				
	Area of Interests (AOI)		Not Area of Interests (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P01	18,55	24,5	48,95	64,8	75,5
P02	19,32	19,9	69,58	71,8	96,9
P03	9,63	26,2	27,06	73,7	36,69
P04	18,1	24	57,19	76	75,29
P05	5,31	12	38,78	87,9	44,09
P06	7,67	21,9	22,82	78,1	34,99
P07	5,12	2,9	159,13	92,3	172,25
P08	13,17	7,7	155,73	92,2	168,9
P09	0,32	1,1	26,77	98,8	27,09
P10	5,08	10,3	44,1	89,6	49,18

Fixation counts represent how many fixations are made by participants during task performance on specific objects defined by the evaluator as Area of Interests (AOIs) for analysis. Fixation duration shows how much time is fixated on these specific objects. The figures below show the percentages of fixation counts and durations of 10 participants in eye-tracking study. Since the the gaze sample size (10 out of 20 participants) was acceptable (should be upper than at least 60%), the figure below shows only these 10 participants' total values in percentages classified as Area of Interest (AOI) and not Area of Interest (NAOI).
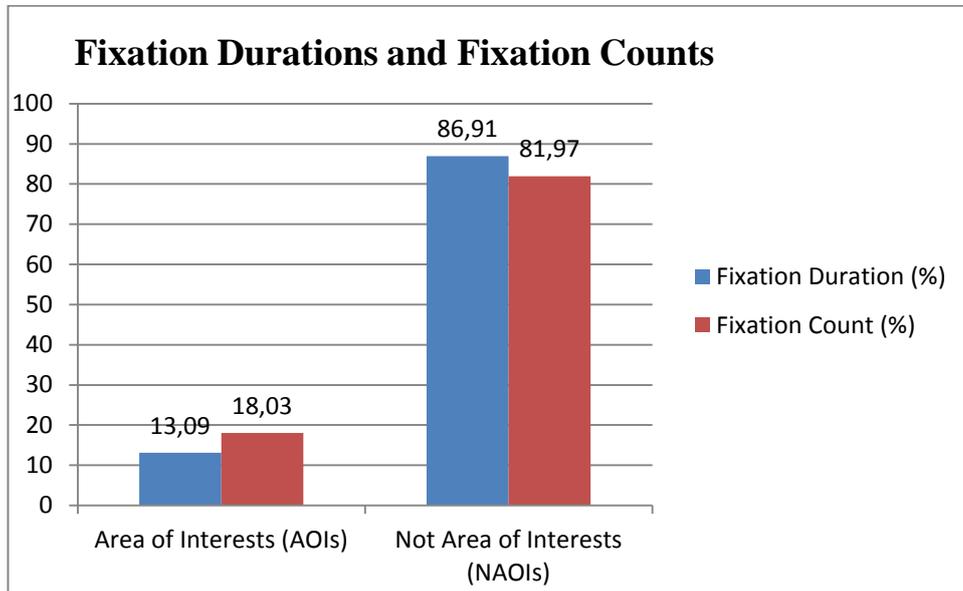
Figure 4.27 Overall Fixation Durations and Fixation Counts Percentages of Task1

Figure 4.27 shows the percentages of fixation durations and fixation counts classifed as AOIs and NAOIs. These percentage values were estimated by summing up 10 participants' values of fixation durations and fixation counts for each AOI and NAOI.To gain a deeper insight, Figure 4.28 presents the percentages of fixation durations and fixation counts for each AOI and NAOI defined by the evaluator.

In Figure 4.28, AOIs were indicated with an asterisk symbol (*) to distinguish them from Not Area of Interests (NOIs). As seen on the graph, great proportion of the fixations fell into two irrelevant objects named 'Sol Panel' (Left Panel) and 'Bağlantılar' (Links) and one relevant object named 'Poliklinikte Arama' (Search in Polyclinic book). When the graph is examined in more depth, it can be seen that the participants focused more on the irrelevant objects than the relevant ones as proven in Figure 4.27 . It is also seen that fixation count percentages for these two relevant objects, namely 'bağlantılar' (links) and 'sol panel' (left panel), have greater proportion compared to the fixation duration percentages related to these objects. This shows that participants mostly fixated on these objects with short eye visits.
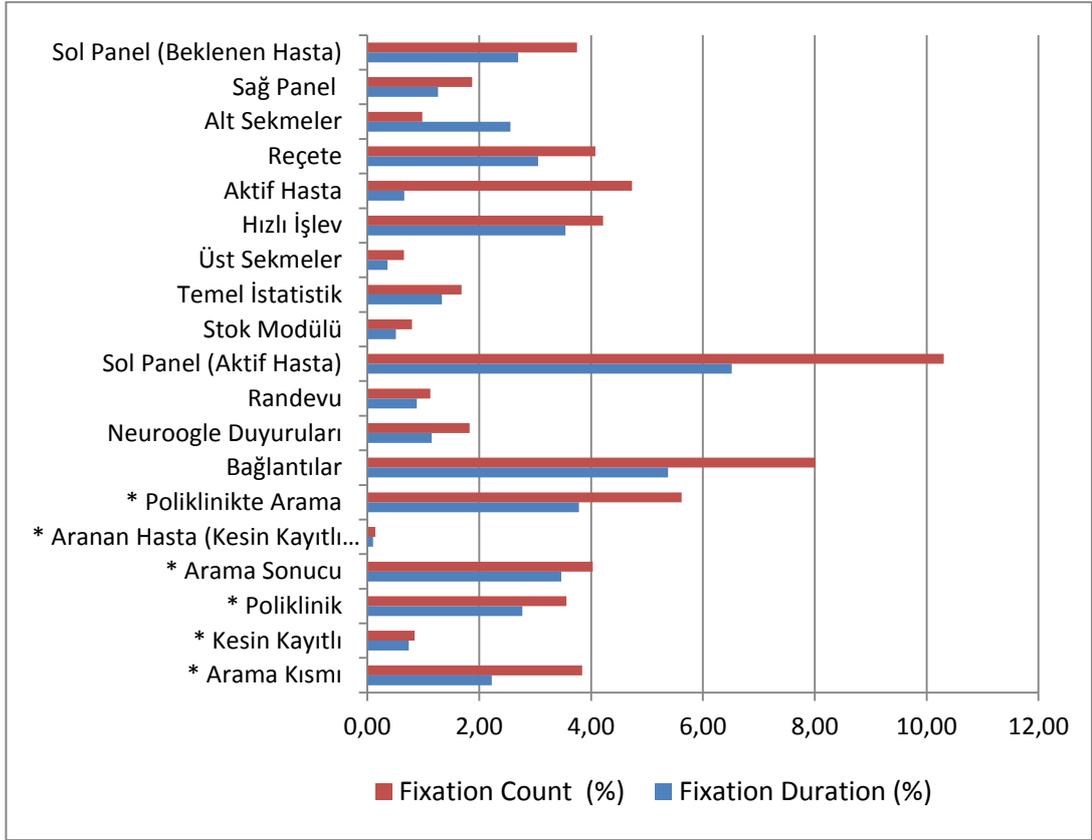
Figure 4.28 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task1

4.5.1.5. Think-Aloud

"*Daha bilgilendirici, yönlendirici uyarılar olmalı.*"

"*There should be more informative and guiding alerts*" Layout/Screen Organization – Problem

"*Gereğinden fazla ekran var burda. Bu kadar ekranın arasında ne yapacağımı bilemiyorum.*"

"*There are more screens than needed. I don't know what to do with all these screens*" Layout/Screen Organization - Problem

"*Çok fazla metin var çok fazla renk var.*"

"*There are too many texts and colour*" Layout/Screen Organization - Problem

"Renk kodları ile ilgili hiçbir bilgi yok"

"There is no information in terms of colour" Color - Problem

"Fontlar çok küçük"

"Fonts are too small" Resolution - Problem

"Ekranın alt köşesinde bir uyarı mesajı yanıp sönüyor ama niye yanıyor acaba?"

"An alert message is blinking at the lower corner of the screen. What is causing it?"
Lack of Indication of System Status - Problem

"Google'a benzeyen tuhaf bir yerde arayım"

"I'd rather search at an awkward location similar to google" Meaning of Labels -
Problem

"Adres grupları ne acaba? Ne alaka burda?"

"What's the addressgroups? What's the meaning of their presence here?" Meaning
of Labels - Problem

*"Hasta isminin üzerine gelince resmin büyüyüp küçülmesi çok rahatsız ediyor,
heryerde bir hareket var gibi"*

*"The expanding and contracting of the picture when the cursor is on the patient's
name is quite annoying. There seems to be motion everywhere."* Graphics - Problem

*"Şurada (ekranın sol alt kısmı) birşey var mesela, birşey aramaya devam ediyor gibi
ama ne aradığını bilmiyorum. Bunu ben başlatmadım bildiğim kadarıyla"*

*"Here (at the lower part of the screen) something seems to be searched but I don't
know what. As far as I know I didn't start it"* Lack of Indication of System Status –
Problem

4.5.2. Task 2: updating registration information of a specific patient

4.5.2.1. Completion Time

For task 2 the ideal case of completion time was 19,35 seconds on average estimated
using the cog-Tool program, and stated in the cognitive modeling results section. The

graph below (Figure 4. 29) shows the results of all participants' completion time regarding task 2 and their comparisons with the ideal case.
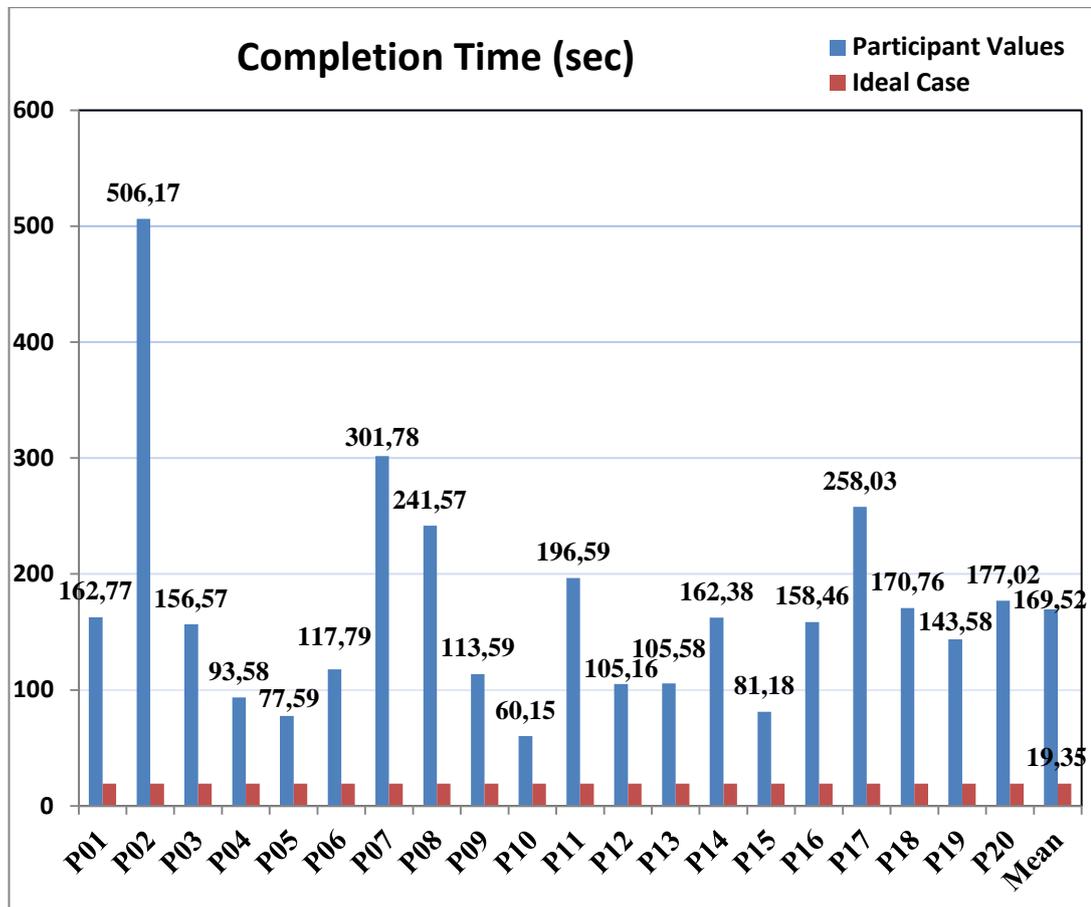
Figure 4.29 Task2 – Completion Time Graph

4.5.2.2. Mouse Clicks

For task 2, the ideal case of mouse clicks was 11 counts on average during the modeling of task in the cog-Tool program. Figure 4.30 shows the results of all the participants' mouse clicks estimations.
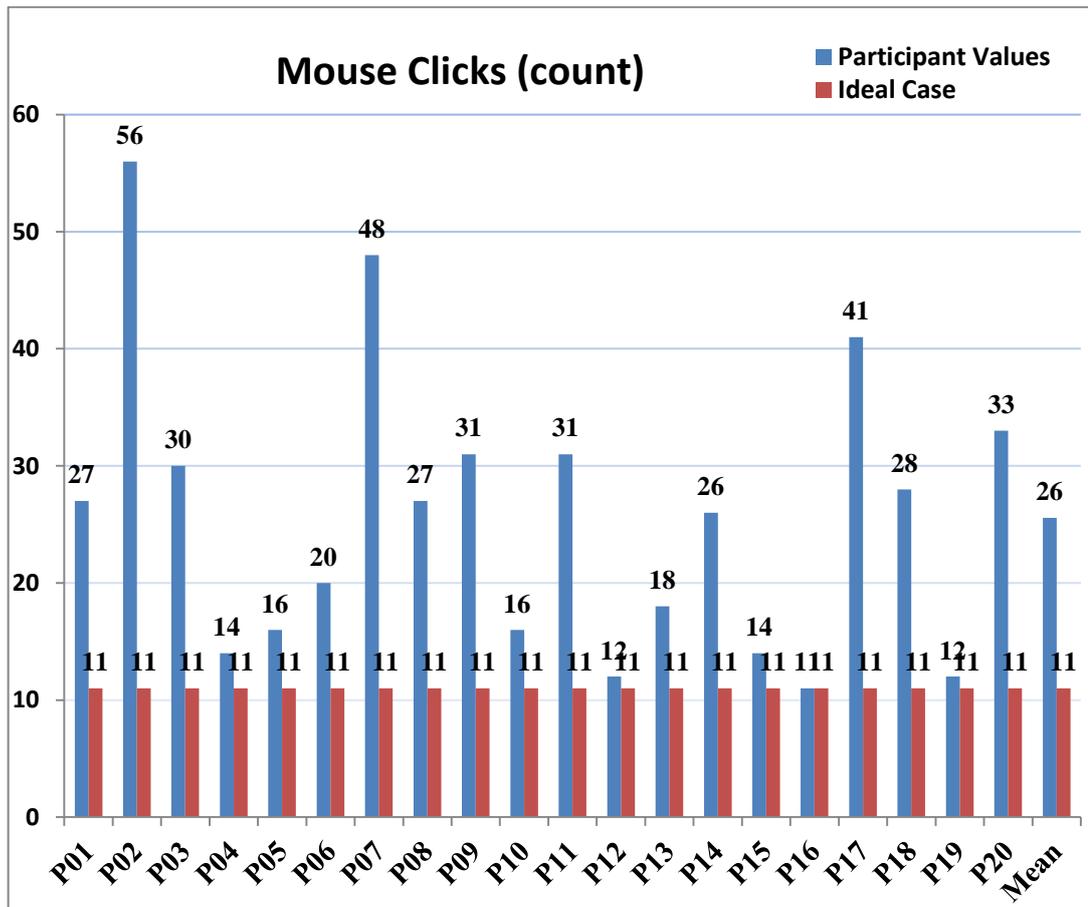
Figure 4.30 Task2 – Mouse Clicks Graph

4.5.2.3. Area of Interests

Area of Interests (AOIs) were defined for task 2 in order to analyze fixation statistics illustrated in Figure 4.31. In the figure the yellow box represents the irrelevant object named 'Üst Sekmeler' (Upper Tabs), the turquoise box represents the irrelevant object named 'Sol Panel' (left panel), the green box represents the irrelevant object named 'Kayıt Türü Seçimi' (Select record type). The remaining blue and purple boxes show relevant objects (AOIs), namely 'E-Posta' (e-mail), 'Kan Grubu' (Blood Type), 'Sosyal Güvence' (Social Security) and 'Kaydet ve Kapat' (Save and Close). This figure also represents one segment of task 2, and in order to complete task 2 there were additional AOIs.
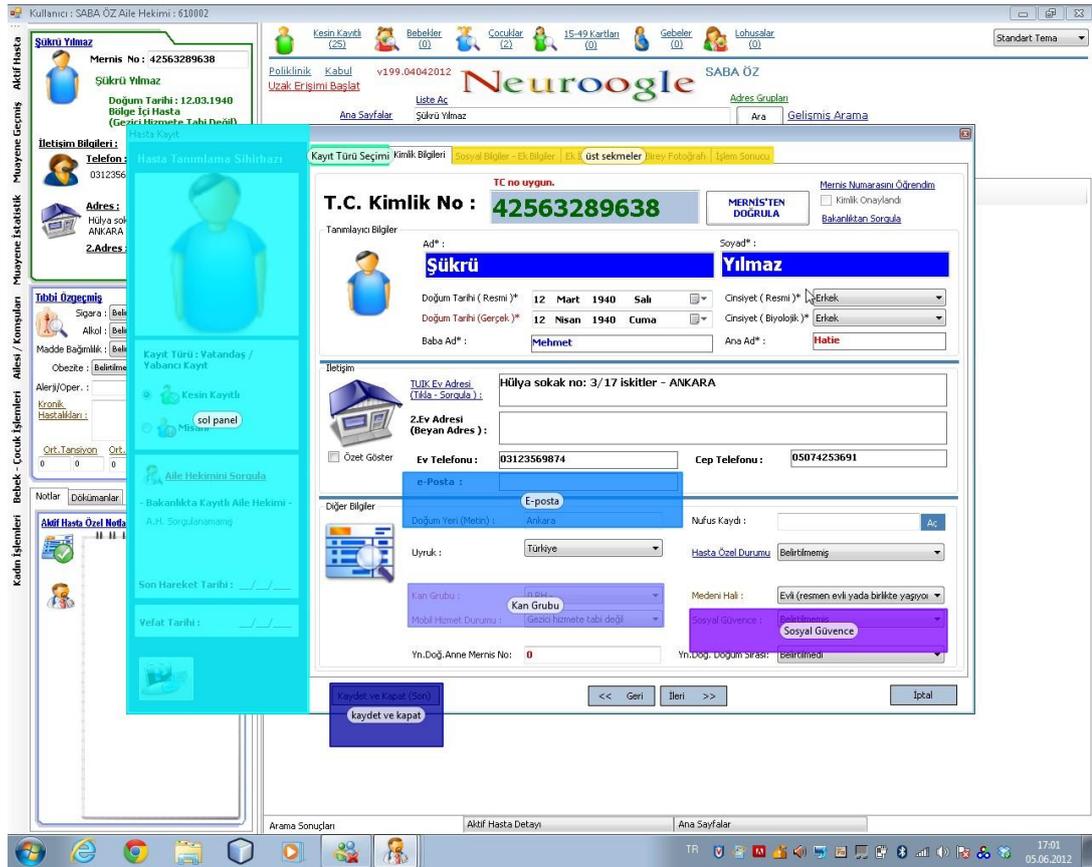
Figure 4.31 Areas of Interest for Task2

4.5.2.4. Fixation Duration and Fixation Count Statistics

Table 4.6 Task2 – Fixation Durations

Participant	Fixation Durations (sec)				Total Time (sec)
	Area of Interests (AOI)		Not Area of Interests (NAOI)		
	Time (sec)	%	Time (sec)	%	
P01	23,15	14,2	139,6	85,8	**162,77**
P02	73,79	14,6	387,2	76,5	**506,166**
P03	57,69	36,8	98,88	63,2	**156,573**
P04	16,68	17,8	76,9	82,2	**93,582**
P05	20,86	26,9	56,73	73,1	**77,586**
P06	34,43	29,2	83,36	70,8	**117,789**
P07	29,66	9,83	272,1	90,2	**301,782**
P08	38,49	15,9	203,1	84,1	**241,573**
P09	3,77	3,32	109,8	96,7	**113,587**
P10	14,43	24	45,72	76	**60,154**

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The graphs below show total fixation count and fixation duration percentages of participants classified as AOIs and NAOIs.

Fixation Durations and Fixation Counts
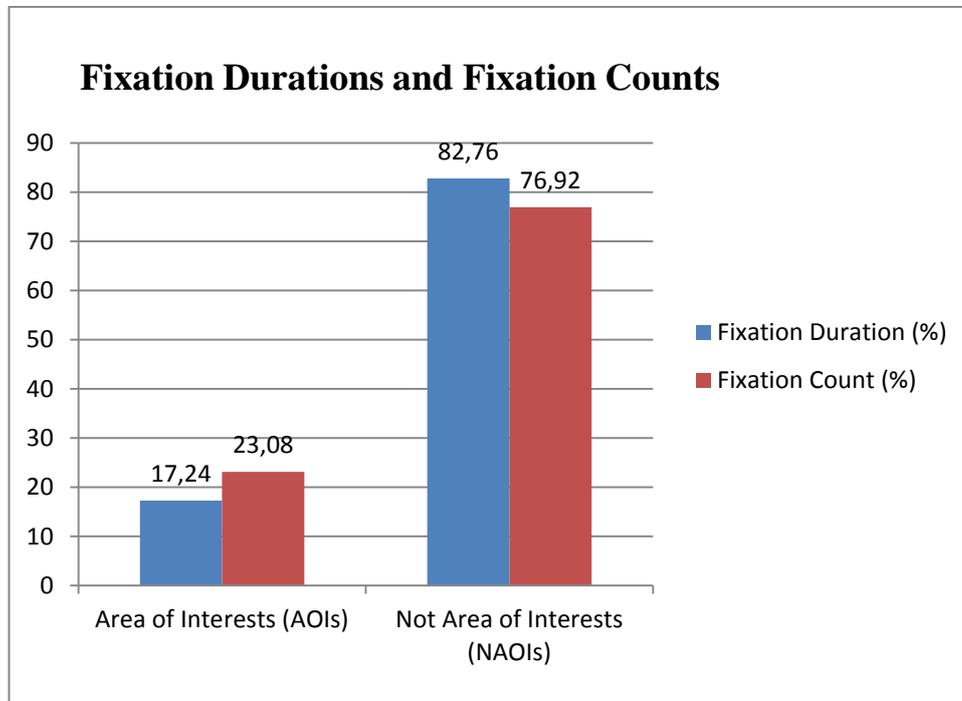
Figure 4.32 Overall Fixation Durations and Fixation Counts Percentages of Task2

Figure 4.32 shows that participants focused mostly on irrelevant items during the performance of task 2. One reason for this is that they always tried to find where they could reach patient identity information on the system. As a result of this, they mostly focused on irrelevant objects when they were searching for items compatible with task 2. To see which items attracted more attention, a detailed analysis of fixation durations and fixation counts with respect to AOIs and Not AOIs were conducted and presented in Figure 4.33 . In Figure 4.33, AOIs are represented with an asterisk symbol (*) to distinguish them from NAOIs. Among AOIs, 'Arama Kutusu' (search box) has received more fixations since participants learned how to search patient from previous task. When observing fixation distributions to irrelevant objects, it can be seen that 'Sol Panel' (Left panel) and 'sağ panel' (right panel) were the mostly fixated sections among NAOIs.
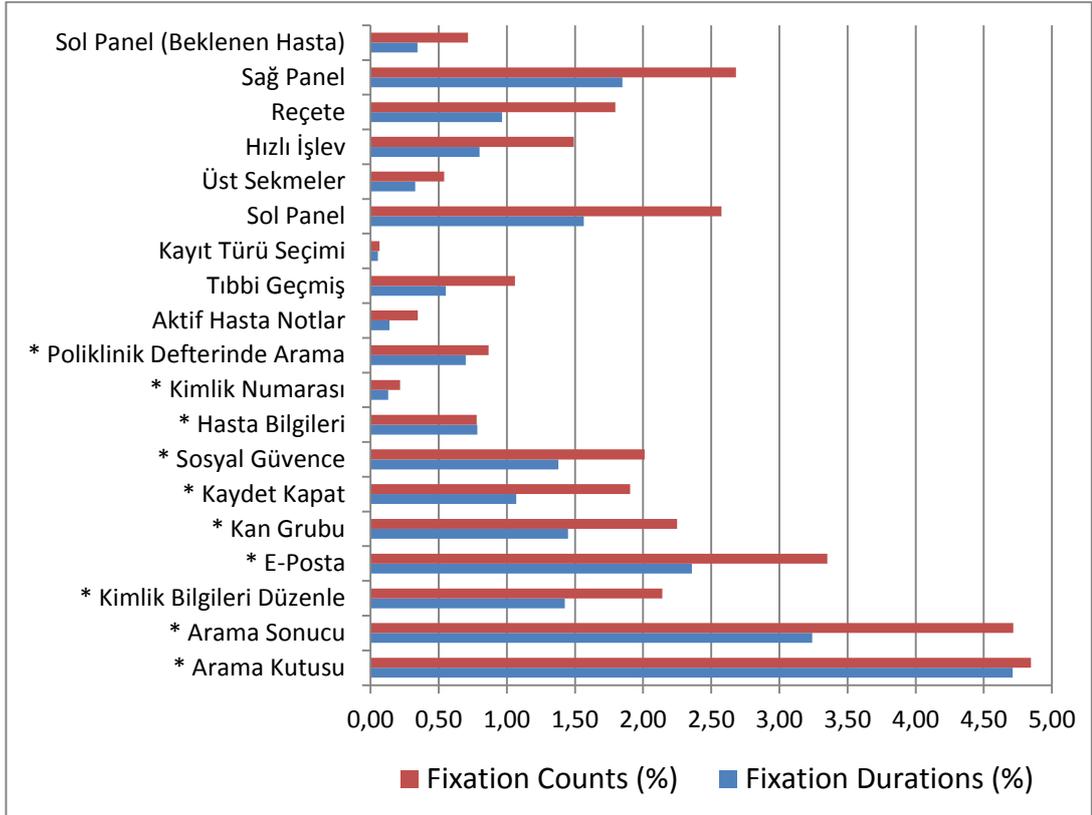
Figure 4.33 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task2

4.5.2.5. Think-Aloud

"*Yok bulamıyorum ben, e-posta adresi nerde?*"

"*No, I can't find it. Where's the e-mail address?*" Layout/Screen Organization - Problem

"*Keşke e-posta kısmına bir imge gibi birşey koyulsaymış, Mesela alt kısımda var (duyuru bilgi sistemi penceresi) orda da olsa iyi olurdu*"

"*I wish something like an icon had been placed at the e-mail location, for instance there is one (information system announcement window) It would be better if there were one here too.*" Layout/Screen Organization - Problem

"*Buraya başka şeylerde yazabilirim, aslında bu tür yerlerde '@' kullanıp kullanılmadığına dair bir check yapılırsa iyi olur.*"

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"I can write other things here too. In fact, it'll be better to check whether '@' should be used or not"

"Mesela Mernisten sorgula denildiğinde Mernis sorgulaması açılana kadar orda bir zaman geçti. Bu zamanda ne yapıldığına dair bir bilgi yoktu"
"For instance, it took 'Mernis' too long to respond when asked for an inquiry. There was no notification regarding what had been done during that period" Lack of Indication of System Status - Problem

"Mesela şu anda bilgileriniz sistemden çekiliyor gibi birşey derse faydalı olur."
"For example, it will be useful if it says something like 'your information is extracted from the system'. "

"sosyal güvence değiştirdim, sosyal güvence yazısı yeşil olunca göze pek çarpmıyor"
"I have altered social security field. It isn't eye-catching when social security field is in green" Color – Problem

4.5.3. Task 3: Assigning a patient to Poliklinik Defteri (Polyclinic Book)

4.5.3.1. Completion Time

Ideal completion time for task 3 was calculated as 13,73 and the graph below (Figure 4.34) shows all the participants' task 3 completion times.
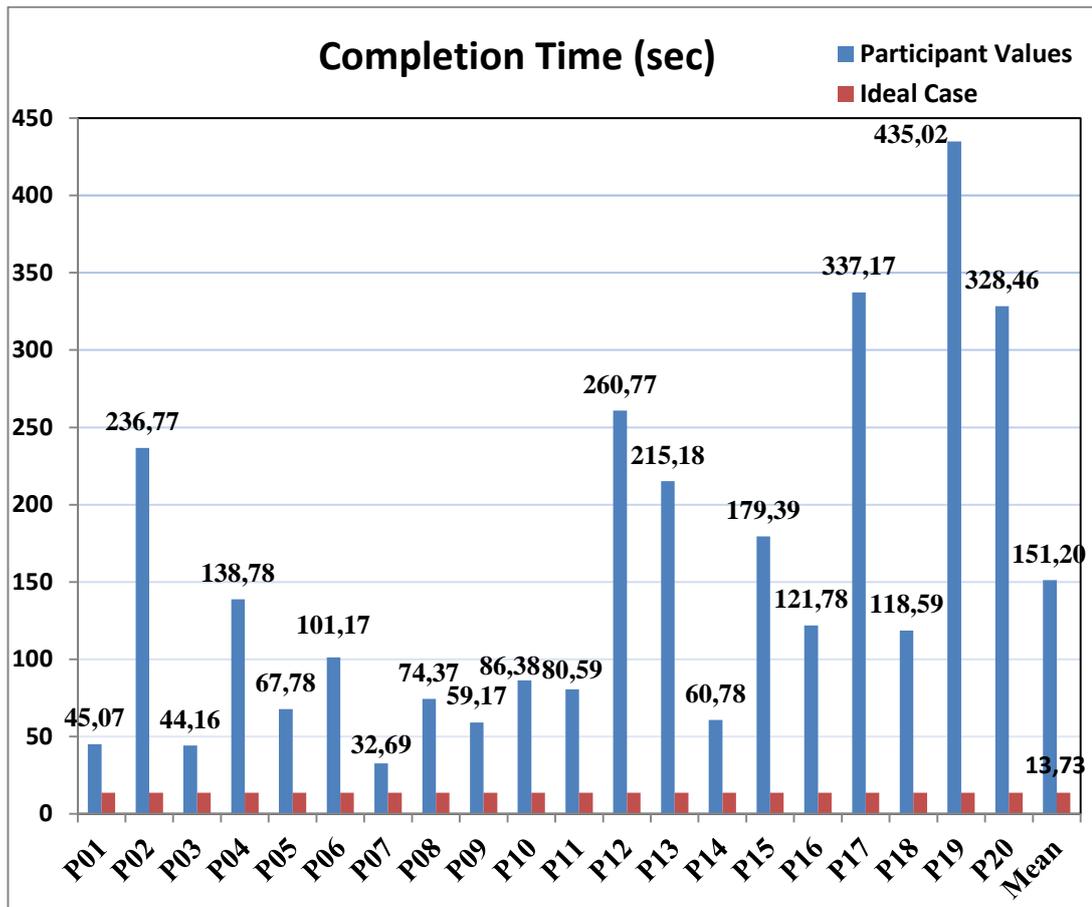
Figure 4.34 Task3 – Completion Time Graph

4.5.3.2. Mouse Clicks

The ideal Mouse click count was estimated as 4 for task 3. The graph below (Figure 4.35) shows all all participants' mouse click counts during the task performance.
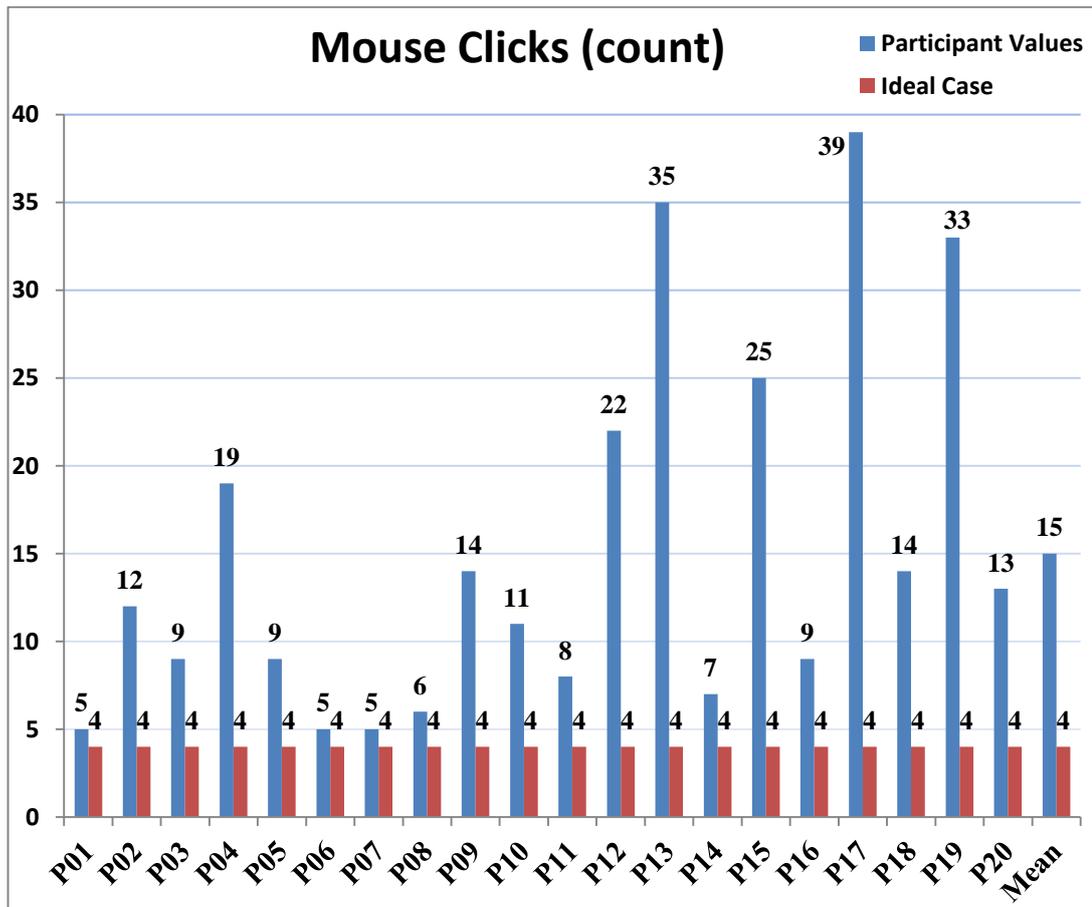
Figure 4.35 Task3 – Mouse Clicks Graph

4.5.3.3. Areas of Interest

Areas of Interest (AOI) were defined for task 3 in order to analyze fixation statistics illustrated in Figure 4.36. This figure shows the phase in which participants found the patient searched for and right clicked on his/her name. To complete task 3, participants had to find the patient first and then they needed to clicke on the 'Protokol Defterine At' (Assign to Protocol or Polyclinic Book) option on the right click menu of the patient name. The blue colored box named 'Protokol Defterine At' shows one of the AOIs for this task and the green box named 'Aktif Hasta' (Active Patient), the orange box named 'Tıbbi Geçmiş' (Medical History) and the pink box named 'Aktif Hasta Notlar' (Active Patient Notes) were some of the NAOIs.

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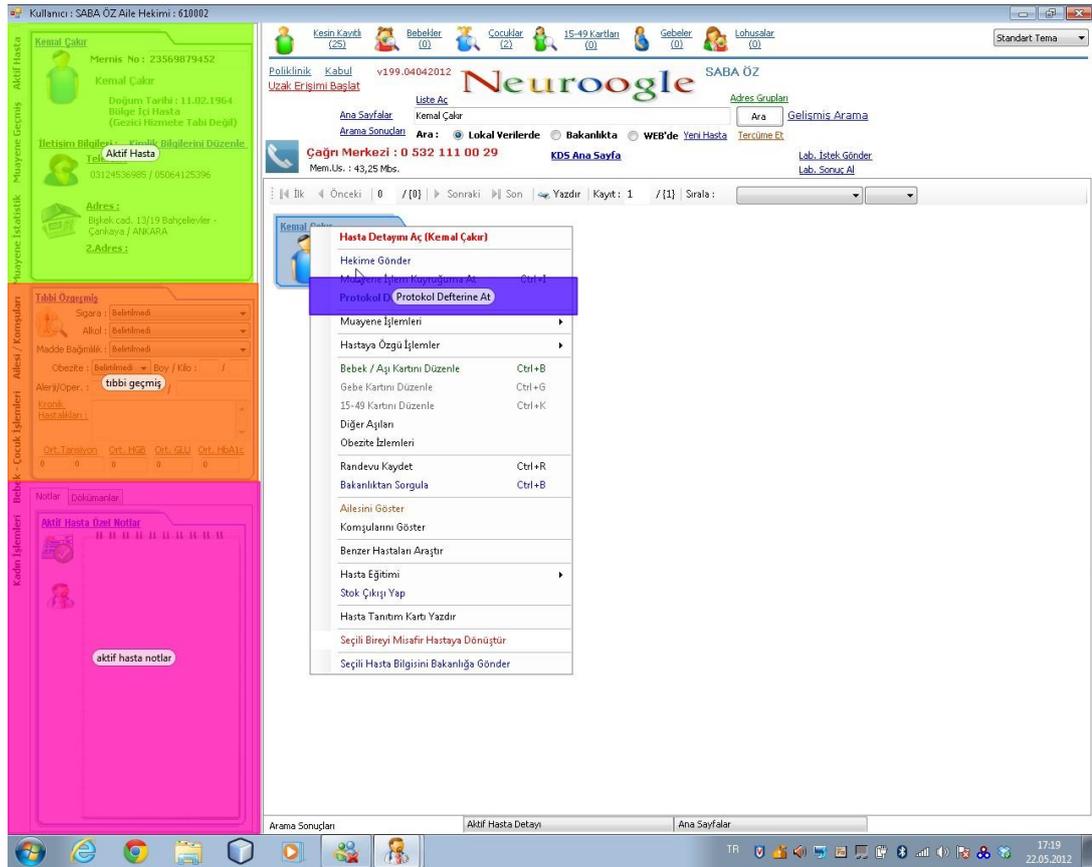
Figure 4.36 Area of Interests for task3

4.5.3.4. Fixation Duration and Fixation Count Statistics

Table 4.7 Task3 – Fixation Duration

Participant	Fixation Durations (sec)				
	Area of Interests (AOI)		Not Area of Interests (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P01	14,32	31,78	30,75	68,22	45,07
P02	50,35	21,27	117,05	49,44	236,77
P03	12,36	27,99	22,80	51,63	44,16
P04	22,41	16,15	107,37	77,37	138,78
P05	14,66	21,63	44,12	65,09	67,78
P06	17,05	16,85	75,12	74,25	101,17
P07	1,3	3,98	31,39	96,02	32,69
P08	16,18	21,76	49,19	66,14	74,37
P09	1,49	2,52	48,68	82,27	59,17
P10	8,51	9,85	59,87	69,31	86,38

The graphs below show total fixation count and fixation duration percentages of participants classified as AOIs and NAOIs
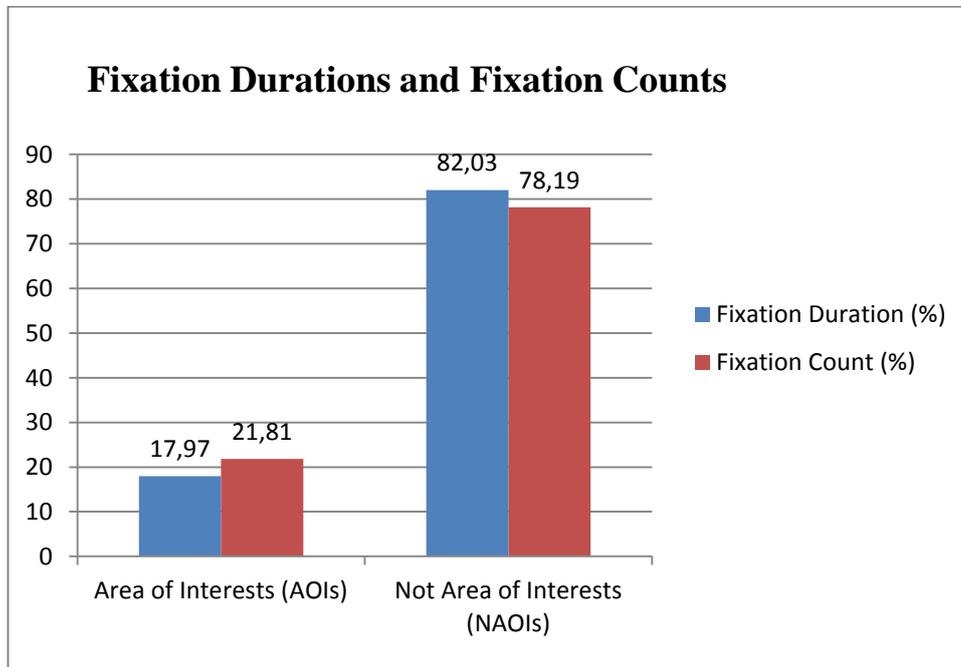
Figure 4.37 Overall Fixation Durations and Fixation Counts Percentages of Task3

When figure 4.37 is examined, it can be said that participants focused more on irrelevant objects with a great proportion. This resulted from searching for a 'Protokol Defterine At' button since it was not located on the visible part although it is a frequently used feature. Generally participants tended to add a patient to protocol (poliklinik) defteri by opening a polikilink defteri first and then searching for the patient in it. Only some participants were able to explore by chance an option of 'protokol defterine at' located on the right click menu of patient name. Figure 4.38 shows the detailed analysis of the fixations. AOIs for task 3 were indicated with an asterisk symbol (*) in Figure 4.38 to distinguish them from Not Areas of Interest (NAOIs). When the figure is examined it is clearly seen that 'poliklinik defterinde arama' (search in polyclinic book) attracted more fixations of participants. This shows that participants preferred to add a patient to poliklinik defteri by searching for him/her in it.
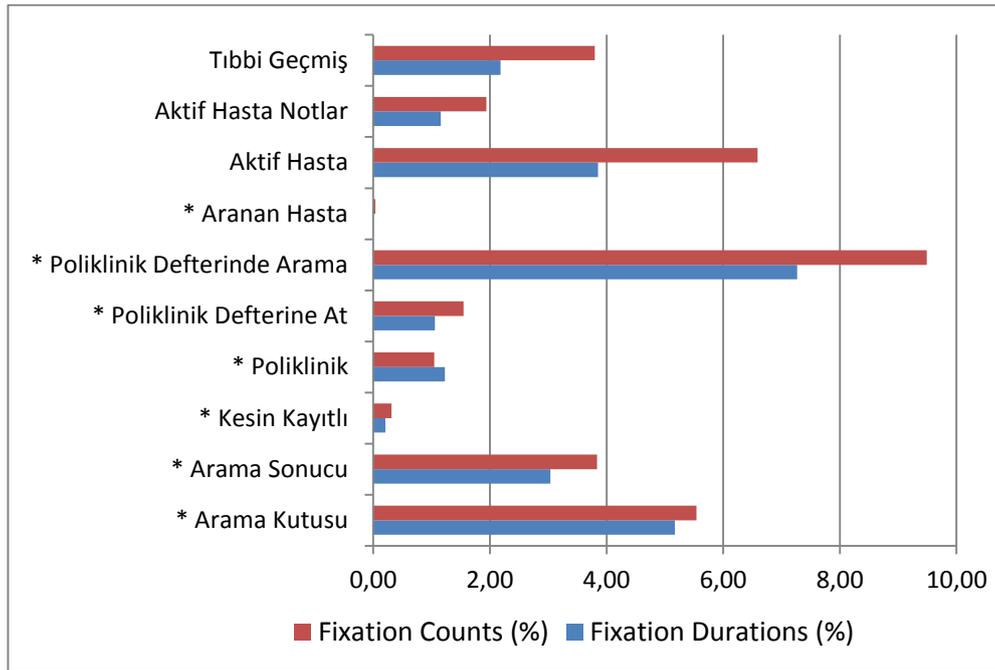
Figure 4.38 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task3

4.5.3.5. Think-Aloud

"Poliklinik diye bir sekme var acaba o mu?"
"There's a tab called 'polyclinic'. Could it be that one?"

"Ama hiç inanarak yapmıyorum bunları, tamamen deneyerek yapıyorum"
"However, I'm not convinced about what I'm doing at all, just experimenting with it." Overall Ease of Use - Problem

"Oldu ama olup olmadığı hakkında hiçbir fikrim yok"
"Done, but I'm not sure if it is done or not" Lack of Indication of System Status - Problem

"*Ekledi birde, bundan hiç haberim yok*"
"*It's also added, but I'm not informed*" Lack of Indication of System Status - Problem

"*Sağ tuşa tıkladım polikinik defterine at çıktı, tamamen şans eseri buldum yalnız*"

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"I clicked on the right button and 'move to polyclinic section' appeared all by chance" Meaning of Labels - Problem

"yalnız attı mı atmadı mı hiçbir fikrim yok. Attı mı ? sanırım atmış, evet."
"Has it been moved or not, I have no idea. I think it has." Lack of Indication of System Status - Problem

"birşey yaparken haber verse güzel olacak"
"It will be better if it informs when performing some task." Lack of Indication of System Status - Problem

"Birde burda anasayfaya geçeceğimiz bir buton yok mu? O çok belli değil mesela, ben hep başa dönmek isterim böyle bir durumda bilmediğim çok emin olmadığım yerlerden kurtulmak için"
"Moreover, isn't there a button here which directs to the home page? It is not clear enough. For instance, I would like to be able to return to the beginning to get rid of sections which I don't know or not sure of" Navigation - Problem

"Hastayı buldum şimdi poliklinik defterine atacağım" "o nasıl oluyor ?"
"I've found the patient record. Now, I'll move him/her to the polyclinic section. How does this happen?"

"şurda poliklinik var oraya tıklayabilirim, birde nedense şuraya atabileceğimi düşünüyorum"
"there's a polyclinic icon here, I can click on it. Also, for some reason, I think can transfer it somewhere else." Consistency of Operations - Problem

"polikliniğe bastım, nereye geldiğimi açıklayan bir yazı yok burda. Kendimi kaybolmuş gibi hissediyorum"
"I clicked on the polyclinic icon, there is no indication to where I am. I feel I'm lost" Lack of Indication of System Status - Problem

"Geri nasıl döneceğim? Çok karışık bir sistemmiş"
"How can I get back? It's a very complicated system." Overall Ease of Use - Problem

"burdan kapatırsam program kapanmış mı oluyor?"

"If I close it here, will the program be closed as well?" Meaning of Labels – Problem

"gerçekten bulması zor"

"It's indeed difficult to find" Overall Ease of Use – Problem

4.5.4. Task 4: Prescribe drugs to a patient

4.5.4.1. Completion Time

For task 4, the ideal completion time was 18,75 estimated using the cog-Tool program.
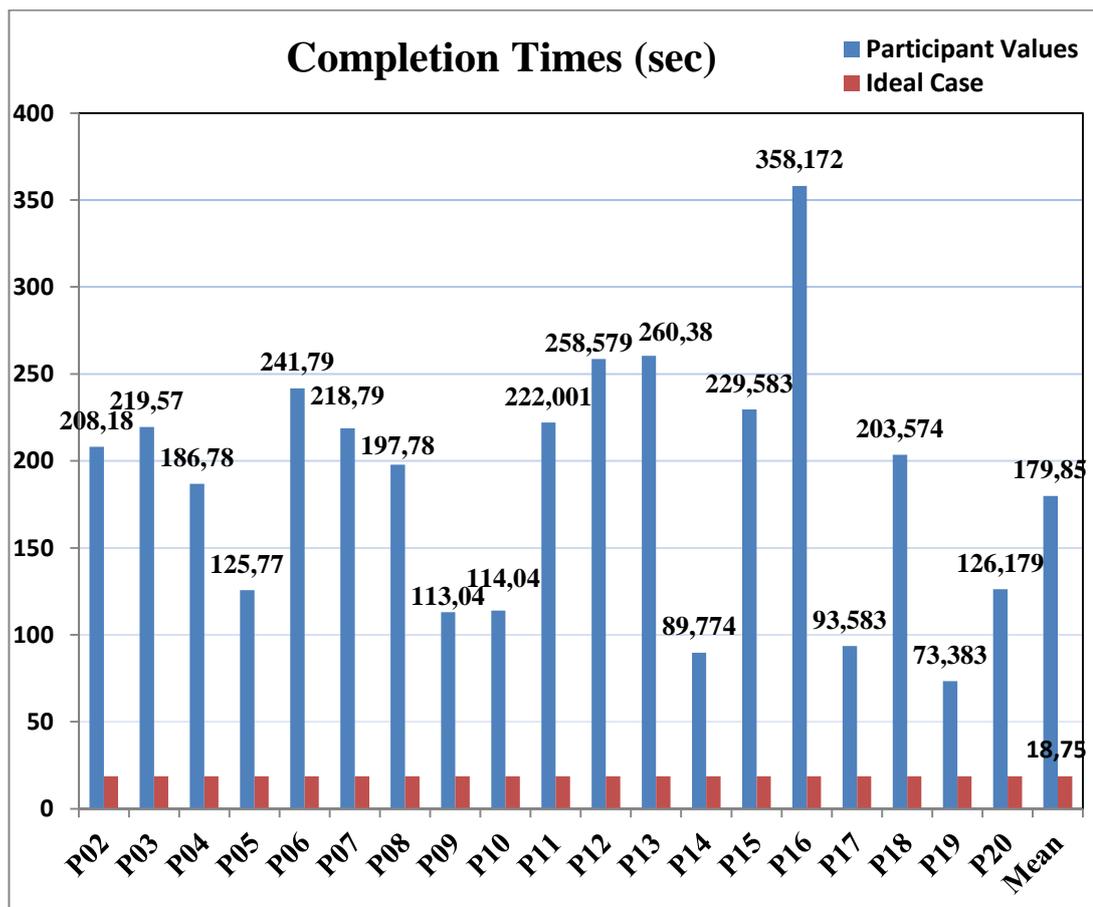
Figure 4.39 Task4 – Completion Time Graph

4.5.4.2. Mouse Clicks

The ideal mouse click count was 12 estimated during the modeling of the tasks in cog-Tool. The graph below (Figure 4.40) shows the results of all the participants' task 4 mouse click counts.
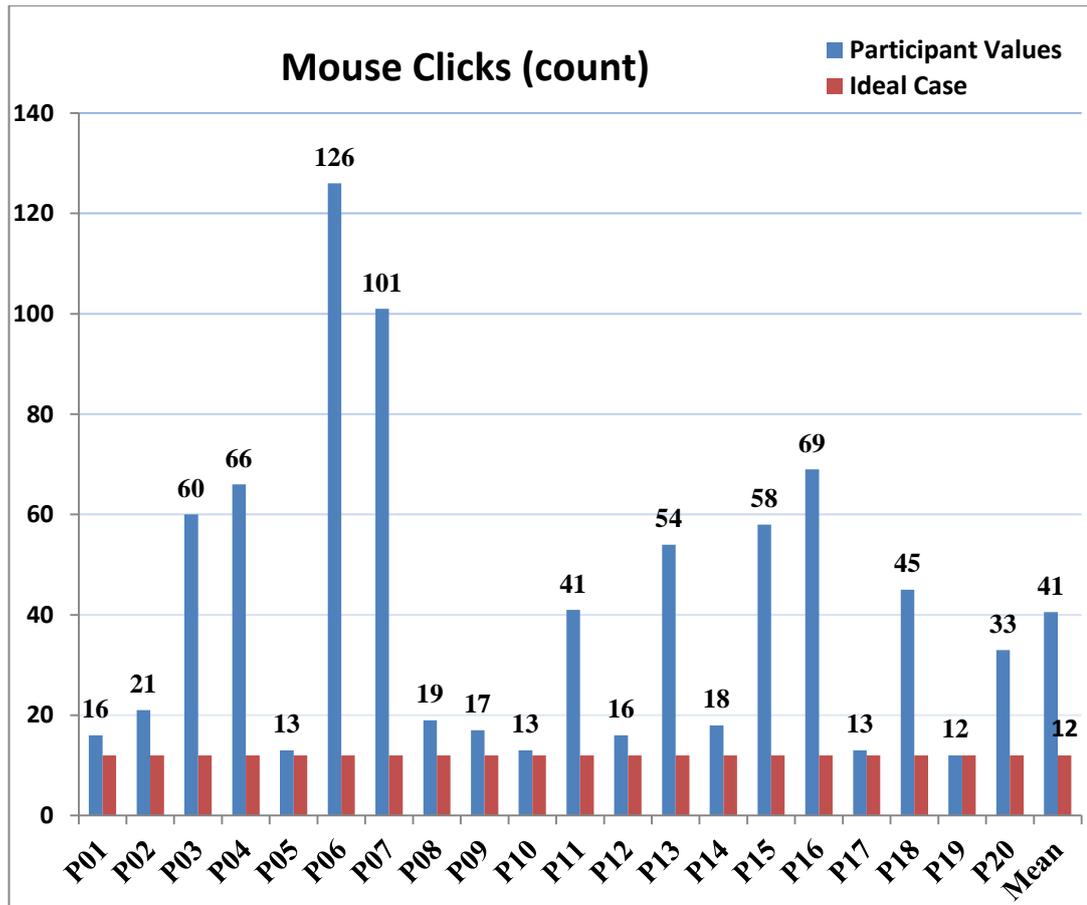
Figure 4.40 Task4 – Mouse Clicks Graph

4.5.4.3. Areas of Interest

Areas of Interest (AOIs) were defined for task 4 in order to analyze fixation statistics illustrated in Figure 4.41. In the figure, the diagnosis screen was illustrated with AOIs and NAOIs. Participants started this task with the poliklinik defteri screen from previous task (task3) and they had to find the open diagnosis screen on it. Since the diagnosis screen consists of many related items for task 4, almost each box

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represents AOIs. The green boxes named 'Muayene Bilgisi' (Examination Information), 'Tanı Seçimi Sekmesi' (Diagnosis Selection Tab) and 'Kaydet', the yellow box named 'Reçete İlaçları' (Prescription Section), the red box named 'Hasta Geçmiş İlaçlar' (Drug History of Patient), the orange box named 'Son Muayeneler' (Last Examination), the blue boxes named 'Sık Kullanılan İlaçlar' (Most frequently

used drugs), 'Tanı - İlaç Listesi' (diagnosis and drug list) and 'Reçete Sekmesi' and lastly the pink box named 'Tanı – İlaç Arama Kutusu' (Diagnosis and Drug Search box) were relevant objects (AOIs) for task 4. The blue boxes located on the upper and left side of the screen named 'Üst Kısım' (upper side) and 'Hasta Bilgiler' (Patient Information) and the red box located on the bottom side of the screen named 'Alt Sekmeler' (Bottom Tabs) were irrelevant objects (NAOIs) for task 4.
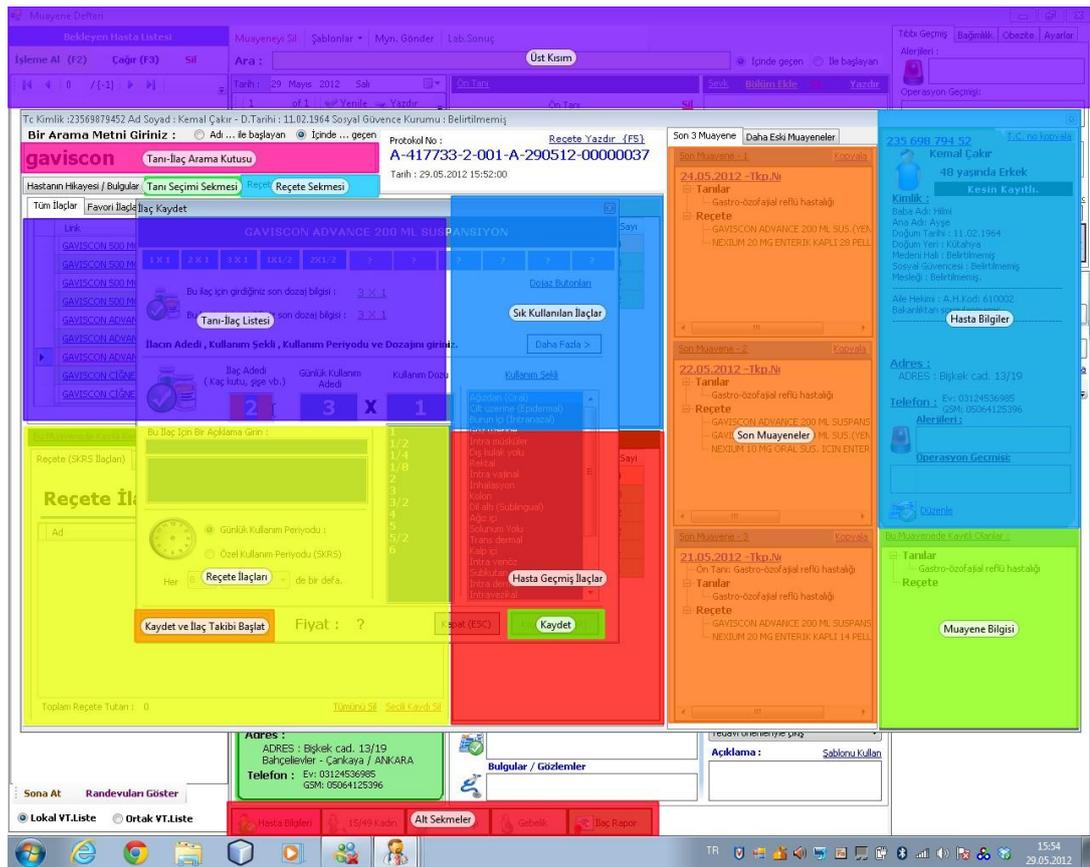
Figure 4.41 Areas of Interest for Task4

4.5.4.4. Fixation Durations and Fixation Count Statistics

Table 4.8 Task4 – Fixation Durations

Participant	Fixation Durations (sec)				Total Time (sec)
	Area of Interests (AOI)		Not Area of Interests (NAOI)		
	Time (sec)	%	Time (sec)	%	
P01	45,05	80,47	10,94	19,53	**55,99**
P02	87,94	42,24	120,24	57,76	**208,18**
P03	149	67,87	70,54	32,13	**219,57**
P04	123,7	66,22	63,09	33,78	**186,78**
P05	67,84	53,94	57,93	46,06	**125,77**
P06	164	67,81	77,83	32,19	**241,79**
P07	155,5	71,06	63,31	28,94	**218,79**
P08	134,8	68,13	63,03	31,87	**197,78**
P09	24,75	21,90	88,29	78,10	**113,04**
P10	35,36	31,01	78,68	68,99	**114,04**

The figures below show the total fixation count and fixation duration percentages of participants classified as AOIs and NAOIs.
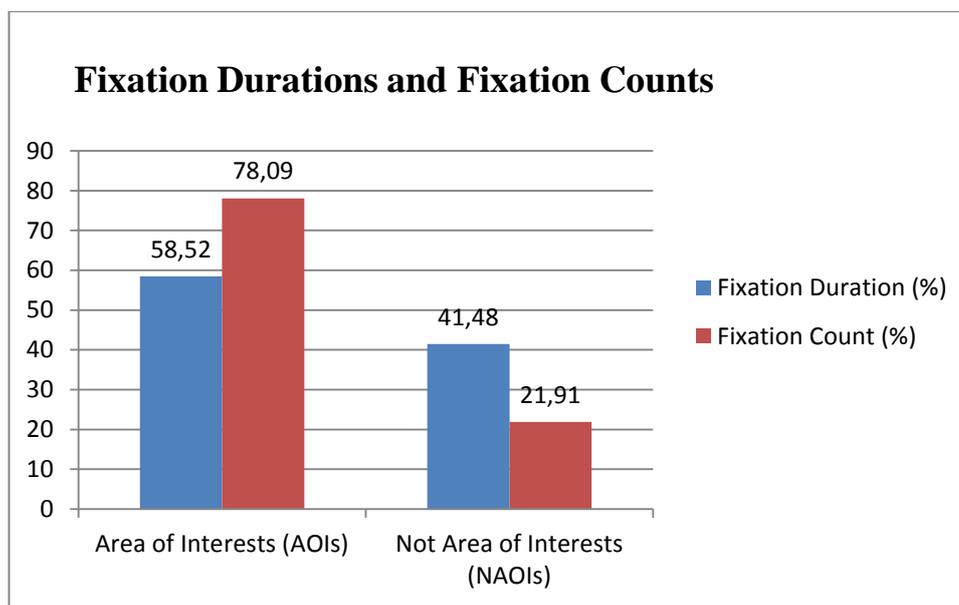
Figure 4.42 Overall Fixation Durations and Fixation Counts Percentages of Task4

In Figure 4.42, it can be clearly seen that AOIs collected more fixations compared to Not AOIs. One of the reasons of greater proportion of AOIs is that some participants spent much time on 'Tanı - İlaç Listesi' (Drug and Diagnosis list) by scrolling on it since they did not realize the search box designed for quick search and find drugs and

diagnoses located on the upper side of the 'tanı – ilaç listesi'. One other reason of this situation is that the diagnosis screen of task 4 consists of many relevant sections in itself, so wherever the participant looked on the screen their fixations mostly fell into AOIs. Figure 4.43 below shows a detailed analysis of AOIs and NAOIs. It can be seen from the results displayed in this figure that the partipants' fixations were

mostly on AOIs rather than NAOIs. As mentioned earlier, 'Tanı – İlaç Listesi' has a great proportion of fixation durations and fixation counts (approximately 25 %). Then 'Reçete İlaçları' (Prescription Section) follows this proportion since participants checked out whether a drug was added to a prescription or not by looking at the prescription section. When looking at the proportions of NAOIs, it can be seen that each of their fixation duration and fixation count proportions ranged between 0 – 5% .
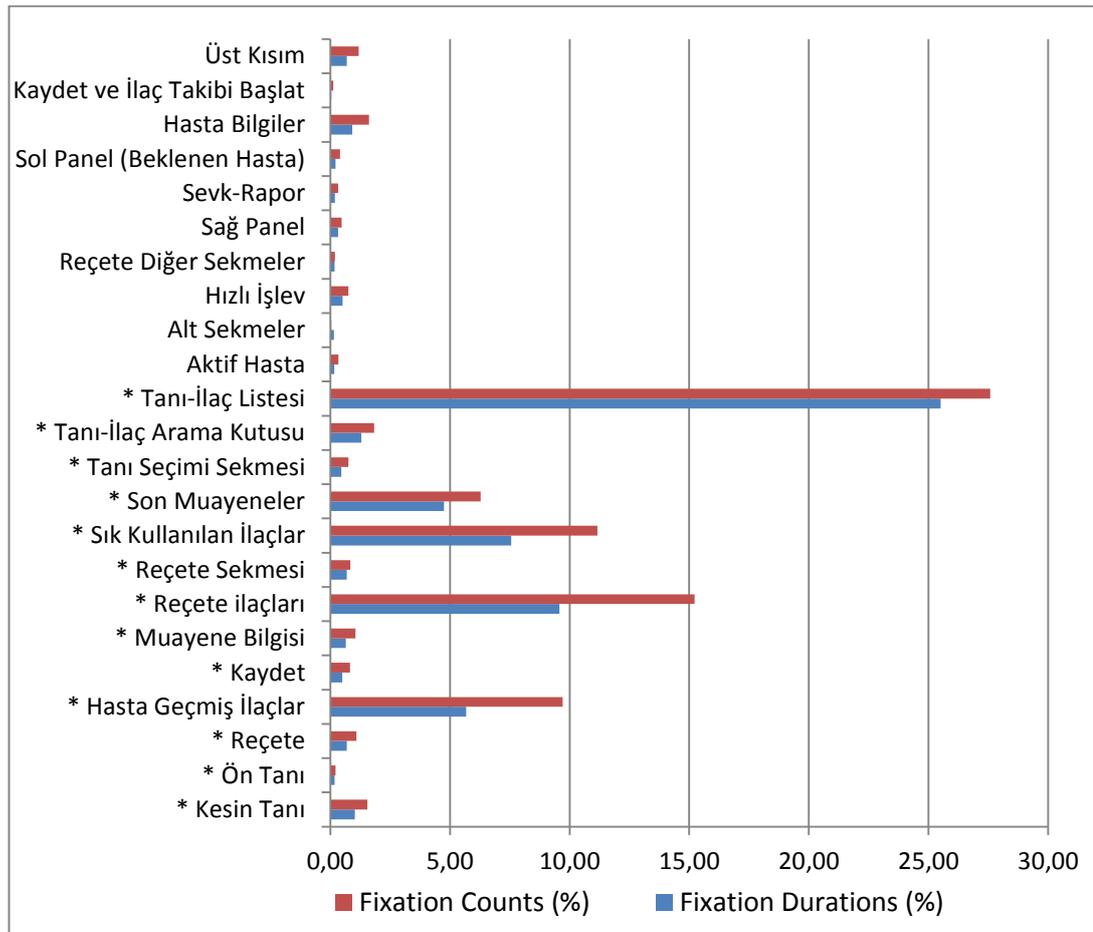
Figure 4.43 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task4

In Figure 4.42, AOIs were stated with an asterisk symbol (*) to distinguish them from Not Areas of Interest (NAOIs).

4.5.4.5. Think-Aloud

"Yanlış bir yer açtım sanırım. Bunu kapatıyorum."
"I think I've opened a wrong page. I'm closing it"

"Sayfa ikide bir değişiyor, devamlı birşeyler yanıp sönüyor. Farklı farklı renkler var. Yani biraz facia sayfa bu"
"The page is changing all the time. Some fields are blinkingconstantly. It's somewhat a disasterous page" Layout/Screen Organization - Problem

"Burdan arama yapabiliyor muyuz acaba?"
"Can we make a search from here?"

"Buralarda ikon kullanılması çok mantıklı olabilir"
"It may be sensible to use icons here"

"Neden sık kullanılan tanıyı görüyorum ki, zaten tanı koymuştum."
"Why do I see frequently used diagnosis? I have already made my diagnosis" Layout/Screen Organization - Problem

"Mesela burada + , - butonları işe yarayabilir" (ilaç günlük kullanım, şişe adedi ve dozajı)
"For instance, + , - buttons may work here" (daily usage of medication, the number of bottles and dosage)

"Ne değerleri kaydettiğime dair en ufak bir fikrim yok." (template değer düzenle ekranı)
"I have no idea about what have been recorded" (template value layout screen)
Lack of Indication of System Status - Problem

"Mesela bunlardan birisi neden kırmızı diğeri neden yeşil?" (Eklenen ilaçların alt plan rengi)

"For example, why is one of them red and the other green? " (the background color of added medication) Color - Problem

"herhalde arama burdadır"
"Probably the search is here"

"kapatma? Kendisi otomatik mi ekliyor acaba, eklemiştir herhalde çıkıyorum. Evet kendisi otomatik ekliyormuş"
"Closing? Does it add automatically? I think it has. I'm leaving, assuming that it adds automatically" Lack of Indication of System Status - Problem

"çok kalabalık ya, her yanda birşey yazıyor nereye bakacağımı şaşırıyorum"
"It's too crowded. Too much information around. I'm confused about where to look at" Layout/Screen Organization - Problem

"şurda daha önce verilen ilaçlar var, tıklasam ekleyecek mi acaba?"
"Here is the medication that has been prescribed earlier. I wonder if it will add it if I click"

"şu mesela aynı ekranmış gibi görünüyor, şunun farklı bir pencere olduğu anlaşılmıyor. Daha kalın çizgiler kullanılabilirdi" (üst üste açılan pencereler)
"For instance it look like the same screen, it is not distinguishable as a different window. Bold lines could have been used" (windows that open top of one another) Layout/Screen Organization - Problem

"burda iki tane kaydet var, ikisinin farkı ne? İlaç takibi başlatıyor demek ki ama şu an hiç bilmediğim için sistemi sadece 'kaydet' e basacağım başka bir ilaç yazabilmek için"
"there are two record buttons here, what's the difference? I assume it's starting medication search but since I don't know the system at all, I'm clicking the record button in order to prescribe another drug." Consistency of Operations – Problem

4.5.5. Task 5 : Changing prescribed drug of a patient

4.5.5.1. Completion Time

The ideal completion time for Task 5 was estimated as 11,69 using the cog-Tool program. The graph below (Figure 4.44) shows all the participants' completion time for task 5.
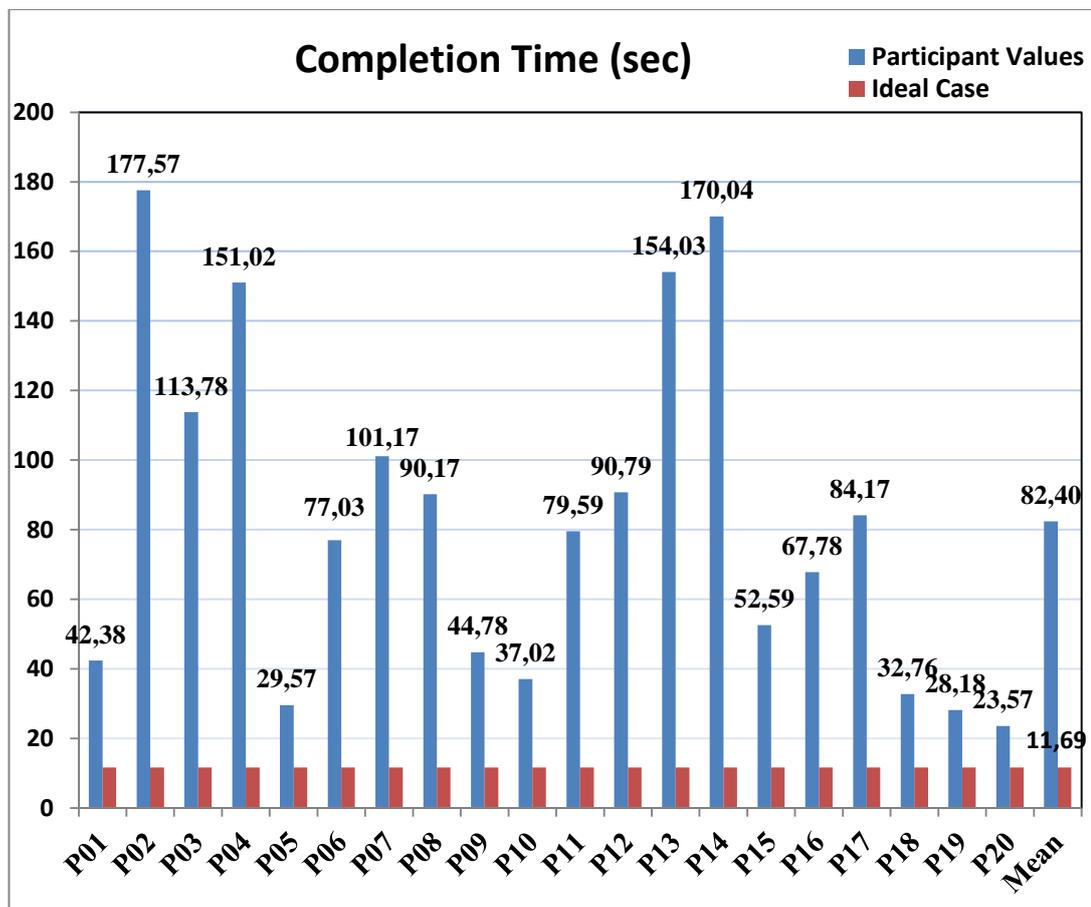
Figure 4.44 Task5 – Completion Time Graph

4.5.5.2. Mouse Clicks

The Ideal mouse click count was 7 for Task 5. The graph below (Figure 4.45) shows all the participants' mouse click counts for completion of Task 5.
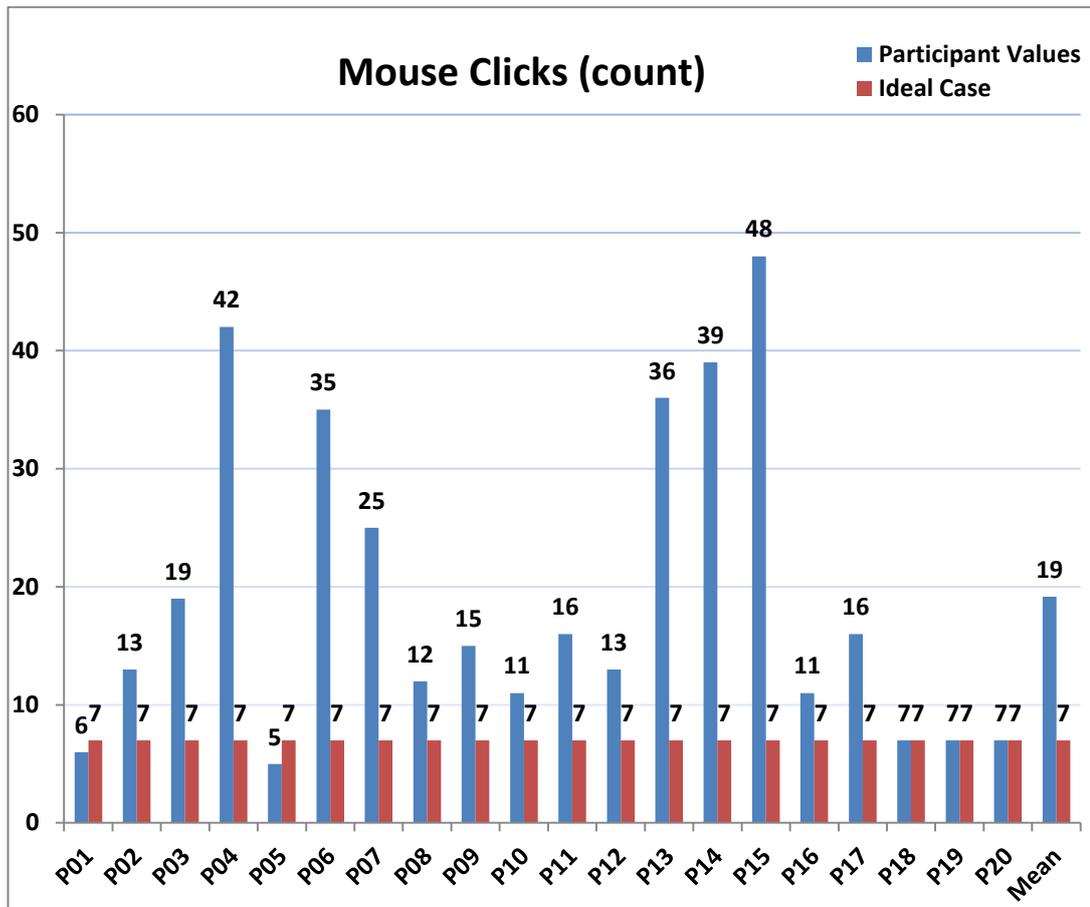
Figure 4.45 Task5 – Mouse Clicks Graph

4.5.5.3. Areas of Interest

Areas of Interest (AOIs) were defined for Task 5 in order to analyze fixation statistics illustrated in Figure 4.46. This figure only shows the first phase of task 5. On this screen only purple box named 'Reçete' was defined as AOI since participants should have clicked on this section in order to change the drug prescribed to the patient on the previous task. Other boxes were irrelevant sections for task 5. The green boxes named 'Sağ Panel' (Right panel) and 'Aktif Hasta' (Active Patient), the blue boxes named 'Sol Panel – Beklenen Hasta' (Left Panel – Waited Patients), 'Kesin Tanı' (Certain Diagnosis) and 'Sevk-Rapor' (Dispatch-Report), the pink boxesnamed'Reçete Diğer Sekmeler' (Prescription Tabs) and 'Hızlı İşlev' (Quick lunch) and the orange box named 'Alt Sekmeler' (Bottom tabs) were examples of NAOIs.
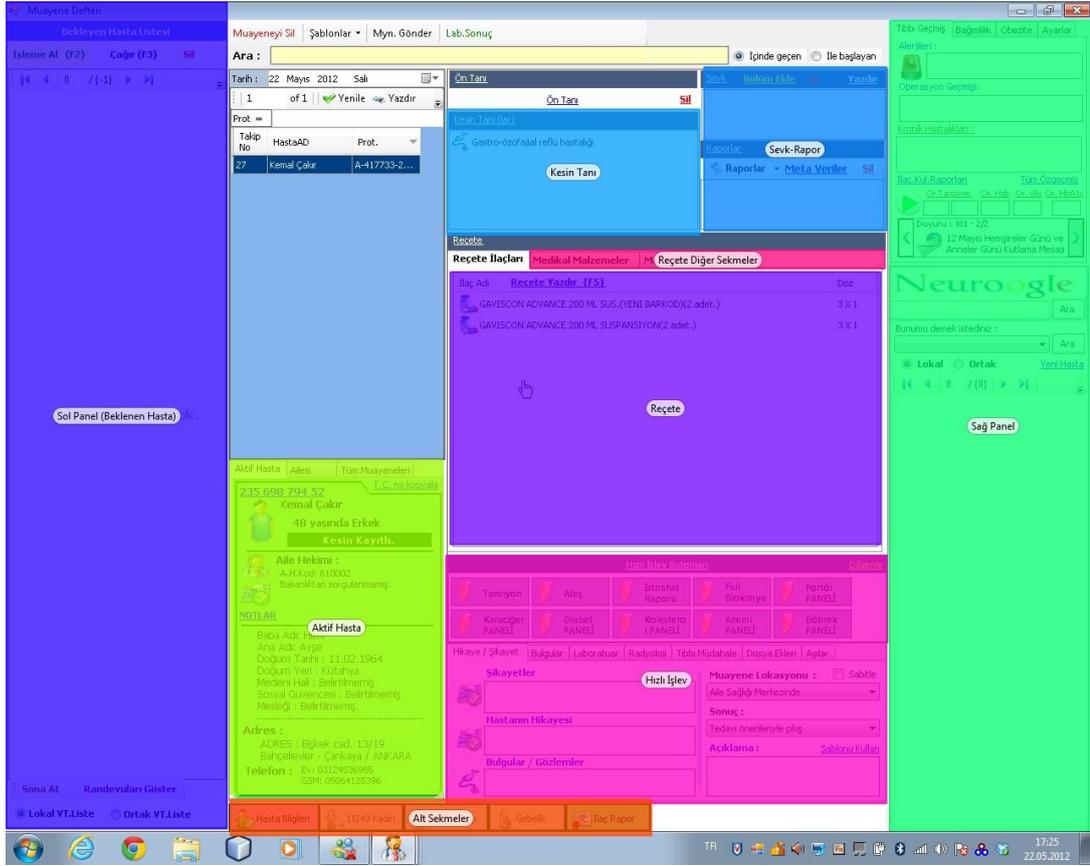
Figure 4.46 Areas of Interest for task5

4.5.5.4. Fixation Duration and Fixation Count Statistics

Table 4.9 Task5 – Fixation Durations

Participant	Fixation Durations (sec)					Total Time (sec)
	Area of Interests (AOI)		Not Area of Interests (NAOI)			
	Time (sec)	%	Time (sec)	%		
P01	24,51	57,84	17,87	42,16		42,38
P02	77,22	43,49	100,35	56,51		177,57
P03	73,03	64,19	40,75	35,81		113,78
P04	106,2	70,35	44,78	29,65		151,02
P05	14,91	50,43	14,66	49,57		29,57
P06	51,08	66,31	25,95	33,69		77,03
P07	66,4	65,63	34,77	34,37		101,17
P08	62,98	69,84	27,19	30,16		90,17
P09	12,86	28,72	31,92	71,28		44,78
P10	10	27,01	27,02	72,99		37,02

The graphs below show total fixation count and fixation duration percentages of the participants classified as AOIs and NAOIs.
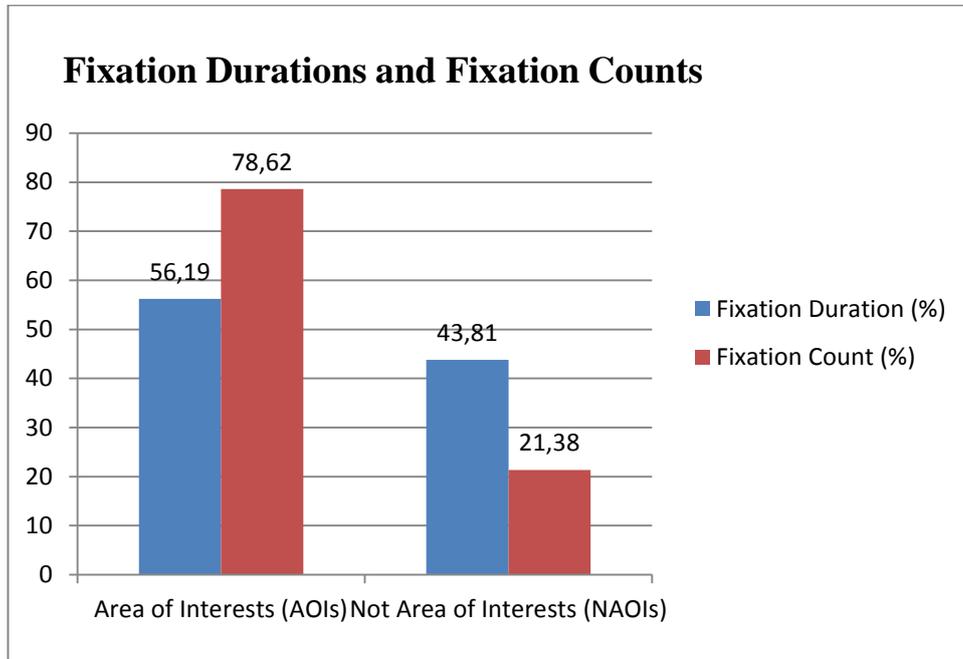
Figure 4.47 Overall Fixation Durations and Fixation Counts Percentages of Task5

It can be seen from both Figure 4.47 and Figure 4.48 that the participants mostly focused on relevant objects compared to irrelevant sections. One reason of this might be that they learned how to add a drug or a diagnosis to patient prescription information from previous tasks. When Figure 4.48 is examined, it can be clearly seen that 'Reçete' (Prescription Section), 'Tanı – İlaç Listesi' (Diagnosis and Drug list), 'Sık Kullanılan İlaçlar' (Most Frequently Used Drugs), 'Reçete İlaçları' (Prescription Drugs) and 'Hasta Geçmiş İlaçlar' (Patient Drug History) were mostly fixated AOIs for Task 5. One remarkable point can be seen from Figure 4.48 that 'Reçete İlaçları' (Prescription Drugs) has greater fixation countpercentage than fixation durations. This shows that participants made short eye visits in this section instead of looking at each fixating for a long time.
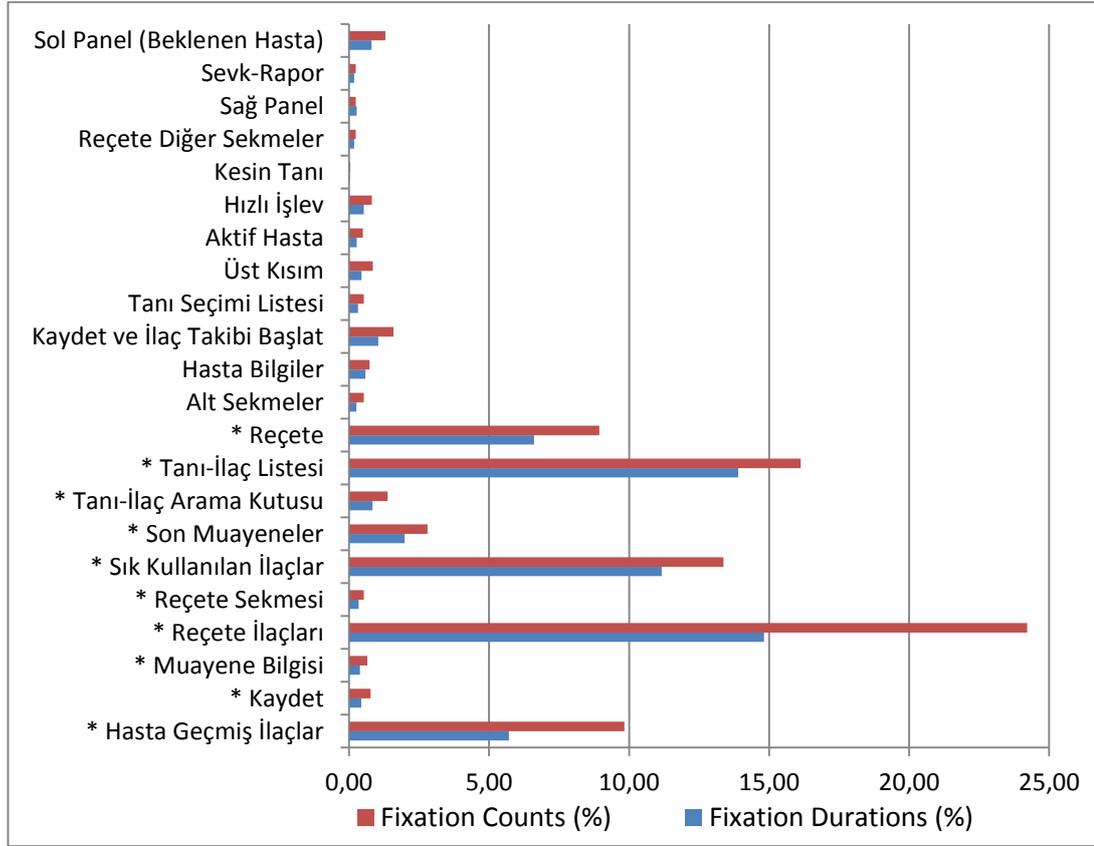
Figure 4.48 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task5

In Figure 4.48, AOIs were indicated with an asterisk symbol (*) to distinguish them from Not Areas of Interest (NAOIs).

4.5.5.5. Think-Aloud

"*hastanın ismine tıkladım ama yeni bir sayfa gelmedi, yeni bir sayfa gelmesini bekledim*" (Poliklinik defteri)
"*Although I clicked on the patient's name, a new page did not open. I waited for a new page to appear*" (polyclinic section)

"*Poliklinik defterini rastgele açtım*"
"*I opened polyclinic screen randomly*"

"Değiştirme ile ilgili birşey yok, En kolayı bir ilaç bulup silip yeniden eklemem gibi ama, sanırım değiştirme biryerden yapılıyor olmalı."

"There's no indication in relation to change. The easiest way is to choose a medicine, erase it and add again. However, I think the change must be done from somewhere else."

"Seçili kaydı diyor ama seçili olduğunu nerden anlayacağım? Şurda mavi birşey var ama, oynatılabiliyormuş birde"

"It says selected record but how am I supposed to know it is selected. There is something blue which is movable as well" Meaning of Labels – Problem

"şimdi şu lansoru silelim yada değiştirme var mı, yok o yüzden önce siliyorum"

"Now, let's erase this 'Lansor'. Can we make a change? No, So I'm erasing it first"

"çıkıyorum, çok kalabalık ya gerçekten"

"I'm leaving this page. It's too crowded indeed" Layout/Screen Organization - Problem

"az önce burda ilaç ekleme diye bir buton vardı şimdi o kayboldu"

"There was an 'add a medicine' icon but it has disappeared now."

"bir şekilde eklemem lazım, sağ tıklıyorum tamam buldum 'yeni ekle' "

"I must add it somehow, I'm right clicking. I've found it 'add new' "

4.5.6. Task 6: Giving prescription to a patient

4.5.6.1. Completion Time

The Ideal completion time for Task 6 was estimated as 2,54 using the cog-Tool program. The graph below (Figure 4.49) shows all the participants' Task 6 completion times.
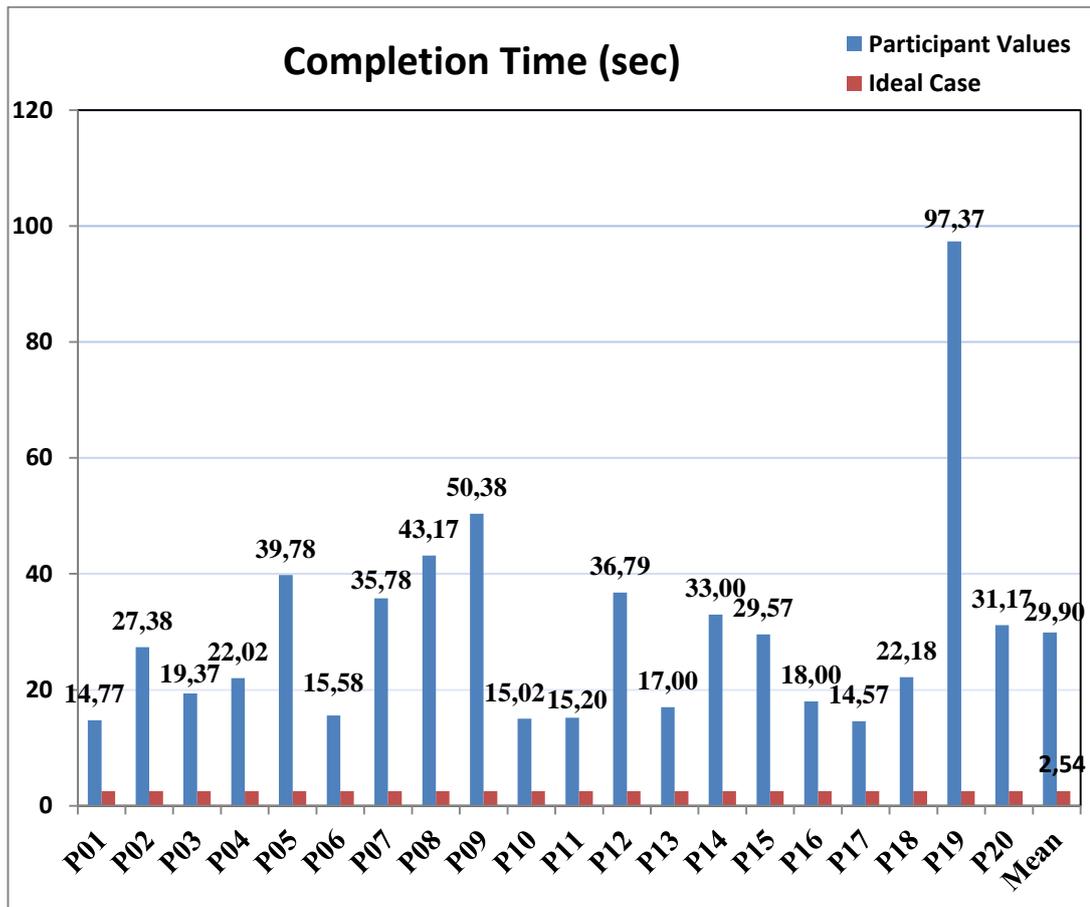
Figure 4.49 Task6 – Completion Time Graph

4.5.6.2. Mouse Clicks

The ideal mouse click count for Task 6 was estimated as 1 since task 6 was completed with one click on the relevant page. The graph below (Figure 4.50) shows the result of all the participants' mouse click values.

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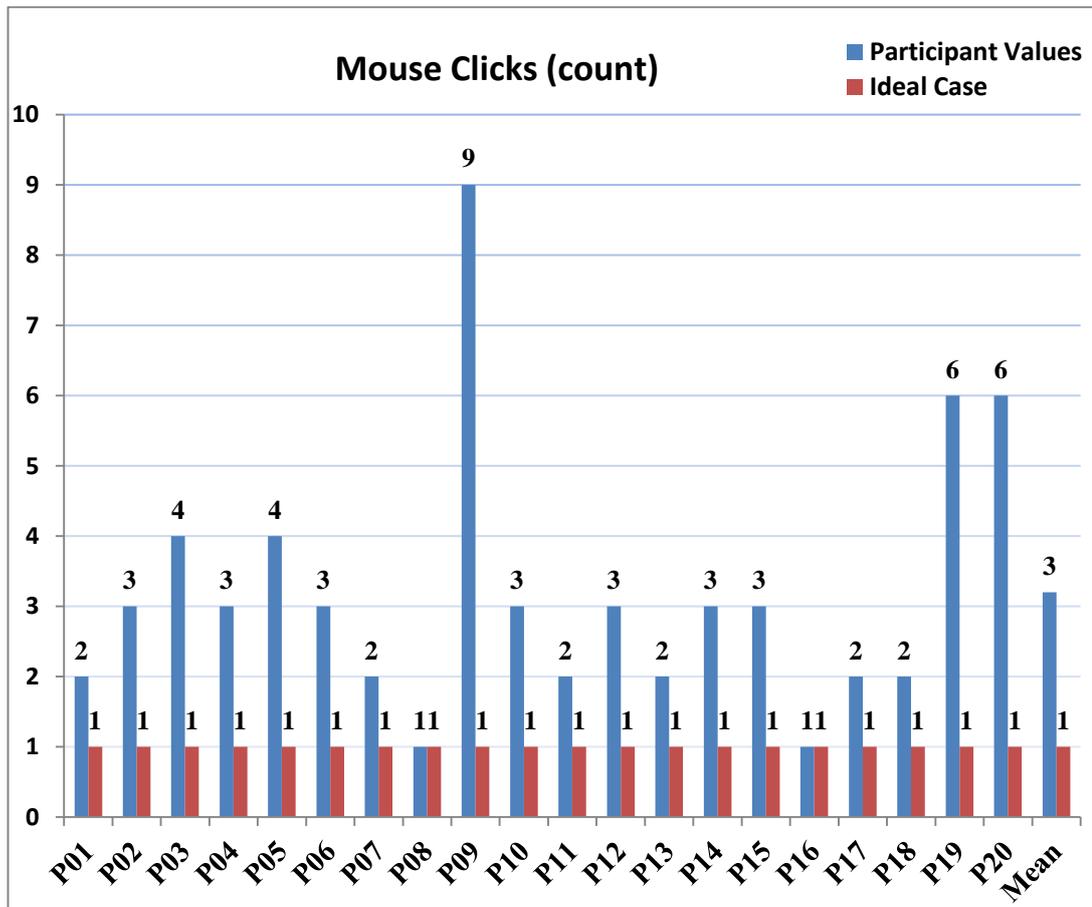
Figure 4.50 Task6 – Mouse Clicks Graph

4.5.6.3. Areas of Interest

Areas of Interest (AOIs) were defined for Task 4 in order to analyze fixation statistics illustrated in Figure 4.51. In Figure 4.50, there are only two AOIs since particiapnts needed to click on one of these AOIs to complete the task. These AOIs were defined as green boxes as seen in the figure and named 'üst reçete yazdır' (Print Out Prescription Button located on upper side) and 'alt reçete yazdır' (print out prescription button located on the bottom). One other AOI that was not shown in Figure 4.50 due to being located on the 'Poliklinik Defteri' (Polyclinic Book) screen was the 'Poliklinik – Reçete Yazdır' (Print Out Prescription Button on Polyclinik Book Screen) button. The blue boxes show the irrelavant sections of Task 5 on Figure 4.51. These NAOIs were, namely 'Muayene Bilgisi' (Examination Information), 'Tanı Seçimi Sekmesi'

(Diagnosis Selection Tab), 'Kaydet' (Save), 'Reçete İlaçları' (Prescription Section), 'Hasta Geçmiş İlaçlar' (Drug History of Patient), 'Son Muayeneler' (Last Examination), 'Sık Kullanılan İlaçlar' (Most frequently used drugs), 'Tanı - İlaç Listesi' (diagnosis and drug list) , 'Reçete Sekmesi' (Prescription Tab), 'Tanı – İlaç Arama Kutusu' (Diagnosis and Drug Search box), 'Üst Kısım' (upper side), 'Hasta Bilgiler' (Patient Information) and 'Alt Sekmeler' (Bottom Tabs).
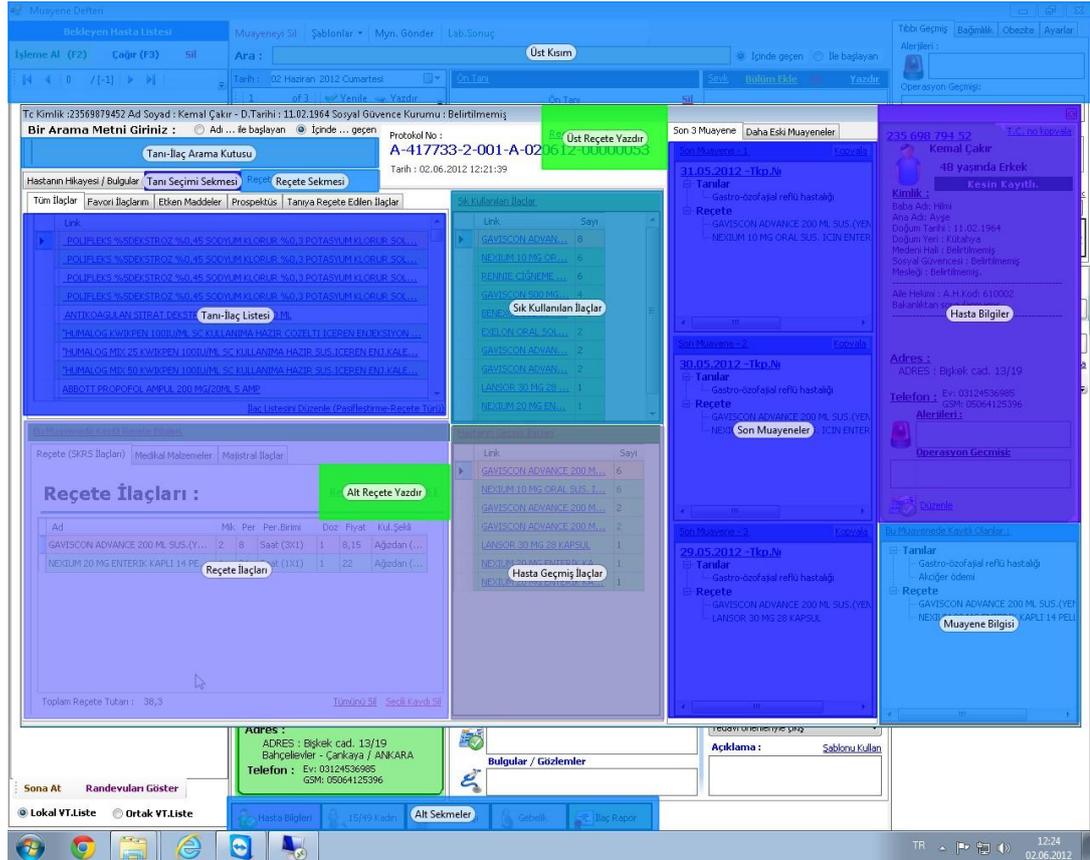
Figure 4.51 Areas of Interest for Task6

4.5.6.4. Fixation Duration and Fixation Count Statistics

Table 4.10 Task6 – Fixation Durations

Participant	Fixation Durations (sec)					
	Area of Interests (AOI)		Not Area of Interests (NAOI)		Total Time (sec)	
	Time (sec)	%	Time (sec)	%		
P01	2,66	18,01	8,74	59,19	**14,77**	
P02	0,62	2,26	23,39	85,44	**27,38**	
P03	0,37	1,91	15,63	80,71	**19,37**	

Table 4.10 (cont.)

P04	2,69	12,22	15,96	72,49	**22,02**
P05	7,71	19,38	28,70	72,15	**39,78**
P06	2,51	16,11	9,70	62,27	**15,58**
P07	5,36	14,98	27,05	75,61	**35,78**
P08	6,15	14,25	33,66	77,96	**43,17**
P09	0,08	0,16	46,93	93,16	**50,38**
P10	3,36	22,37	8,29	55,22	**15,02**

The graphs below show the total fixation count and fixation duration percentages of the participants classified as AOIs and NAOIs.
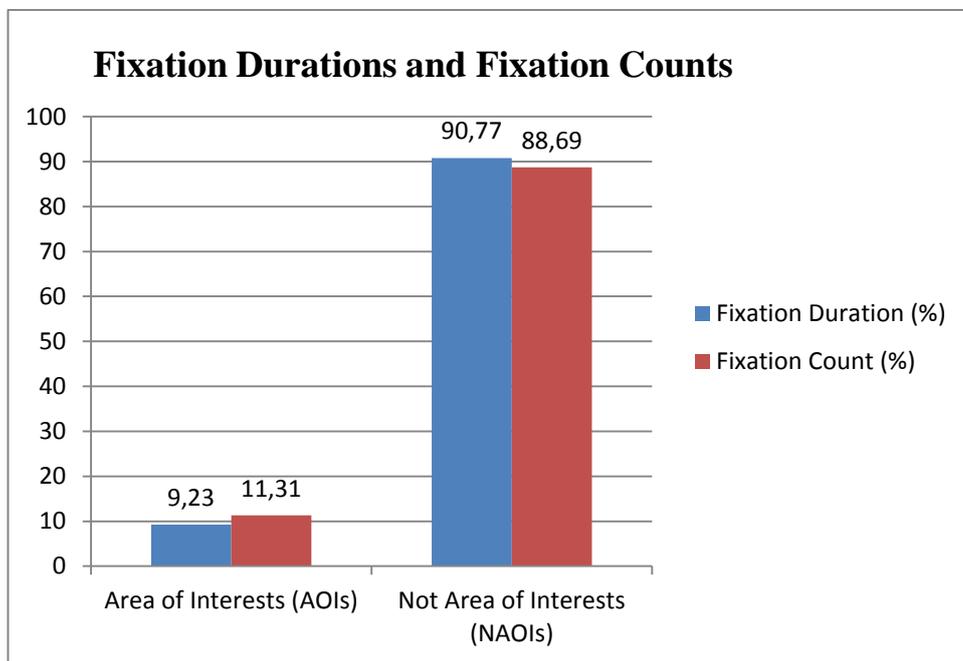
Figure 4.52 Overall Fixation Durations and Fixation Counts Percentages of Task6

When Figure 4.52 is examined, it can be stated that participants mostly focused on irrelevant objects with a great proportion (approximately 90%). One of the reasons is that participants searched on the screen where they printed out prescriptions and when they found the correct button (print out prescription button) they clicked on it immediately without fixating on it much. Hence, the AOIs proportion resulted in a lower value with respect to fixation durations and fixation counts. To gain further insight into this situation, Figure 4.69 illustrating the heat maps gaze plot section can examined more closely. Figure 4.53 shows the fixated objects in detail. 'Reçete

İlaçları' (Prescription Drugs) has a great proportion of fixation counts and durations when compared to the others. This might have resulted from the mentioned 'Reçete Yazdır' (Print-out prescription) button located near the 'reçete ilaçları' section.
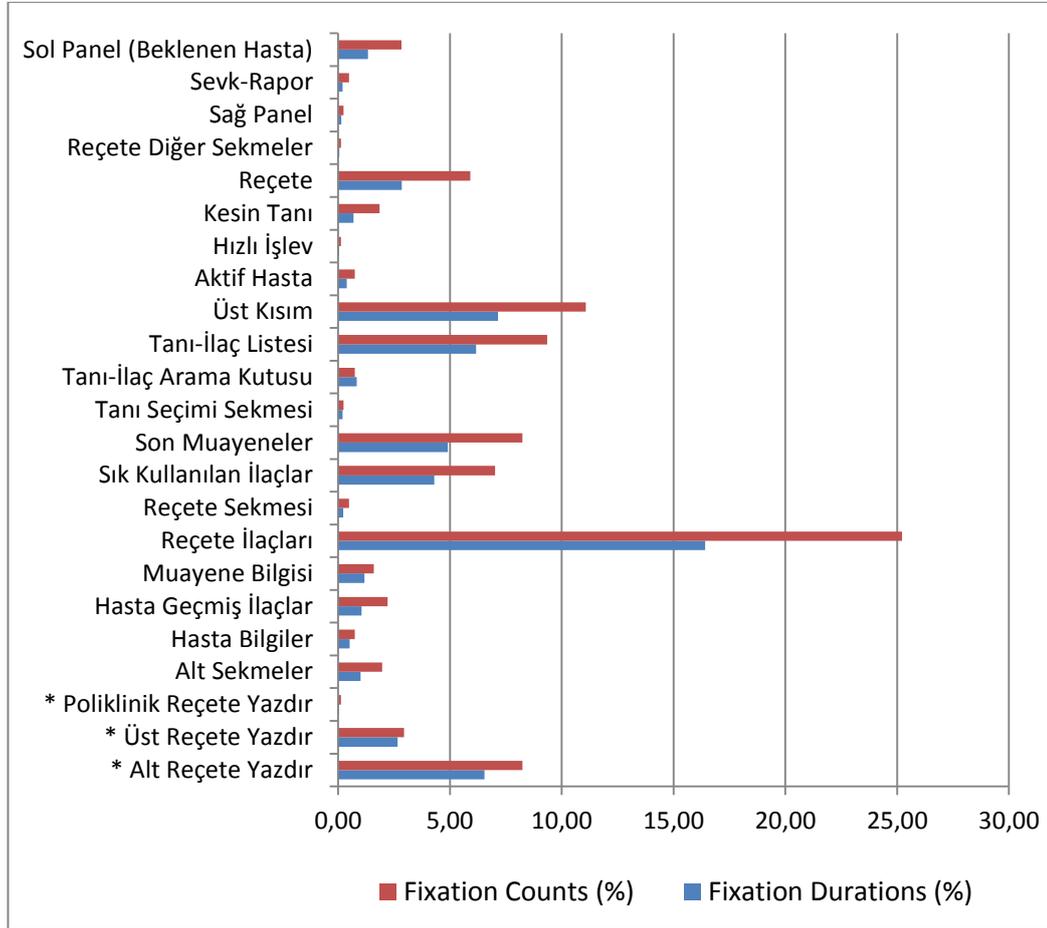
Figure 4.53 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task6

In Figure 4.53, AOIs were indicated with an asterisk symbol (*) to distinguish them from Not Areas of Interest (NAOIs).

4.5.6.5. Think-Aloud

"tıkladım, yalnız aralarda yaptığı şeye dair birşeyler söylerse iyi olur. Tıkladım mı tıklamadım mı bilmiyorum şu an"

"I've clicked. However, it will be good if it informs about the performance. I don't know whether I've clicked or not now" Lack of Indication of System Status – Problem

4.5.7. Task 7: Giving medical report to a patient.

4.5.7.1. Completion Time

The ideal completion time of task 7 was calculated as 14,11 seconds. The graph below (Figure 4.54) shows the participants' completion time of Task 7. Participants indicated with a symbol of '*' could not complete Task 7 and pass on to the next task.
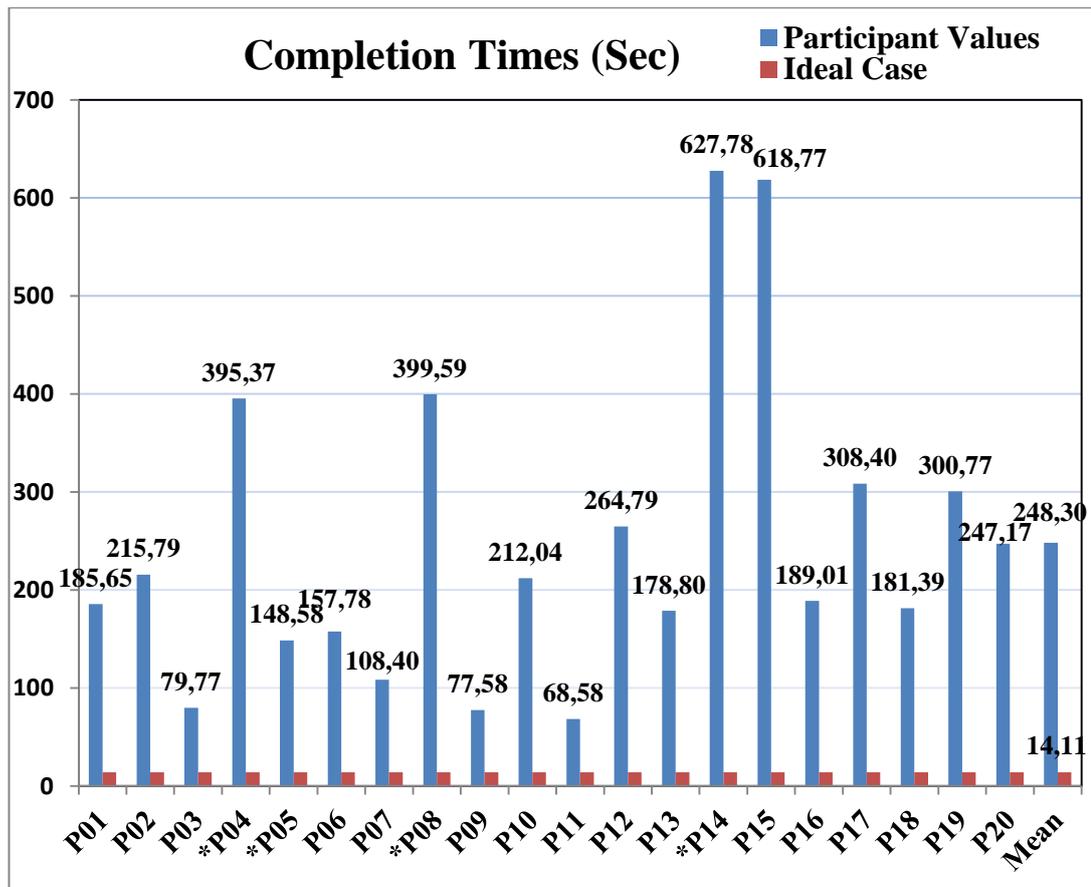
Figure 4.54 Task7 – Completion Time Graph

4.5.7.2. Mouse Clicks

For task 7 the ideal mouse click count was estimated as 9, and the graph below (Figure 4.55) shows the participants' count of mouse clicks.
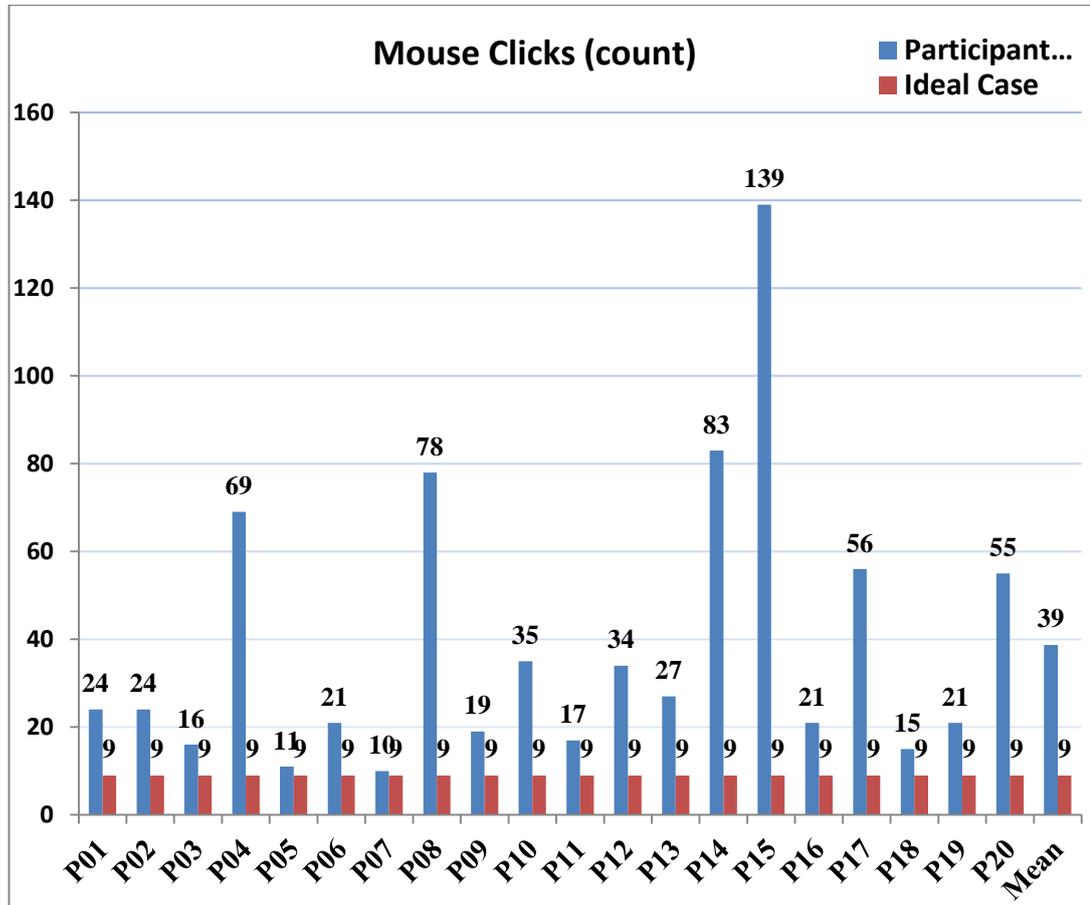
Figure 4.55 Task7 – Mouse Clicks Graph

4.5.7.3. Areas of Interest

Areas of Interest (AOIs) were defined for Task 4 in order to analyze fixation statistics illustrated in Figure 4.56. In Figure 4.56, the AOIs were the blue boxes named 'Raporlar-İstirahat Raporu' (Reports – Medical Report) and 'Hızlı İşlev – İstirahat Raporu' (Quck lunch – Medical Report), the green box named 'Kesin Tanı' (Certain Diagnosis) and 'Hasta İşlem Sırası' (Patients Queue), the orange box named 'Hızlı İşlev' (Quick Lunch), the turquoise box named Reçete (Prescription) and the

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purple box named 'Poliklinik Defterinde Arama' (Search in Polyclinic Book). The remaining different colored boxes were irrelavant objects for Task 7 and were named as 'Sağ Panel' (Right panel), 'Aktif Hasta' (Active Patient), 'Sol Panel – Beklenen Hasta' (Left Panel – Waited Patients), 'Sevk-Rapor' (Dispatch-Report), 'Reçete Diğer Sekmeler' (Prescription Tabs), 'Alt Sekmeler' (Bottom tabs), 'Ön Tanı' (Pre-Diagnosis), and 'İlaç Rapor' (Drug Report).
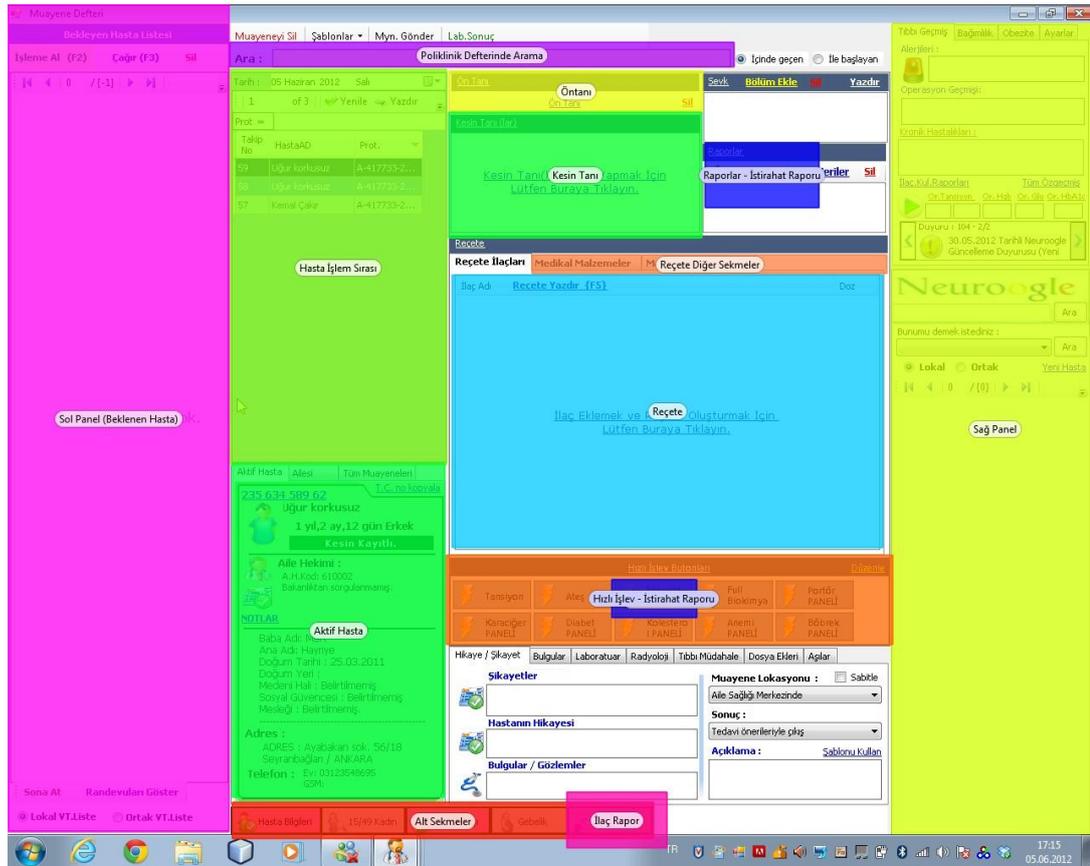
Figure 4.56 Areas of Interest for Task7

4.5.7.4. Fixation Duration and Fixation Count Statistics

Table 4.11 Task7 – Fixation Durations

Participant	Fixation Durations (sec)				Total Time (sec)
	Area of Interests (AOI)		Not Area of Interests (NAOI)		
	Time (sec)	%	Time (sec)	%	
P01	73,83	39,77	111,82	60,23	**185,65**
P02	83,01	38,47	132,78	61,53	**215,79**
P03	34,6	43,38	45,17	56,62	**79,77**
P04	151,6	38,33	243,81	61,67	**395,37**

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Table 4.11 (cont)

P05	52,08	35,05	96,50	64,95	**148,58**
P06	63,28	40,11	94,50	59,89	**157,78**
P07	55,05	50,79	53,35	49,21	**108,40**
P08	4,28	1,07	395,31	98,93	**399,59**
P09	8,91	11,49	68,67	88,51	**77,58**
P10	43,08	20,32	168,96	79,68	**212,04**

The graphs below show total fixation count and fixation duration percentages of the participants classified as AOIs and NAOIs.
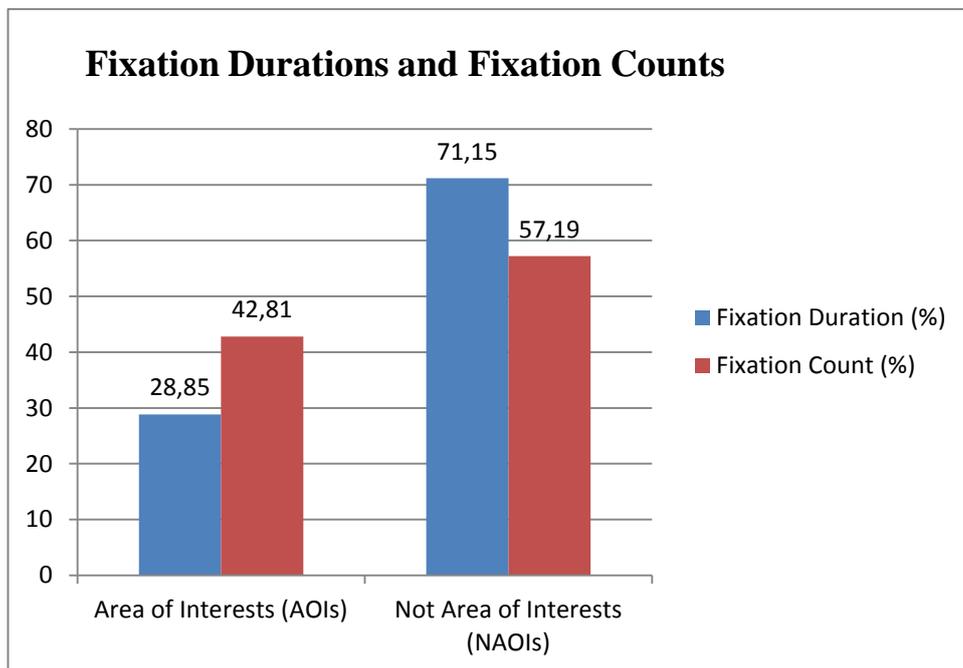
Figure 4.57 Overall Fixation Durations and Fixation Counts Percentages of Task7

As seen in Figure 4.57, participants tended to search related parts of Task 7 and as a result of this they mostly fixated on irrelevant objects. This situation caused great proportion of fixation durations and fixation counts on irrelevant objects (NAOIs). When Figure 4.58 is examined, detailed information on AOIs and NAOIs can be obtained. In this figure, AOIs seem to have great proportion of fixation durations and fixation counts in total, but this graph shows only some irrelevant objects since not all irrelevant objects can be defined. When AOIs are examined it can be stated that 'Tanı – İlaç Listesi' (Diagnosis and Drug List), 'Reçete' (Prescription), 'Sık Kullanılan Tanılar' (Most Frequently used Diagnoses) and 'Hasta İşlem Sırası'

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(Patients Queue) are the mostly focused sections among the AOIs. The reason for this great proportion of AOIs is that participants should have diagnosed a patient first in order to give a medical report. 'Üst Kısım' (Upper side of the screen) is the mostly focused irrelevant object among NAOIs.
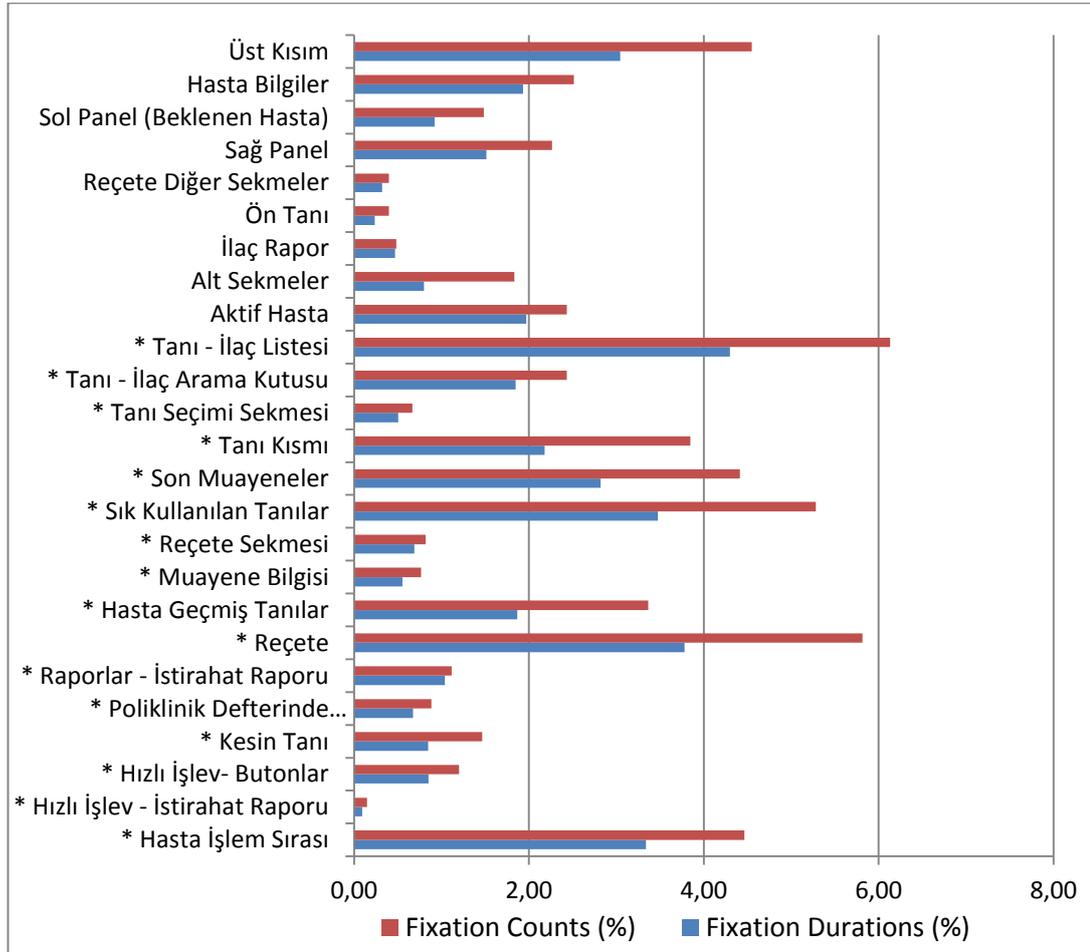

Figure 4.58 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task7

In Figure 4.58, AOIs were indicated with an asterisk symbol (*) to distinguish them from Not Areas of Interest (NAOIs).

4.5.7.5. Think-Aloud

"*Bu tip şeylere eklenmiştir diye eklediği yerde uyarı mesajı çıkması faydalı olur*"

"It'll be useful if a warning message appears indicating the added item at the mentioned spot"

"Rapor süresi kısmında 3 gün mü 3 hafta mı bu bilinmiyor. Günden başka birşey girilmiyorsa bile veri alanı kısaltılıp yanına gün yazılırsa anlamlı olur"

"At the report duration field it isn't clear if it's 3 days or 3 weeks. Even if the data other than the date can not be entered, it will be sensible to shorten the data field and write the date next to it" Meaning of Labels – Problem

"Birde bu işlemi yaptıktan sonra 'Emin misiniz?' gibi bir uyarı mesajı faydalı olur. İptal etmeden önce veya onaylamadan önce 'onaylamak istediğinizden emin misiniz ?' gibi"

*"Moreover, following this operation, it will be usaeful if a warning message saying 'are you sure' appears prior to cancelling or confirming."*Error Prevention - Problem

"heryer tıklanabiliyormuş burda, biraz garip oluyor"

"It's quite strange that every field is clickable" Layout/Screen Organization - Problem

"burdan çıkmadan arayabiliyor muyum, merak ettim şu anda. Hastayı buldum ve ekledim. En azından buradan çıkmam gerekmiyormuş onu öğrendim"

"Can I search without leaving the page? I've found and added the patient. At least I've learnt that I don't have to leave this page."

"bu nedir? Bu niye açıldı peki? Daha ön tanıya tıklamamıştım" (otomatik açılan tanı ekranı)

"What's this? Why did it open? I hadn't clicked on the 'pre-diagnosis' yet." (Automatically opening diagnosis screen)

"ben ne yapacağımı bilmiyorum şu anda, gerçekten bilmiyorum"

"I don't know what to do at the moment, I really don't." Overall Ease of Use - Problem

"bu pencerede mi bulmalıyım? Arka pencerede mi? Gidemiyorum arka pencereye bu varken" "aaa çok korkuyorum"

"Do I have to find it in this window or at the inactive window? I can't go to the inactive window when this is here. I'm scared" Navigation - Problem

"reçete, hayır burası da değil"
"Prescription, No, not here either"

"bilmiyorum, bulamıyorum."
"I don't know, I can't find."

"bu resimler çok hareketli gözümü yoruyor, mouse'u yaklaştırınca çok oynuyorlar"
"These pictures are too dynamic, they irritate me. They move a lot when I draw the mouse closer" Graphics – Problem

"ekledimi acaba, tekrar basıyorum. Hımm zaten kayıtlı tanı diye mesaj geldi"
"I wonder if it has added. I click again. 'Already recorded diagnosis' opened'"

"kendimin ne yapıp yapmadığından emin olamadım, bunlar daha önce var mıydı yok muydu diye?"
"I wasn't sure about what I did or didn't do, whether they were here or not." Lack of Indication of System Status - Problem

"kapat ve tamam butonlarının yerleri ters karıştırdım"
"Close and ok buttons are misplaced, so I got confused" Layout/Screen Organization – Problem

4.5.8. Task 8 : Giving appointment to a patient

4.5.8.1. Completion Time

The ideal completion time for task 8 was 26,93, and the graph below shows the results of all the participants' completion time for Task 8. The participants stated with a '*' mark means that participants could not complete Task 8 and pass on to the next task.
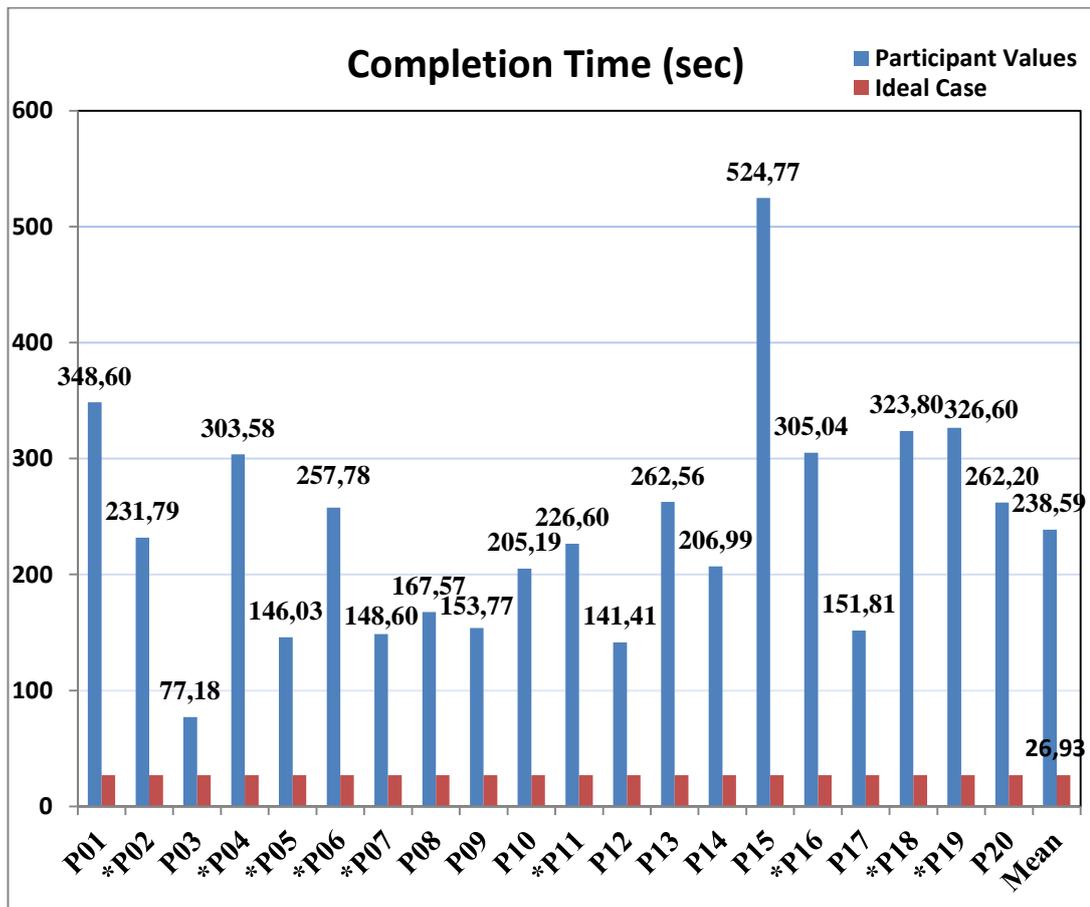
Figure 4.59 Task8 – Completion Time Graph

4.5.8.2. Mouse Clicks

The ideal mouse click count estimated during the modeling of task was 15, and all the participants' mouse click counts are illustrated in the graph below:
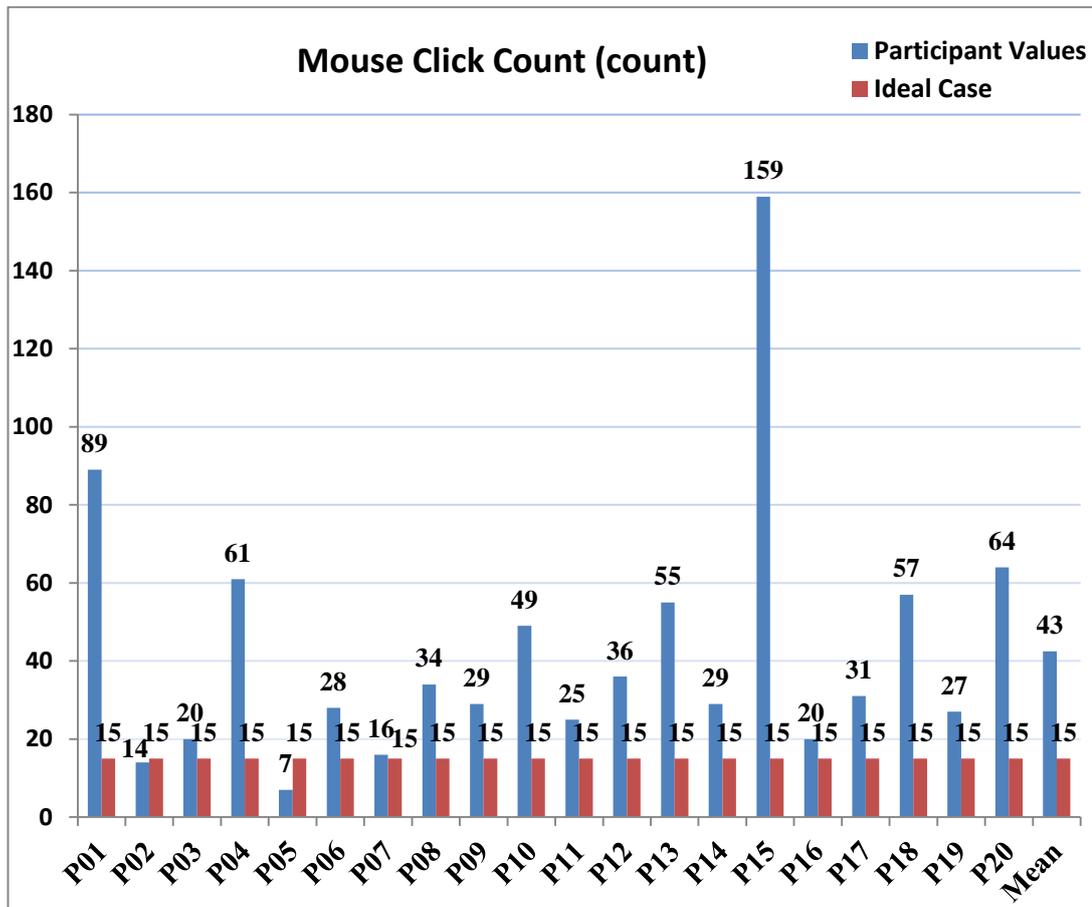
Figure 4.60 Task8 – Mouse Clicks Graph

It is seen on the graph above that some participants (P02 and P05) made less mouse click from an ideal case. This is result of their not completing task.

4.5.8.3. Areas of Interest

Areas of Interest (AOIs) were defined for task 4 in order to analyze fixation statistics illustrated in Figure 4.61. This figure shows only the appointment screen of task 8 and contains mostly AOIs. These AOIs were defined as the green boxes named 'Arama' (search) and 'Geçmiş Randevular' (Past Appointments), the blue box named 'randevu tarihi' (appointment date), the turquoise boxes named 'Bugün' (today) and 'ilgili kişi' (related person), the pink boxes named 'Randevu Türü' (Appointment Type) and 'randevu saati' (appointment time), the red box named 'yeni randevu – randevu türü'

(appointmentt type on new appointment screen), the purple box named 'Tarih' (date) and the yellow boxes named 'yeni randevu' (new appointment) and 'Randevu Kaydet' (save appointment). The irrelavant objects were defined on the other screens, which are the main screen and the polyclinic book screen included in the fixation anlaysis.
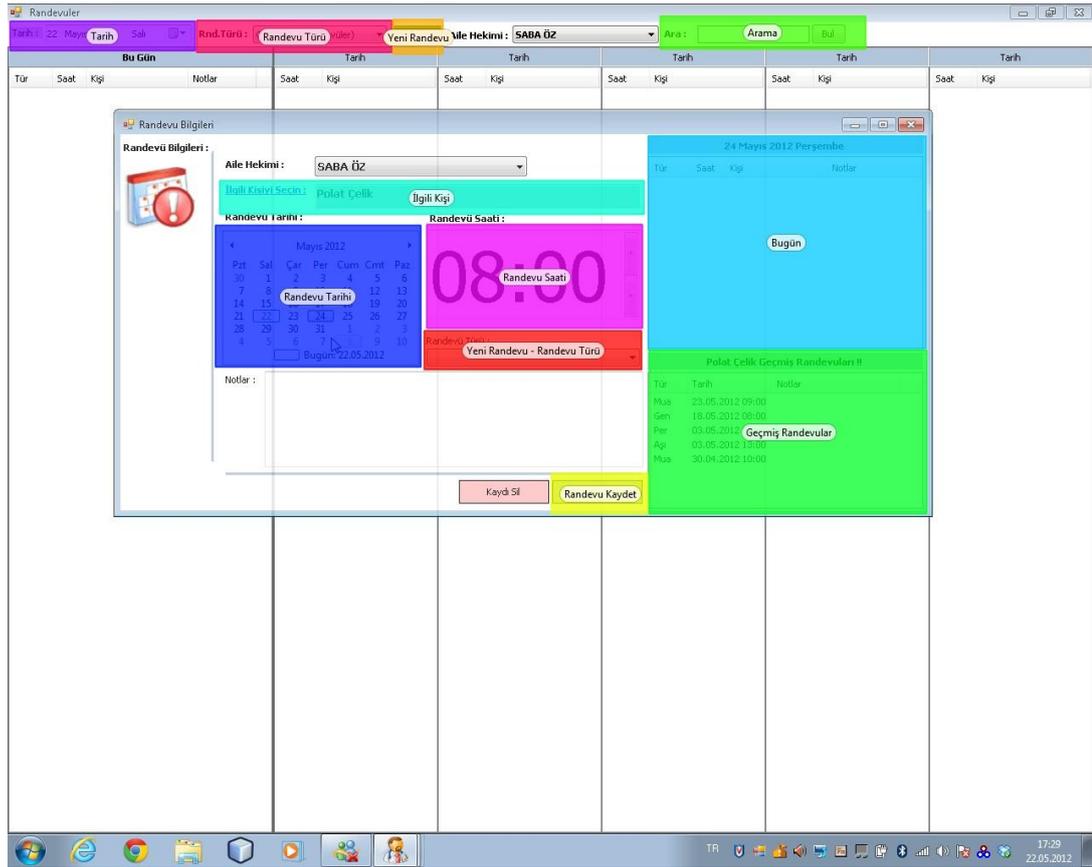
Figure 4.61 Areas of Interest for Task8

4.5.8.4. Fixation Duration and Fixation Count Statistics

Table 4.12 Task8 – Fixation Durations

Participant	Fixation Durations (sec)				
	Area of Interests (AOI)		Not Area of Interests (NAOI)		Total Time (sec)
	Time (sec)	%	Time (sec)	%	
P01	33,7	9,67	314,90	90,33	**348,60**
P02	0	0,00	231,79	100,00	**231,79**
P03	15,84	20,52	61,34	79,48	**77,18**

Table 4.12 (cont.)

P04	0	0,00	303,58	100,00	**303,58**
P04	0	0,00	303,58	100,00	**303,58**
P05	0	0,00	146,03	100,00	**146,03**
P06	8,94	3,47	248,84	96,53	**257,78**
P07	0	0,00	148,60	100,00	**148,60**
P08	50,65	30,23	116,92	69,77	**167,57**
P09	13,85	9,01	139,92	90,99	**153,77**
P10	27,96	13,63	177,23	86,37	**205,19**

The graphs below show the total fixation count and fixation duration percentages of the participants classified as AOIs and NAOIs.
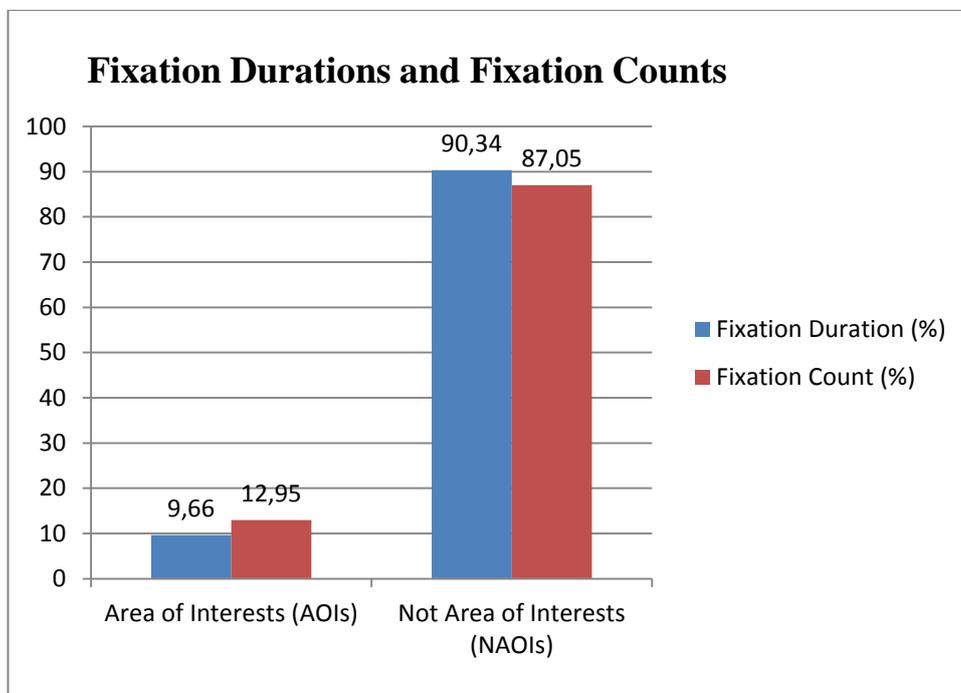
Figure 4.62 Overall Fixation Durations and Fixation Counts Percentages of Task8

Figure 4.62 shows that irrelevant objects have received more fixations by participants with a great proportion (approximately %90). Figure 4.63 verifies this situation with detailed analysis results. As seen in Figure 4.63, AOIs (marked as *) have lower proportions compared to NAOIs. The most significant reason for this is that half of the participants (5 over 10) could not complete this task; hence, only 5 participants could reach the appointment screen. Among the AOIs, 'Randevu Tarihi' (Appointment Date), 'Arama Sonucu' (Search Results) and 'Arama kutusu' (Search

box) have great proportions. When the irrelevant sections are examined, it can be seen that 'hasta işlem sırası' (Patients queue) has great proportion compared to other irrelevant objects. The reason for this is that the participants were not sure if a patient was added to the patient queue since the system did not give any information message that stated whether a patient was added to the queue. They had to check out the patient queue to be sure if a patient was added and as a result of this, AOI defined for patient queue section received more fixations.
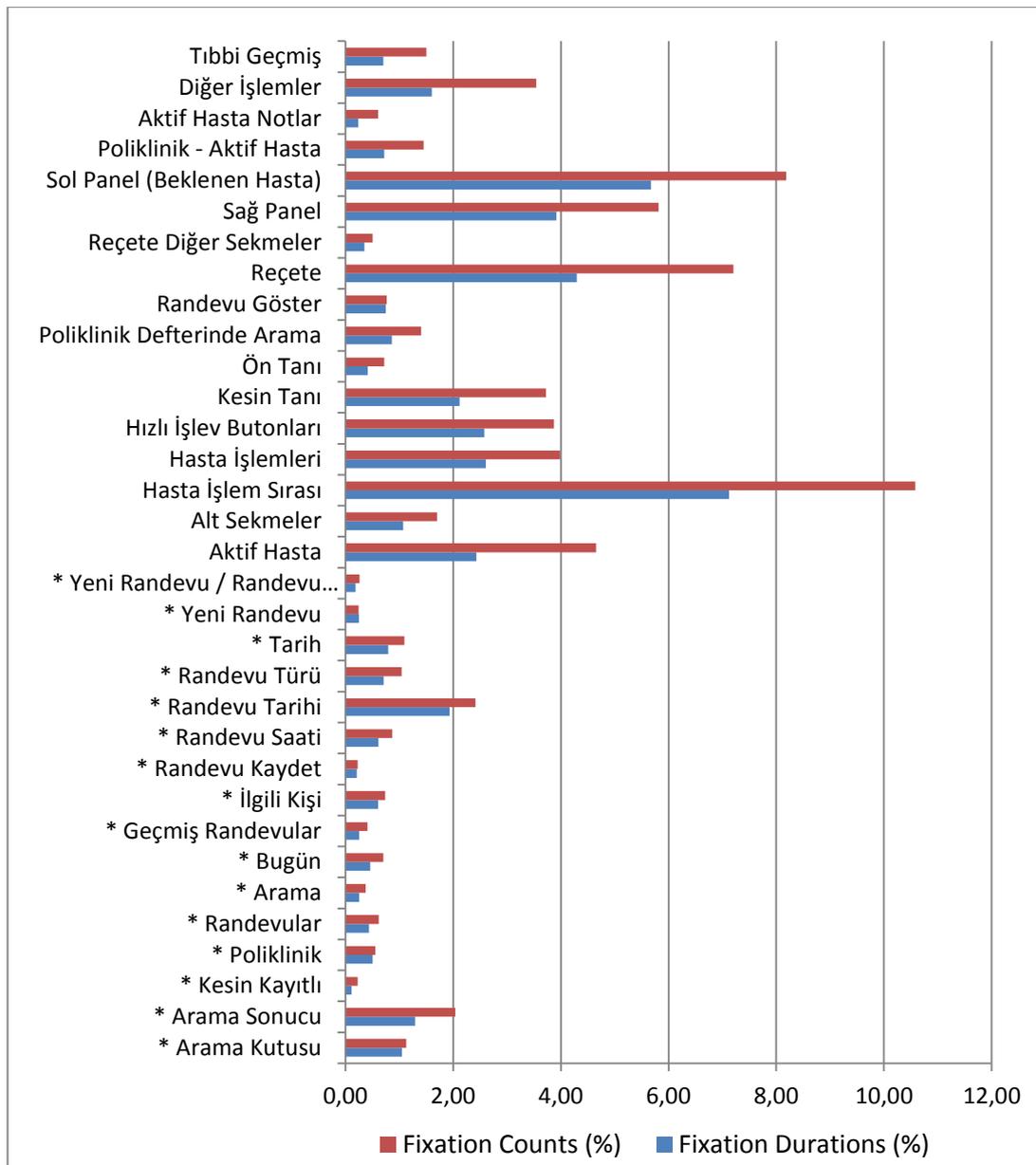
Figure 4.63 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task8

In Figure 4.63, AOIs were indicated with an asterisk symbol (*) to distinguish them from Not Areas of Interest (NOIs).

4.5.8.5. Think-Aloud

"Şurda alakasız bir yerde 'Randevu göster' butonu var."
"There is a 'show appointment' button at an irrelevant place"

"Randevusu yokmuş. Randevuları işlem kuyruğuna at ne demek bilmiyorum."
"He/she doesn't have an appointment. I don't know what 'move the appointments to the operation queue' means" Meaning of Labels – Problem

"Aile hekiminin işlem kuyruğuna atacak ama başka bir yerden olacağını zannetmediğim için tamam diyeceğim ama yanlış birşeyde yapıyor olabilirim"
"It will be move family physician to operation queue. Assuming that is not done elsewhere. I'll confirm but I might be doing something wrong."

"Yaptıktan sonra pencereyi kapatsa mantıklı olabilir"
"It may be sensible if it closes the window after it's done. "

"yeni kelimesi yerine yeni randevu veya randevu ver şeklinde buton konursa daha anlamlı olabilir"
"It'll make more sense if the word 'new' is replaced by 'new appointment' or 'make an appointment'." Meaning of Labels – Problem

"rendevu türüde var, mutlaka seçilmesi gereken yerler işaretli olmalı. İlgili kişiyi seçmek gerektiğini düşündüm ama seçemedim"
"There is also 'appointment type'. The mandatory fields should be marked. I thought it was necessary to select the relevant person but couldn't."

"Mesela bu alanın içerisine yazı yazamıyorum ama imleci içine koyabiliyorum. Eğer herhangi birşey yapamıyorsam seçilemiyor olması lazım. Başka birşey istemediğini tahmin ederek 'kaydet' butonuna tıklıyorum ama hastayı seçmem gerektiğine dair uyarı mesajı aldım. Hastayı seçmem gerekiyor"

"For instance, I can't write inside this field but I can place the cursor. Provided that I can't do anything, it shouldn't be selected. Assuming that it doesn't ask for anything more, I click the 'record' button but received a warning message saying that I should select the patient."

"Yine tamam butonuna bastıktan sonra eklenmiştir, yapılmıştır gibi bir mesaj çıkması anlamlı aslında, ama zaten anladığım kadarıyla eklenmemişte"
"Also, it is sensible to receive a 'done' message after clicking the 'ok' button. However, as far as I understand, it was not added" Lack of Indication of System Status - Problem

"bu hastanın randevusu var mı nerden bakacağız?"
"How are we supposed to find out if the patient has an appointment or not."

"randevu kaydet var ama randevuyu nerden sorgulayacağız anlayamadım"
"There is 'record appointment but I don't understand how we're supposed to search about the appointment.'"

"hasta detaylarına baksam bulabilir miyim acaba? Yok bulamadım"
"Can I find if I go through patient details? No. I couldn't find."

"randevu vermem için ne yapacağım acaba?"
"What am I supposed to do to give an appointment?"

"bu sayfa açılmak zorunda mı? Açılmasın bence" (otomatik açılan tanı ekranı)
"Does this page have to open? In my opinion it should not open" (automatically opening diagnosis screen)

"tüm muayenelerin altında randevu olur mu diye düşündüm ama yokmuş"
"I wondered if there would be 'appointment' under each examination but there isn't"

4.5.9. Task 9: Checking the medical history of a patient.

4.5.9.1. Completion Time

The ideal completion time for Task 9 was calculated as 25,28 and the graph below (Figure 4.64) shows the results of all the participants:
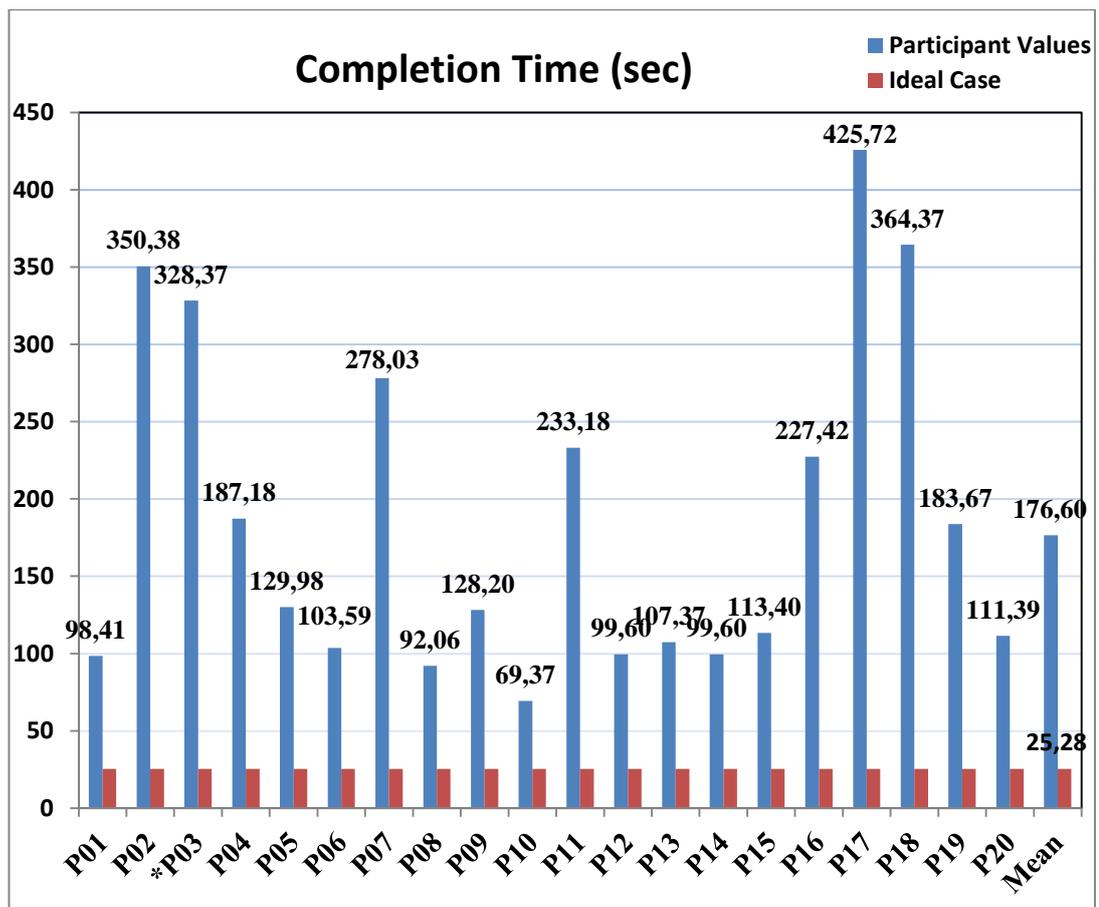
Figure 4.64 Task9 – Completion Time Graph

The participants marked with a '*' symbol (P03) means that participants could not complete Task 9.

4.5.9.2. Mouse Clicks

For an ideal case there should be 15 mouse clicks to complete Task 9. All participants' mouse click counts during the performance of Task 9 are presented in the graph below (Figure 4.65).
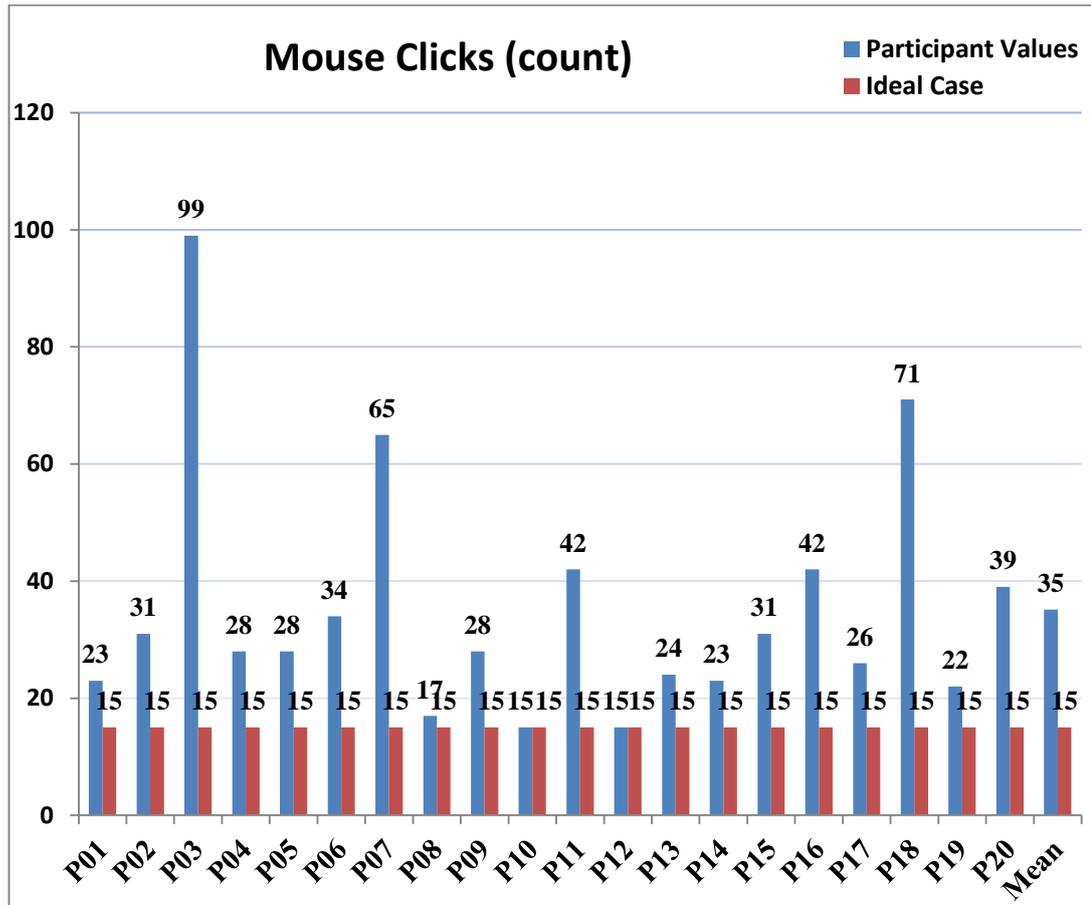
Figure 4.65 Task9 – Mouse Clicks Graph

4.5.9.3. Areas of Interest

Areas of Interest (AOIs) were defined for Task 9 in order to analyze fixation statistics illustrated in Figure 4.66. In this figure, the blue box named 'Aktif Hasta' (Active Patient) and the turquoise box named 'aktif hasta notlar' (active patient notes) were some of the irrelavant objects (NAOIS). The pink boxes named 'Obezite' (obesity) and 'tıbbi geçmiş' (medical history), the purple box named

'sigara - alkol' (cigarette – alcohol consumpiton), the orange box named 'kronik hastalıklar' (chronical diseases) and 'yeni kronik hastalık' (new chronical disease) were some of the relevant objects (AOIs).
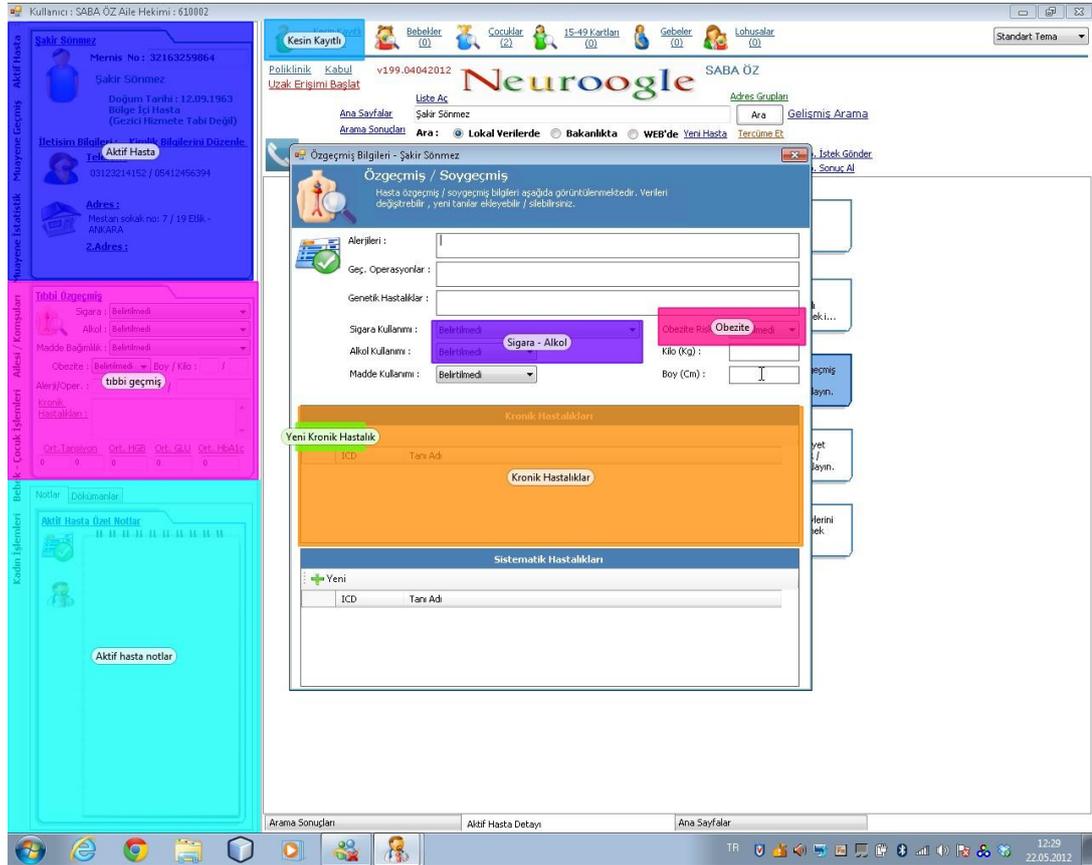
Figure 4.66 Areas of Interest for Task 9

4.5.9.4. Fixation Duration and Fixation Count Statistics

Table 4.13 Task9 – Fixation Durations

Participant	Fixation Durations (sec)				Total Time (sec)
	Area of Interests (AOI)		Not Area of Interests (NAOI)		
	Time (sec)	%	Time (sec)	%	
P01	42,08	42,76	56,33	57,24	98,41
P02	76,74	21,90	273,64	78,10	350,38
P03	79,77	24,29	248,60	75,71	328,37
P04	50,34	26,89	136,84	73,11	187,18
P05	29,39	22,61	100,59	77,39	129,98
P06	41,1	39,68	62,49	60,32	103,59

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Table 4.13 (cont.)

P07	67,17	24,16	210,86	75,84	**278,03**
P07	67,17	24,16	210,86	75,84	**278,03**
P08	47,96	52,09	44,10	47,91	**92,06**
P09	20,99	16,37	107,21	83,63	**128,20**
P10	14,12	20,35	55,25	79,65	**69,37**

The graphs below show total fixation count and fixation duration percentages of the participants classified as AOIs and NAOIs.
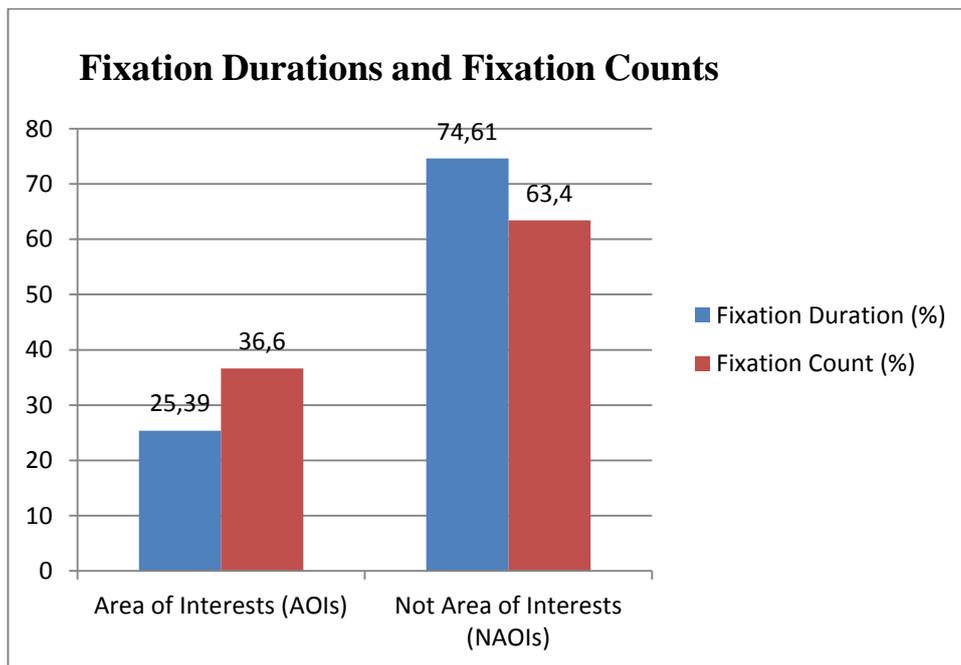
Figure 4.67 Overall Fixation Durations and Fixation Counts Percentages of Task9

Figure 4.67 shows that participants mostly focused on irrelevant objects with a great proportion (74% for fixation duration and 63% for fixation count). One of the striking points with the graph is that there is approximately 10% difference between fixation count and fixation duration. If AOIs are taken into consideration in the graph, it can be said that participants fixated on AOIs with short eye visits. This means that they fixated on relevant objects with quick eye movements rather than long glance on these objects. On the other hand, when not areas of interest (NAOIs) are observed in Figure 4.67, it can be clearly seen that participants made long stays on objects for each fixating and as a result of this, 10% difference between fixation count and fixation duration occurred. Figure 4.68 below shows the detailed analysis

of fixations. Among AOIs (represented with an asterisk '*'), great proportion of fixations fell into 'tıbbi geçmiş' (medical history) and 'kronik hastalıklar' (chronically diseases). On the other hand, great proportion of fixations fell into 'Reçete' (Prescription), 'Hasta İşlem Sırası' (Patient queue) and 'Aktif Hasta' (Active patient) among irrelevant sections (NAOIs). The reason for this is that participants mostly tried to perform this task on 'poliklinik defteri' (polyclinic book) screen rather than performing it on the main screen by searching for a patient whose medical history was checked out.
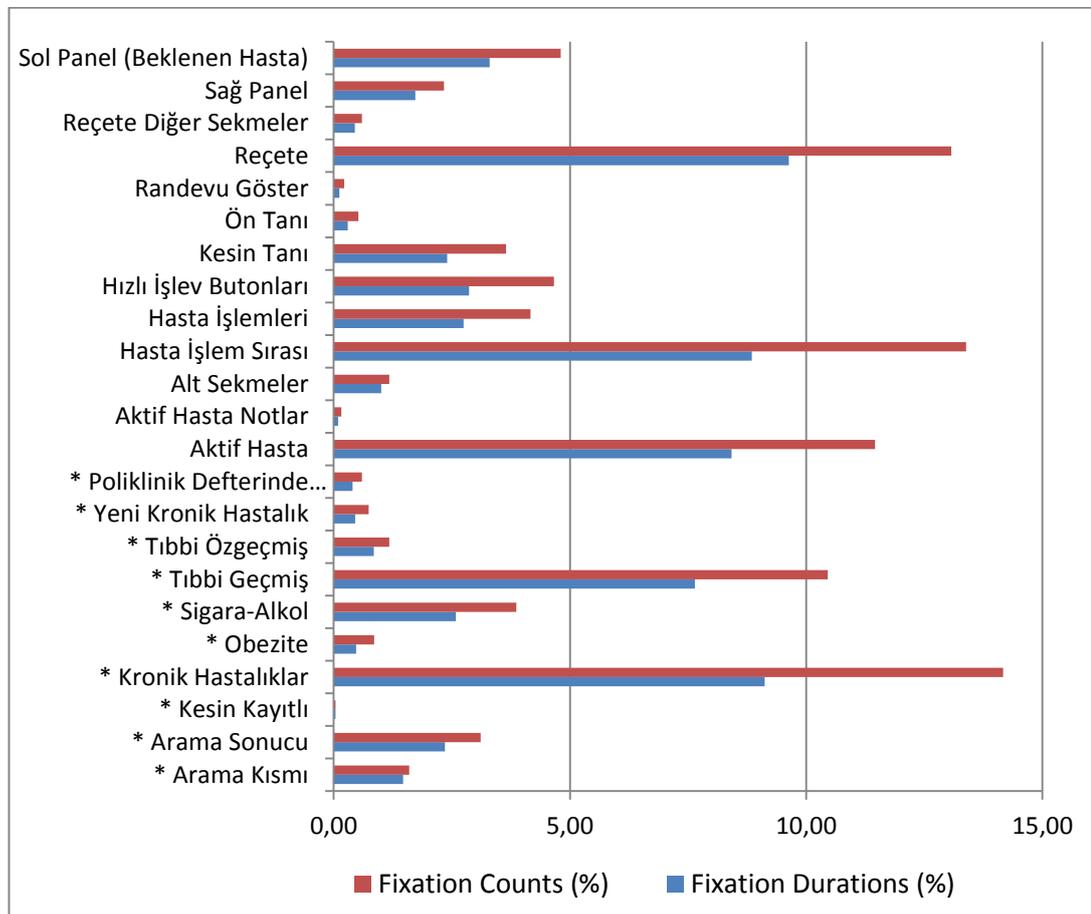
Figure 4.68 Fixation Count and Fixation Duration Percentages among AOIs and NAOIs for Task8

In Figure 4.68, AOIs were stated with an asterisk (*) symbol to distinguish them from Not Areas of Interest (NAOIs).

4.5.9.5. Think-Aloud

"Yüklemeler çok uzun zaman alıyor ve işlemin tamamlanmasını beklemem gerekiyor mu veya o sırada işlem yapabilir miyim bilgisi olmadığı için ben birşeyler yapmaya çalışıyorum ama galiba işe yaramıyor o sırada yaptığım şeyler"

"Loading takes too long and there's no indication whether I should wait for the runnşng operation to complete or start running a new one simultaneously. I'm trying to perform some operations but it doesn't seem to work." Response Time - Problem

"Aslında özgeçmiş gibi birşey olsa iyi olurmuş"
"Actually, something like a patient history would be good"

"kronik genetik hastalıkları nerden bakabiliriz?"
"Where can we find about chronic / genetic disorders?"

"boş tanılı muayene, pardon? Bu ne demek şimdi?"
*"Empty diagnosed examination, sorry? What does this mean now? "*Meaning of Labels - Problem

"gerçekten içim daraldı."
*"I'm really frusturated."*Overall Ease of Use - Problem

"şu düzenle'ye basarak herşeyini görebilirim diye düşünerek, bu sayfada açıldı madem. İlla birşey yapacağız bu sayfada. Önüme gelip duruyor"
"Thinking that I could view everything I clicked this 'organise' button and this page opened. Since it has opened, we must do something. It keeps appearing."

"tıklıyorum, bakıyorum. Özel notlar varmış, başka birşey varmı? Yokmuş, o zaman kapatıyorum bunu"
"I clicked and look. It's the 'special notes', Is there anything else? There isn't so I close it"

"iptal diyorum çıkmak için, çıkamıyorum iptal çalışmıyor" (alt ekran)
"I try cancel to leave but I can not. Cancel does not work" (lower screen)

"Tıbbı özgeçmiş tamam gördüm ama kimin tıbbi özgeçmişine bakıyorum emin değilim. Mesela şurda kimi bulacağımı bilmiyorum"

"Medical history is ok, I have sen it but I'm not sure whose medical history it is"
Meaning of Labels – Problem

4.6. Heat Maps and Gaze Plots

Heat Maps and Gaze Plots are ways of visualizing eye-tracking data. Heat maps show fixation diversity with a colored map in which the red color represents the highest fixation distribution among participants and green shows the lowest fixation distribution among participants on the screen. Gaze plots illustrate all participants' fixations on the screen by assigning a color and fixation numbers for each participant. To show heat maps and gaze plot results, two tasks (Task 1 and Task 6) were used. The results are displayed in the figures below:
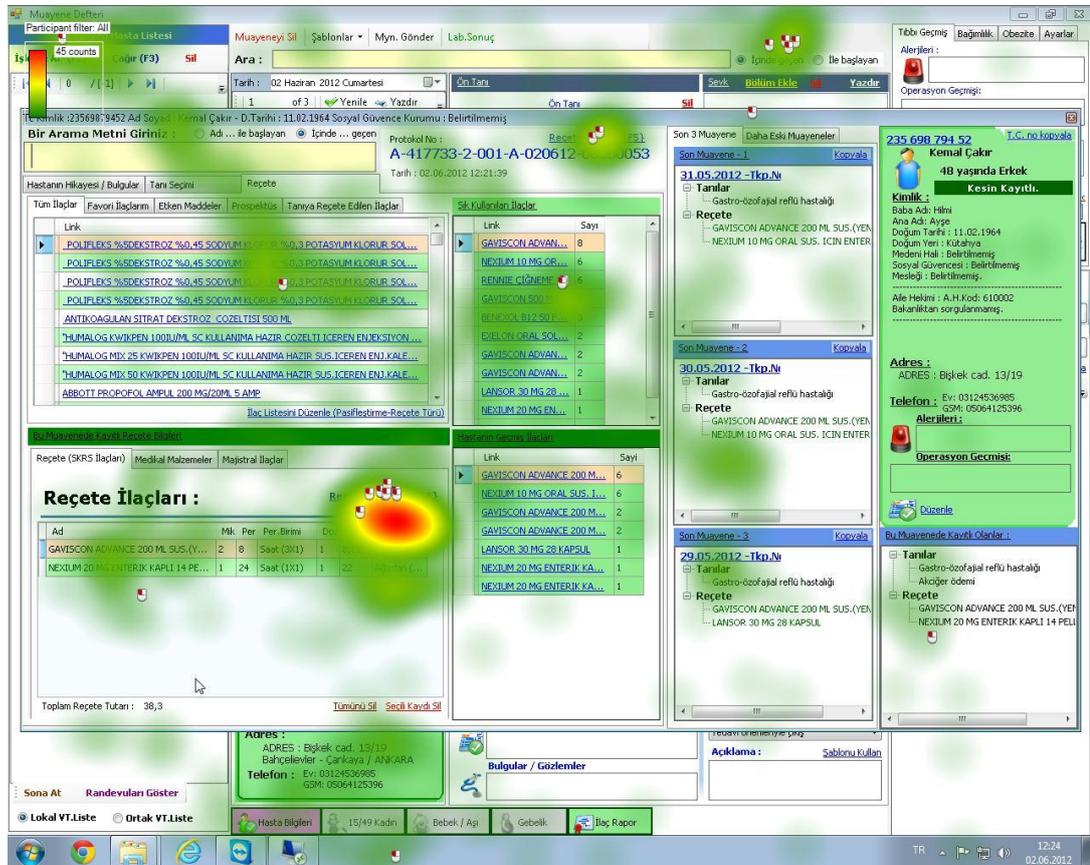
Figure 4.69 Heat Map of Task 6 (Print out Prescription)

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As seen on in Figure 4.69, all participants focused on a link named "Reçete yazdır (F5)", This was the link that needed to be clicked on in order to complete the task. However, there were scattered fixations on the screen as understood from Figure 4.69. This is the evidence that participants searched for the 'Reçete Yazdır' (Print out precription) button on the screen by scanning various parts of the screen. One important thing is that they mostly preferred to click on the print out prescription button at the bottom although the same button was located on the upper side of the screen also. The reason for this might have been that the print out prescription button on the bottom was placed near the 'Reçete' (prescription) section where participants mostly focused on performing the tasks.

Gaze Plots also show where participants mostly fixated on the screen. Since gaze plots show every fixation of each participant by assigning them a color it is possible to observe scan paths of each participant.
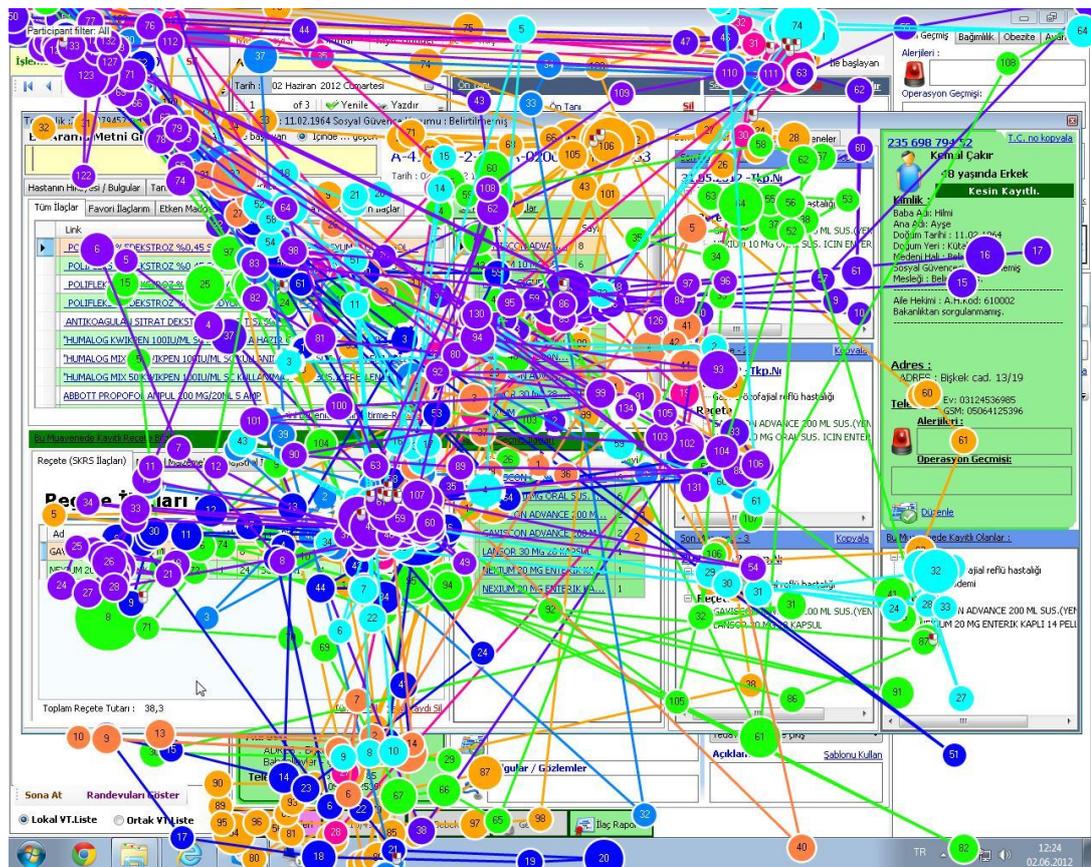
Figure 4.70 Gaze Plots of Task 6 (Print out Prescription)

In Figure 4.70 each colored bubble shows the specific participant's scanning pattern of a screen. As seen on the graph, participants mostly fixated on the middle section of the screen.

The figures below show a heat map and gaze plots of one section of Task 1. To reveal this gaze plot and heat map figures, recordings were divided into a sub section that start with the beginning of Task 1 performance and ends with when participants select one of the three ways of completing Task 1 by clicking the relevant objects (kesin kayıtlı button, poliklinik defteri link and arama box). Results are as follows;
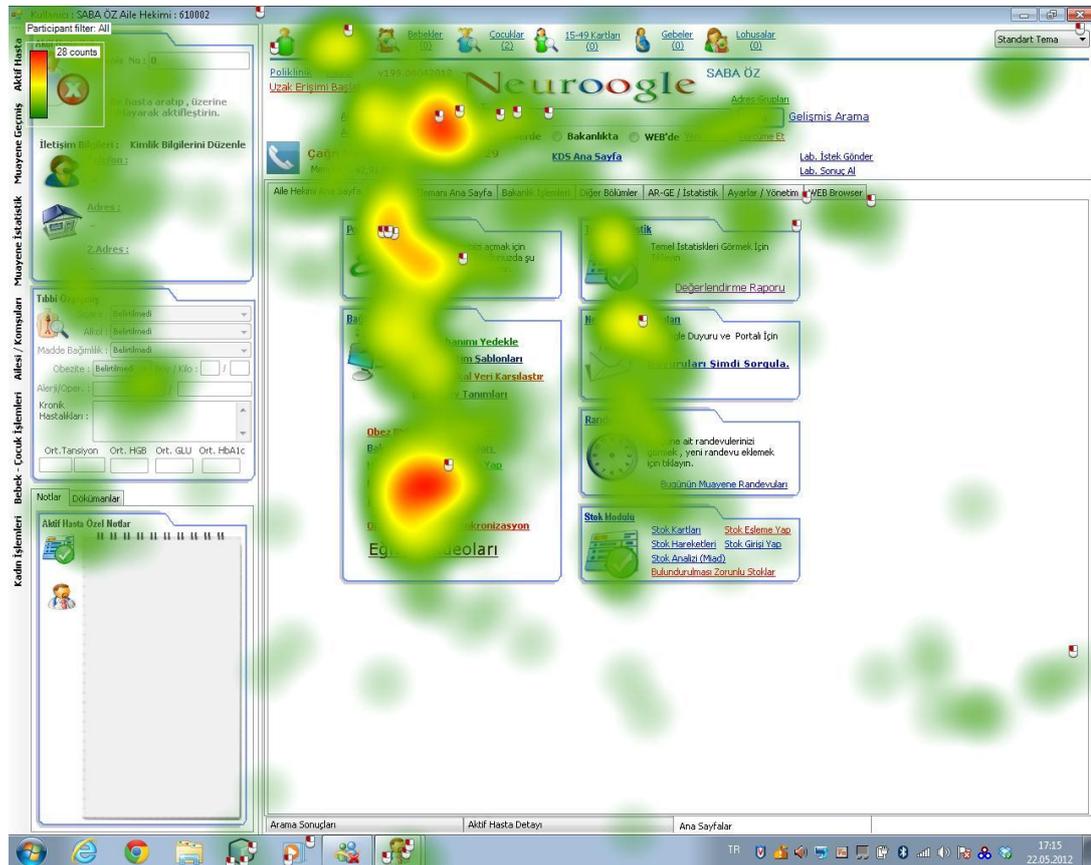
Figure 4.71 Heat Map of Task 1 (Finding specified patient in a system)

Heat map of task 1 shows that participants got confused and focused mostly on irrelevant areas. On the graph it can be seen that there were 3 major focus points of

the participants. These points were indicated with the color of red via the software named Tobii studio. The upper two major focus points represent arama box and poliklinik defteri. These two items are relevant for the completion of Task 1. However, the major focus point on the bottom side of the screen fell into irrelevant items for Task1. Also, on the graph green areas show that participants scanned the screen to find relevant objects.

Figure 4.72 shows the gaze plot of section one of Task 1 mentioned above. When these fixation points are examined, it is clearly seen that participants mostly focused on the left, middle and upper side of the screen.
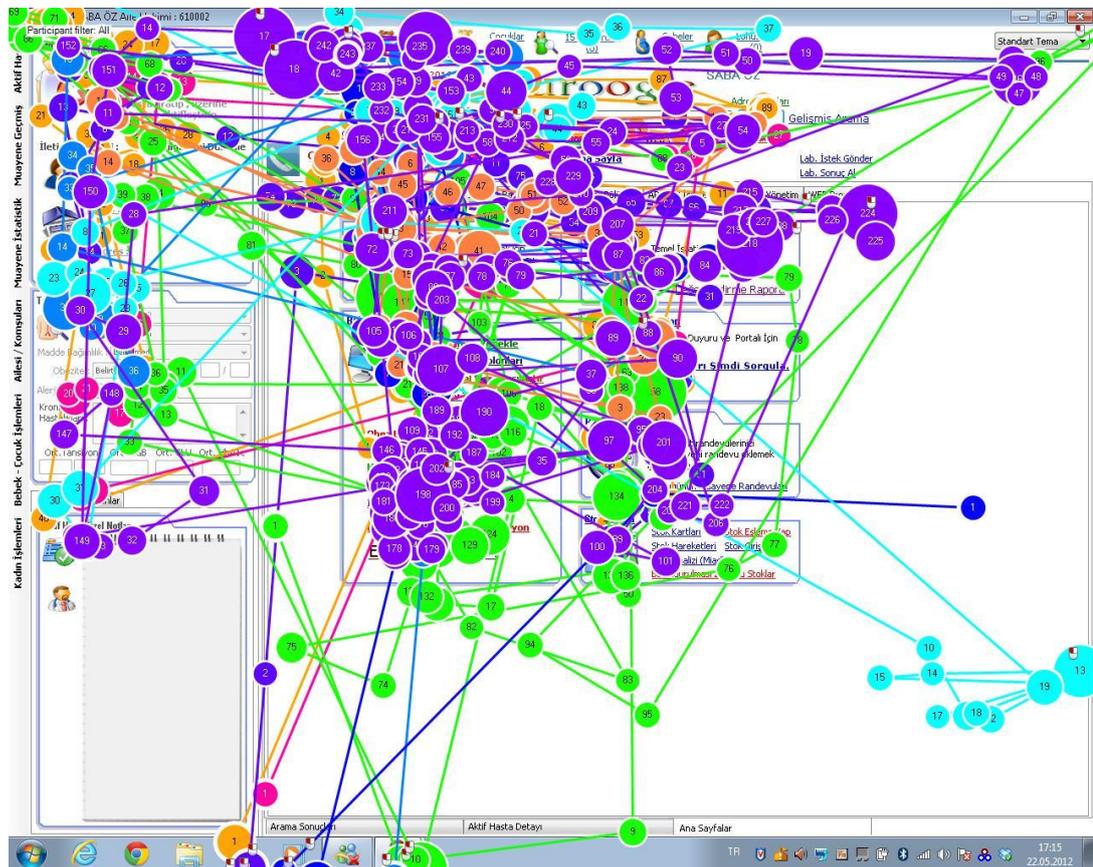
Figure 4.72 Gaze Plots of Task 1 (Finding specified patient in a system)

4.7. System Usability Scale (SUS) Results

This scale is used for quickly detecting usability of the Neuroogle FMIS. The scale was rated by the participants of the study after they participated in the test and completed their task performances. The two tables below show the result of the estimations related to the scale.

Table 4.14 System Usability Scale Rating Frequency

	Strongly Disagree				Strongly Agree
Items	**1**	**2**	**3**	**4**	**5**
Item1	5	5	0	4	6
Item2	1	0	4	8	7
Item3	4	5	5	4	2
Item4	2	3	5	4	6
Item5	1	4	3	9	3
Item6	5	7	3	4	1
Item7	6	6	3	3	2
Item8	10	3	3	2	2
Item9	3	3	7	3	4
Item10	0	2	2	7	9

Table 4.14 shows the overall distribution of the ratings among all the participants. The columns show the rating scale between 1 (strongly disagree) and 5 (strongly agree). The rows show the total frequency of the rating of participants with respective to each item. Since items cannot fit into the table, they are indicated with their number (items1-10). See Appendix E for all SUS items.

The graph below (Figure 4.73) shows the SUS results with a curve that indicates a normal distribution.
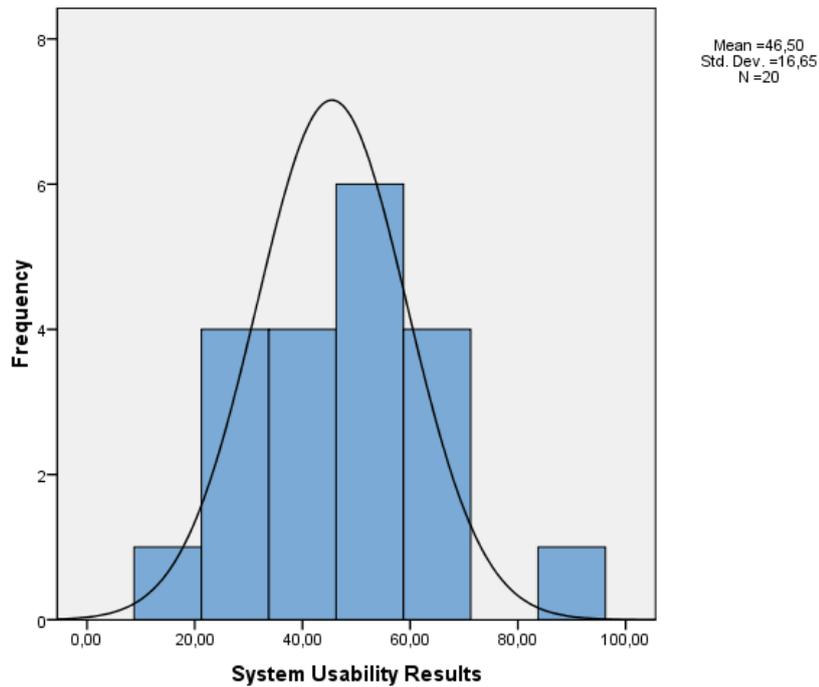
Figure 4.73 System Usability Scale Results Distribution Graph

These results are presented in the table below with corresponding participants and the mean value, which shows the system's overall usability score.

Table 4.15 System Usability Scale (SUS) Results

Participants	Total Contributions	Usability Results (Total contributions * 2,5)
P01	13	32,5
P02	11	27,5
P03	21	52,5
P04	16	40
P05	20	50
P06	14	35
P07	25	62,5
P08	20	50
P09	19	47,5
P10	11	27,5
P11	19	47,5
P12	12	30
P13	6	15
P14	19	47,5

Table 4.15 (cont.)

P15	17	42,5
P16	26	65
P17	34	85
P18	28	70
P19	17	42,5
P20	24	60
Mean	18,6	**46,5**

As seen in the table above, each participant's usability result was estimated. The overall Usability result of the system was calculated by averaging all participants' values and found to be 46,5.

4.8. Task Success Rate

Although many of the tasks were completed successfully by the participants, there were some tasks that could not be completed by some participants. The table below shows the overall task completion success rates of the participants:

Table 4.16 Task Success Rates

Participants	Task1	Task2	Task3	Task4	Task5	Task6	Task7	Task8	Task9
P01	+	+	+	+	+	+	+	+	+
P02	+	+	+	+	+	+	+	-	+
P03	+	+	+	+	+	+	+	+	-
P04	+	+	+	+	+	+	-	-	+
P05	+	+	+	+	+	+	-	-	+
P06	+	+	+	+	+	+	+	-	+
P07	+	+	+	+	+	+	+	-	+
P08	+	+	+	+	+	+	-	+	+
P09	+	+	+	+	+	+	+	+	+
P10	+	+	+	+	+	+	+	+	+
P11	+	+	+	+	+	+	+	-	+
P12	+	+	+	+	+	+	+	+	+
P13	+	+	+	+	+	+	+	+	+
P14	+	+	+	+	+	+	-	+	+
P15	+	+	+	+	+	+	+	+	+
P16	+	+	+	+	+	+	+	-	+
P17	+	+	+	+	+	+	+	+	+
P18	+	+	+	+	+	+	+	-	+
P19	+	+	+	+	+	+	+	-	+
P20	+	+	+	+	+	+	+	+	+
Total	20/20	20/20	20/20	20/20	20/20	20/20	16/20	11/20	19/20
Success Rate	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**80%**	**55%**	**95%**
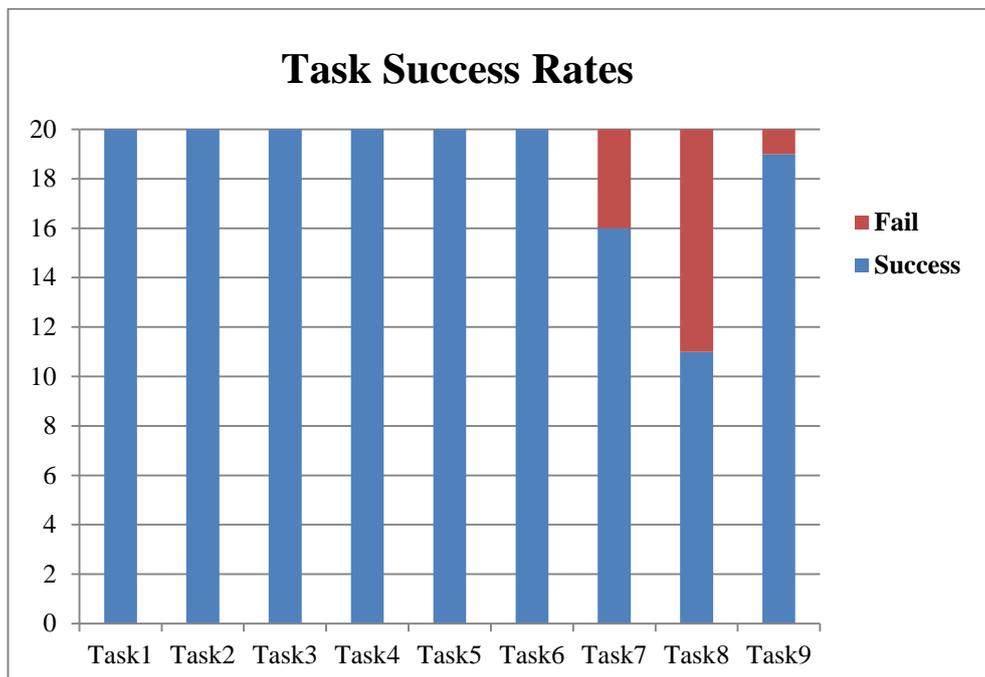
Figure 4.74 Task Success Rates Graph

Figure 4.74 shows the visual representation of Table 4.16. When the graph is examined, it can observed that only 3 tasks (Tasks 7-9) have fail cases. It is understood by the graph that the first 6 tasks were completed by all the participants and the last 3 tasks were completed only by some participants. Task 8 has lower success rates (55% respectively).

4.8.1. The Effect of Domain Expertise on Task Success Rates

Since participants consisted of both medical doctors and information technology (IT) specialties, it was possible to compare the success rates of the participants from both specialties with respect to task accuracy (completion percentage of tasks), average task completion time and total completion time. Figures below show the results of these comparisons.
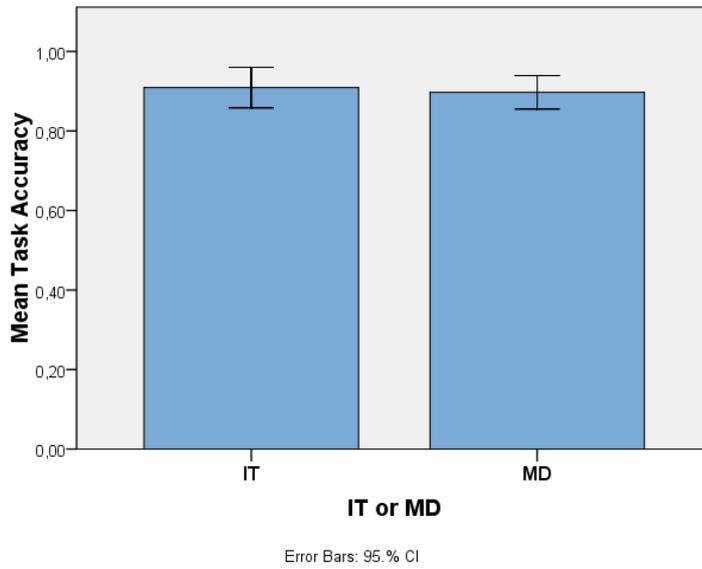
Figure 4.75 Comparison of IT and MD specialists according to Task Accuracy

Figure 4.75 shows that there are no differences between IT and MD specialists with respect to completion percentages of the tasks. The graph shows that the participants from both specialties completed the tasks with percentage of approximately 90%. An independent t-test conducted over completion percentages of both groups did not reveal a significant difference (t(18)=0.35, p>0.05)
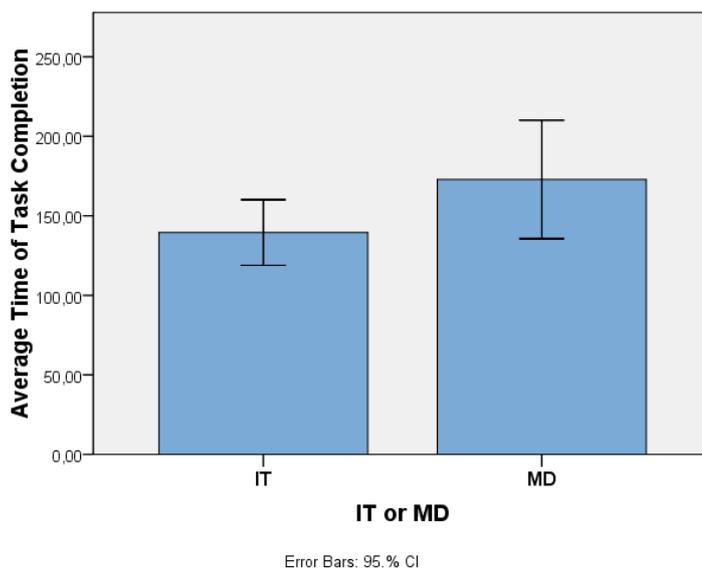
Figure 4.76 Comparison of IT and MD specialists according to average time of task completion

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When Figure 4.76 is examined, it can be stated that there is not much difference between participants from IT and MD specialties with respect to average time of task completion. Although, IT specialists completed the tasks more quickly than MD specialists as the graphs show, an independent t-test indicated that this difference was not statistically significant (t(18)= -1.96, p>0.05).
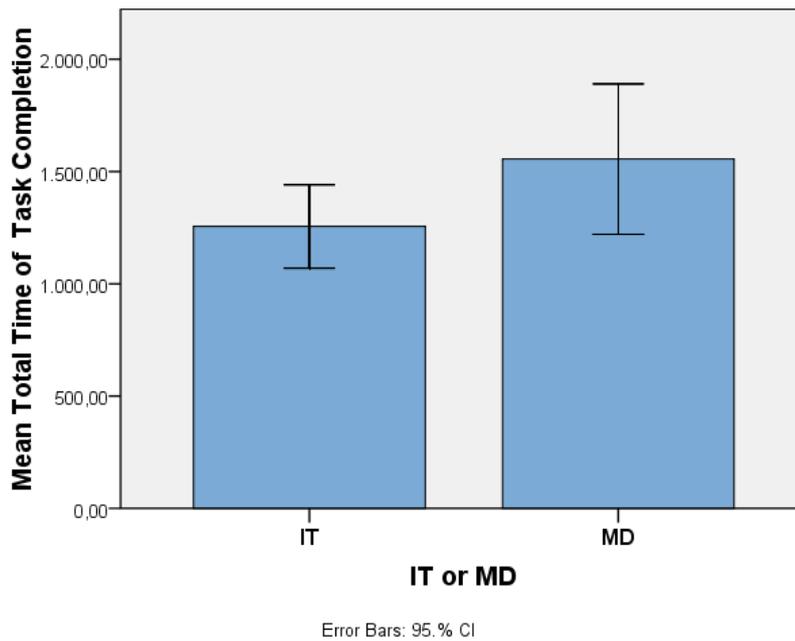
Figure 4.77 Comparison of IT and MD specialists according to total time of task completion

When Figure 4.77 is examined, it can be observed that there is no statistically significant difference between IT and MD specialties in terms of their total task completion time (t(18)= -1.96, p>0.05). IT specialists completed all the tasks more quickly than MD specialists totally (approximately 1300 seconds).

4.9. Summing Up Findings

To sum up, some essential findings were collected from all of the methods applied in this study. The semi-structured interview was conducted at the beginning of the study and it outlined which operations are frequently performed during daily work of

family doctors with using the Neuroogle interface. The semi-structured interview was also provided some valuable information about the usage of the Neuroogle interface and attitudes / opinions of family doctors towards the system. In addition to semi-structured interview, video capturing that was applied during the site visits of family health center provided significant information about how the most frequently used operations are performed by the family doctors (actual users) and it also helped to explore the steps of these frequently used operations. Task analysis method supplied workflow models of these main tasks or operations. The flowcharts of these tasks (see Appendix H) illustrated their steps of completion. Cognitive modeling was mainly used to predict completion time of these frequently used tasks by expert users. Findings of cognitive modeling method were approximate completion time by an expert user for each task and these findings constituted baseline for further analysis (an eye-tracking experiment). Heuristics evaluation conducted by using both Nielsen's (1993) and Xerox Company's guidelines provided global and general design errors or deficiencies of Neuroogle interface with respect to usability issues. Nielsen's (1993) heuristics provided some important design errors of the system and Xerox heuristics evaluation provided which of the main guidelines or heuristics were met by the system. Eye-tracking experiments provided significant quantitative data for deep analysis of Neuroogle interface. For eye-tracking experiments novice users of the system were selected to see how the Neuroogle interface is learned by the users who had not experienced the system before by dealing with main tasks. Findings of eye-tracking study were completion time of tasks, mouse click amounts during task performances, fixation durations and fixation counts on task-related vs. non-task-related objects, heat maps that shows mostly engaged in sections of screens and gaze plots that shows scan paths of users over screens. These quantitative data analyzed deeply to reveal how design issues explored by heuristics evaluations affect the usage of the Neuroogle system and whether or not the system is learned easily by novice users without giving them any training or tutorial. Moreover, task success rates were estimated by analyzing quantitative data that was collected from eye-tracking experiments and the results of this estimation revealed which of the main (or frequently used) tasks was more difficult to complete by novice users. This estimation was also beneficial to explore underlying reasons for having difficulty

with some tasks and to reveal design issues by taking help from these reasons. Think-aloud method mainly used as supplementary method for eye-tracking study. This method provided an evaluation of the system by the end-users' perspective. Findings of the think-aloud method were grouped expressions of the end-users that point out design issues of the Neuroogle system and reveal comments or opinions of end-users on this system. These findings were valuable to define design errors or deficiencies of the system and making recommendations to improve usability of the Neuroogle interface. System usability scale (SUS) was administered just after the completion of eye-tracking and think aloud sessions and provided significant information about users' satisfaction with the system and ratings of perceived usefulness of the system. To measure users' satisfaction with the system and ratings of perceived usefulness of the system an estimation was made according to rule explained in methodology section of the study. System usability scale's findings provided overall usability score of the Neuroogle interface. Finally, the effect of domain expertise on tasks success rates revealed that there is no statistically significant difference ($p > 0.05$) between IT and MD specialties in terms of their total task completion time, average task completion time and task accuracy.

CHAPTER 5

DISCUSSION

In this study five main usability evaluation methods, namely semi-structured interview, system usability scale, heuristics evaluation, eye-tracking study and think-aloud were used. These methods served different aims and needs in different phases of the study. Semi-structured interview, for example, was used to obtain information about how and to which purpose the Neuroogle software is used by family doctors. With the help of information obtained from a semi-structured interview, main tasks performed by family doctors in their daily work are defined and their workflows were pointed out by the task analysis method by flowcharts. Then these flowcharts of main tasks were modeled in cognitive modeling tool namely Cog-Tool to predict how much time expert users need to complete these tasks in Neuroogle system. The results of cognitive modeling method that are approximate completion time of tasks by expert users were used as baseline when performances of participants of eye-tracking experiments were examined by the usability evaluator. Heuristics evaluation involves evaluating a system by the help of specified guidelines or heuristics, so it enables the evaluator to assess the system in comprehensive way without depending on some specific tasks. Thus, heuristics evaluation was beneficial to explore more global problems in Neurogle interface with respect to usability issues. Since heuristics evaluation supported more general and superficial results regarding to usability issues of the Neuroogle system, eye-tracking experiments were conducted to determine and observe how the problems defined by the heuristics evaluation

affect the use of the system. Beside the eye-tracking experiment, think-aloud method helped to investigate cognitive process of users dealing with tasks and their comments/contributions on the Neuroogle interface. Since all methods used in the study provided making supplementary observations with each other, the usability evaluation of the Neuroogle interface was improved.

Data collected from all of these methods were analyzed and their results were reported in the previous chapter. This chapter summarizes and discusses the findings in the light of the research questions. The 3 main research questions for the current study regarding the analysis of the usability of Neuroogle FMIS are listed below:

- (RQ1) What are the most important tasks carried out by family doctors on a FMIS like Neuroogle?
- (RQ2) What usability issues are there on the existing Neuroogle interface in relation to the important tasks?
- (RQ3) How can the Neuroogle interface be improved based on the usability issues identified?

Question 2 is further decomposed into 3 main sub-components based on standardized dimensions of usability; namely effectiveness, efficiency and satisfaction.

To evaluate the *effectiveness* of the Neuroogle FMIS;
- (RQ 2.1) What percentage of the tasks are accurately completed by the users?
- (RQ 2.2) Which tasks are the most difficult for the users to complete? What kinds of obstacles/errors do they face when they failed to complete a task?

To evaluate the *efficiency* of the Neuroogle FMIS;
- (RQ 2.3) How long does it take users to perform each task?
- (RQ 2.4) How many mouse clicks do users perform to complete each task?
- (RQ 2.5) How long do users fixate on task-related vs. non-task-related objects?
- (RQ 2.6) What are the main design issues of Neuroogle interface in terms of established usability heuristics?

To probe the user *satisfaction* dimension of usability;

- (RQ 2.7) How do the users rate the perceived usefulness of the system and their satisfaction by using the system?

- (RQ 2.8) What kinds of comments do the users make about the interface while they are engaged in the tasks?

5.1. RQ 1. What are the most important tasks carried out by family doctors on a FMIS like Neuroogle?

To reveal the most important tasks carried out by family doctors on a FMIS like Neuroogle, a semi-structured interview and video capturing of family doctors' screens were conducted at the beginning of the study. One of the interview questions was "What are the fundamental operations you perform by using this FMIS?" The purpose of this question was to uncover fundamental tasks used by family doctors in daily working routines. Since this study aimed to reveal usability issues of the Neuroogle FMIS, it was more convenient to consider the most important tasks used by family doctors throughout the study. These tasks or operations are explained in both the methodology and results sections of the study. Moreover, video recordings of family doctors' screens were beneficial to see how these important tasks were performed by family doctors in real time working environment during site visits. As a result of the interview and video recordings, 9 tasks were selected for the usability analysis of Neuroogle. Then flow charts of these 9 tasks were devised based on screen recordings and they were modeled in a cognitive modeling tool (Cog-Tool) in order to estimate their completion time by expert users.

5.2. RQ 2. What usability issues are there on the existing Neuroogle interface in relation to the important tasks?

The second research question of the study was to reveal usability issues of the existing Neuroogle interface in relation to the important tasks defined by the result of RQ1. This question was further decomposed into sub questions based on standardized dimensions of usability; namely effectiveness, efficiency and

satisfaction. Neuroogle is evaluated in terms of effectiveness and efficiency through heuristic evaluation, cognitive modeling and a usability experiment conducted with an eye tracker.

5.2.1. RQ 2.1. What percentage of the tasks are accurately completed by the users?

This question aimed to evaluate the effectiveness of the Neuroogle system. To evaluate the effectiveness of the Neuroogle interface, the percentage of the tasks accurately completed by the users was revealed by eye-tracking experiments conducted by the participation of both medical professionals and IT experts. After the participants completed all the experiment sessions , the data collected via the eye-tracking device were analyzed by using the eye-tracking data analysis software named Tobii Studio, which was explained in Chapter 2. The results of the task completion rates were presented in Table 4.16 and Figure 4.74 in Chapter 4. When Table 4.16 was examined, it was observed that the first 6 tasks were completed by all the participants (100% respectively). Task 7 was completed by 16 participants (80% success rate), Task8 was completed by 11 participants (55% respectively) and Task 9 was completed by 19 participants with 95% success rate.

5.2.2. RQ 2.2. Which tasks are the most difficult for the users to complete? What kinds of obstacles/errors do they face when they failed to complete a task?

This question also aimed to evaluate the effectiveness of the Neuroogle Interface. When the results of the analysis obtained from the eye-tracking experiments in light of the research question 2.1 were interpreted, it can be stated that the most difficult task for the participants to perform was Task 8 with a success rate of 55%. One of the reasons for this situation is that participants could not find where an appointment is made on the Neuroogle interface. They started to perform Task 8 by opening the poliklinik defteri (polyclinic book) screen mostly, since they assumed that the appointment section was placed on this screen. On the polyclinic screen they mostly

fell into contradiction with the button named 'Randevuları Göster' (Show appointments). They were supposed to look or make appointments by clicking on this button; however, this button had a function of showing only the current day's appointments and did not have any options to make an appointment for the patient. When the overall fixation duration and fixation count percentages of Task 8 were examined in Figure 4.62, it can be observed that the participants mostly engaged in the irrelevant sections of the screens (90% respectively). This proves that they could not find the relevant button or link that showed all the appointments and made an appointment for the patient. Fixation count and fixation duration percentages among AOIs and NAOIs in Figure 4.63 can be examined to see which sections participants mostly engaged in during Task 8 performance. When Figure 4.63 in Chapter 4 is examined, it can be clearly seen that participants mostly engaged in "sol panel" (the left panel) where the button named "randevuları göster" was placed and "hasta işlem sırası" (patient queue).

5.2.3. RQ 2.3. How long does it take users to perform each task?

This question aimed to evaluate the efficiency of the Neuroogle system. To arrive at an answer for this question, eye-tracking experiment data were examined in depth and the completion time of each task for all the participants were presented in Chapter 4. To see the overall completion time of all the tasks, all the participants' task completion time values for each task performed during eye-tracking experiment sessions were averaged and compared with the ideal case that represents expert users' completion time estimated by the Cog-Tool. Figure 5.1 displays these results. In Figure 5.1, the blue bars show the average time of participants' task completion time values for each task and the red bars show the ideal case of completion time of tasks. When calculating the average time of participants' task completion time values, participants who could not complete the task were eliminated from the analysis.
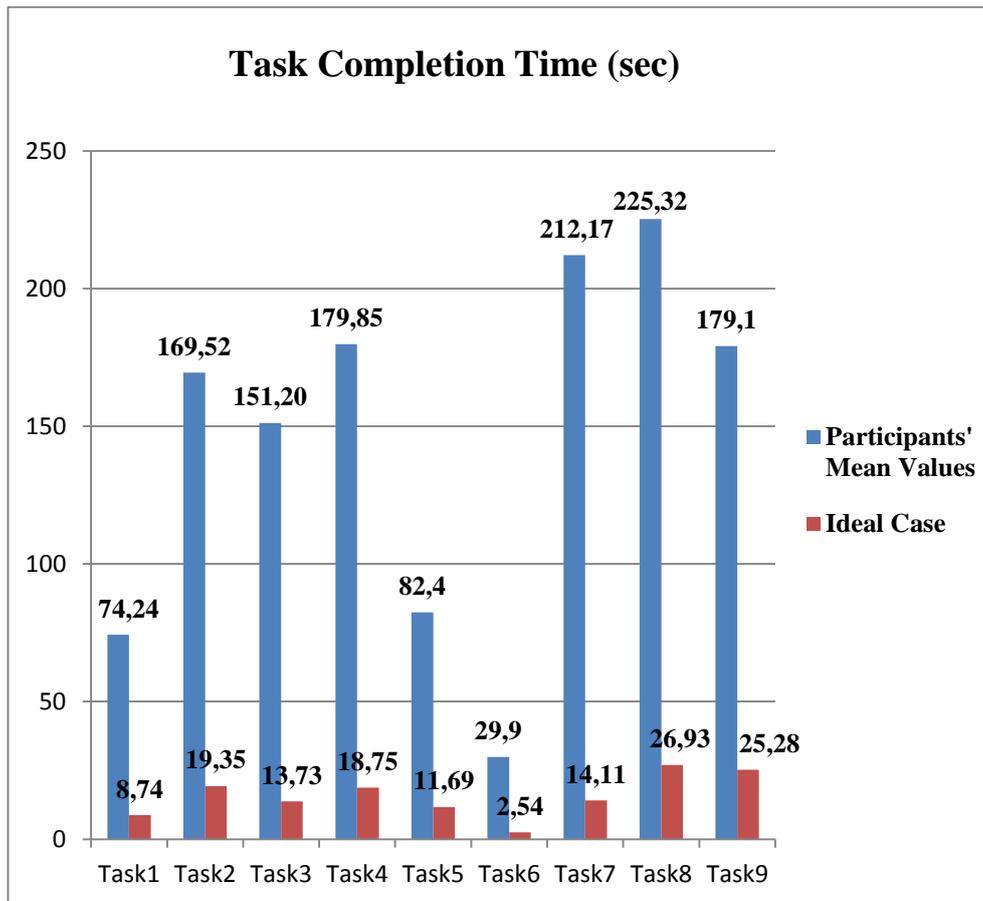
Figure 5.1. Average Task Completion Times of Participants

When Figure 5.1 is interpreted, it can be seen that all the tasks were completed by spending a considerably more time compared to ideal cases. This shows that participants mostly tended to search the relevant sections regarding each task. As a result, they lost so much time during task performance. We expected to observe that

as users get familiar with the system their average task completion times would tend to be closer to the ideal case. Since this difference did not show a decreasing trend, one can argue that Neuroogle FMIS does not adequately fulfill the learnability attribute of usability. This attribute can be defined as follows: "*The system should be easy to learn so that the user can rapidly start getting some work done with the system.*"(cited in Liljegren, 2006).

It is also seen from Figure 5.1 , although more time was spent to complete all of the tasks by the participants, especially Task 7 and Task 8 stand out from the rest as they

were the most time consuming tasks compared to others. When screen recordings were examined, it was seen that participants mostly had difficulty finding where the medical report was given in the system during the performance of Task 7. They started to perform Task 7 with the "tanı ve ilaç" (diagnosis and prescribing) screen of "poliklinik defteri" (polyclinic book) section since Task 6 was completed on this screen. Generally participants were inclined to find relevant objects with tasks on the current screen and they could not think of closing the current page if they did not find that feature for a long time. They were supposed to turn off the software when they exitted from the current page and always asked whether they exitted from the software if they exitted from the current page. As a result of this thought, they did not venture to close the current page and consumed much time on the page that does not contain a button to give a medical report. Task 8 was another challenging task for the participants. Participants had difficulty in finding the "Randevu" (appointment) button on the Neuroogle system. Generally they were misled by the button named "randevuları göster" (show appointments) on the "poliklinik defteri" (polyclinic book) screen as stated in the RQ2.2. section above. These observations point to broader usability issues in terms of how users navigate across different screens. The number of sections and pop-up pages that the users need to manage during similar tasks has been a general issue of this interface. The overall complexity of the layout also made it difficult for users to successfully locate the relevant buttons for therir tasks.

5.2.4. RQ 2.4. How many mouse clicks do users perform to complete each task?

This question also aimed to evaluate the efficiency of the Neuroogle interface. To estimate the number of mouse clicks of eye-tracking experiment participants, video recordings of participants were examined and compared with the ideal case of each task, which was estimated by using the cognitive modeling tool (Cog-Tool). Figure 5.2 shows the mouse click counts for all tasks. The blue bars in Figure 5.2 shows the average value of the participants' mouse clicks for each task and the red bars show the ideal mouse click numbers. During the computation of average values of participants' mouse clicks, participants who could not complete the tasks were

excluded from the estimation. As seen in Figure 5.2, the participants performed many mouse clicks for each task compared to the ideal case, but especially Task 8 and Task 4 were the tasks which were completed with considerably more number of clicks. The reason of more mouse clicks on Task 8 was that participants could not find the making appointment part among the screens as stated above. On the other hand, the reason for clicking so many times on objects during the performance of Task 4 was that participants could not notice the search box at the upper side of the drug and diagnose list. As a result of this, they had to search for a drug or diagnosis by scrolling on this list manually by clicking on it several times.
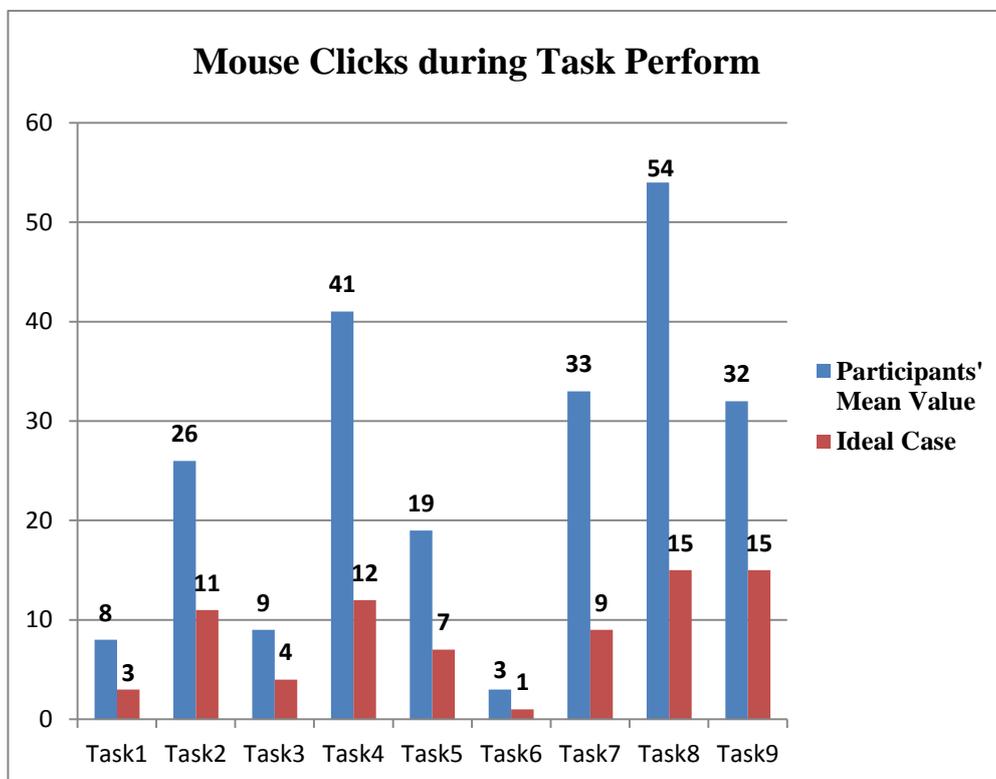

Figure 5.2 Average Mouse Clicks Quantity of Participants

5.2.5. RQ 2.5. How long do users fixate on task-related vs. non-task-related objects?

To reveal how long users fixate on task-related versus non-task-related objects fixation duration metric of Tobii Studio Software was used. Fixation duration is one

of the measurements of eye-tracking data that shows how much time participants fixated on specific objects. To calculate fixation durations, an evaluator defines boxes named Area of Interest (AOI) on screens of tasks in the Tobii Studio Software. Figure 5.3 summarizes fixation duration statistics for all the tasks in terms of percentages. Fixation duration value is estimated by summing up all participants' fixations on relevant and irrelevant objects. On the graph, blue bars show relevant items with the tasks (in other words Areas of Interest) and the red bars show irrelevant objects with respect to tasks (Not Areas of Interest) that the participants focused on. When the graph is examined, almost all tasks, except for Task 4 and Task 5, have a high proportion of irrelevant objects focused on by the participants. During Task 4 and Task 5 performances, participants mostly focused on objects relevant to the task. This refers to a usability problem indeed. When eye-tracking recordings of the participants were examined, it was seen that some participants consumed much time on fixating the 'Tanı – İlaç Listesi' (Diagnosis and Drug list) section while they were prescribing a drug or diagnosing a disease for a patient specified in the task definition. This list is designed for both prescribing a drug and diagnosing a disease for patients but it contains many drugs (even drugs that are not sold in drugstores) and disease types. To simplify searching a drug or disease on this long list, a search box was located on the upper side of the list by the design team of the software. Since this search box was not presented visible enough, some participants did not notice the search box and searched for a drug and a disease by scrolling on this long list manually, which caused them to consume much time on the list. This situation revealed one of the usability problems of a Neuroogle software, which can be defined as layout / screen organization problem or meaning of labels problem (Kushniruk & Patel, 2004). This search box should be modified and designed in a more attractive way so that user can notice it and associate its function with the drug and disease list.
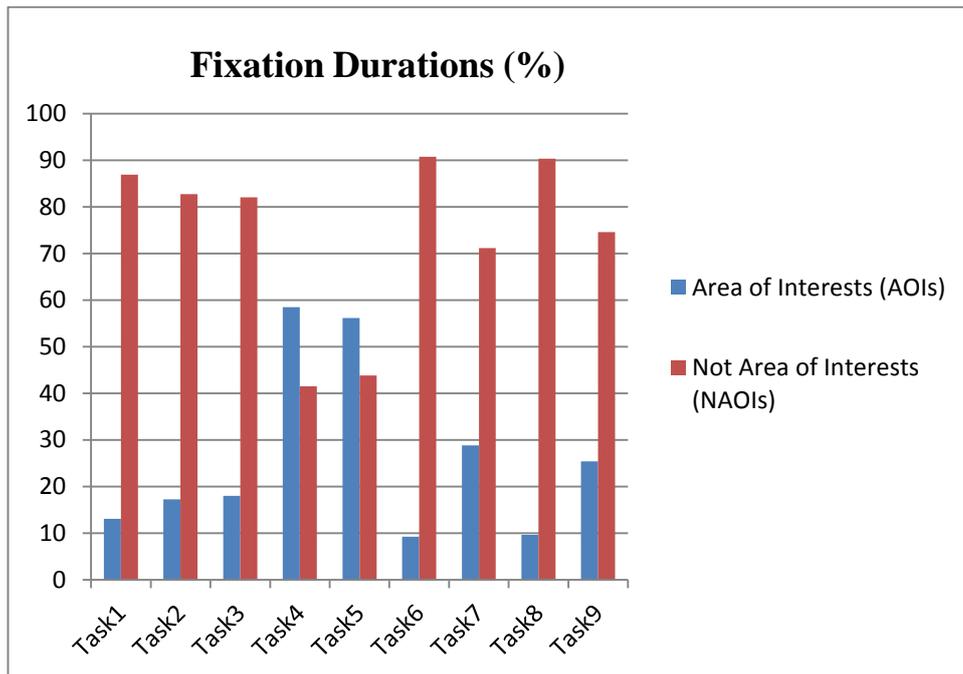
Figure 5.3 Fixation Duration Statistics for All Tasks

Fixation count is another measurement value obtained from eye-tracking data, and it shows how many times participants of the study fixated on specific objects related with a task. To measure these statistics, an evaluator defines boxes on relevant or irrelevant sections of tasks to reveal whether participants fixated on relevant sections or not.

Figure 5.4 shows fixation counts by percentage of all participants' summed up values. The blue bars show fixation count percentages of relevant objects of tasks and the red bars show fixation count percentages of irrelevant sections of tasks. As seen in Figure 5.4, almost all tasks have great proportion of fixations on irrelevant objects except for Task 4 and Task 5. The reason for this is that participants spent so much time on fixating relevant objects for Task 4 and Task 5 named 'Tanı – İlaç Listesi' (Diagnosis and Drug List) since they did not realize the existence of a search box that simplified searching for a disease and a drug from the list. This points out a usability problem as mentioned above. When all the tasks are examined in Figure 5.4, there are considerable differences between fixation counts on relevant objects and fixation counts on irrelevant objects, especially for Tasks 1,2, 3 and Task 8. This

situation reveals that participants mostly experienced difficulty in finding relevant objects for these tasks. As a result of experiencing difficulty in finding the relevant sections of tasks, they scanned the screen with quick movement of eyes and made more fixations on irrelevant sections.
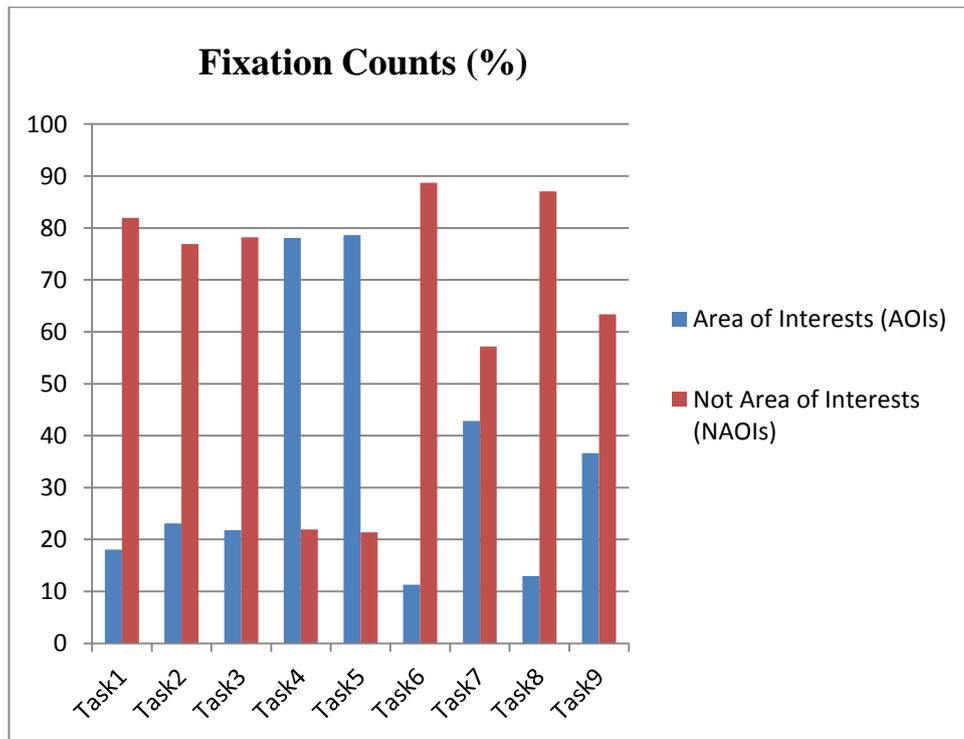
Figure 5.4 Fixation Count Statistics for All Tasks

5.2.6. RQ 2.6. What are the main design issues of Neuroogle interface in terms of established usability heuristics?

This question aimed to reveal design errors of the Neuroogle interface based on usability principles. To reveal design errors of the Neuroogle interface, Nielsen's (1993) heuristics evaluation were made by three usability evaluators and the Xerox heuristic evaluation was made by one usability evaluator. The results of these evaluations were reported in Chapter 4. The most critical design error was the "bölüm ekle" (add section) button, which gives an error message in software language and shuts down the Neuroogle FMIS. Another design error was that there was no help or documentary section in Neuroogle FMIS when users needed help. This situation strongly violates the heuristics of help and documentation (Nielsen,

1993) and should be fixed immediately. Moreover, on the screen for making an appointment there is a box named "ilgili kişiyi seçin" (select relevant person), which misleads users. This problem was discovered by eye-tracking experiment participants also. When the participants tried to type in this box it did not allow them to type anything. Figure 5.5, presented below, shows this misleading box:

Figure 5.5 Design Error on Making an Appointment Screen

One of the participants commented on this issue during the think aloud session as follows;

> "*Mesela bu alanın içerisine yazı yazamıyorum ama imleci içine koyabiliyorum. Eğer herhangi birşey yapamıyorsam seçilemiyor olması lazım. Başka birşey istemediğini tahmin ederek 'kaydet' butonuna tıklıyorum ama hastayı seçmem gerektiğine dair uyarı mesajı aldım. Hastayı seçmem gerekiyor*"

> "*For example, I don't write anything in this area (text box) but I can place the cursor inside of it. If it is not allowed to do anything inside of this box, it should not be selected also. I click on 'save' button by assuming that there is nothing else to do but I get a warning message whcih says that I should select the patient. So, I should select the patient.*"

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This condition violates the heuristics of Match between System and the Real World (Nielsen, 1993). End-users mostly hold the idea that a text box is designed for writing something inside of it, so the design team of the software should take this key point into consideration in order to design software that addresses end-users' needs and conceptual model of information. Aiming at good mappings between the computer display of information and the end-users' conceptual model of information lies behind the approaching the goal of a user-oriented dialogues (Nielsen, 1993).

Xerox heuristics evaluation results were interpreted whether 13 main criteria were met by the system. The degree of satisfying these criteria by the system was determined by the total percentage of Yes and No options for each criterion. These 13 main criteria and their corresponding Yes, No and N/A percentages are listed below;

- Visibility of System Status (Yes: 21%, No: 69%, N/A: 10%)
- Match Between System and the Real World (Yes: 21%, No: 63%, N/A: 17%)
- User Control and Freedom (Yes: 43%, No: 48%, N/A: 9%)
- Consistency and Standards (Yes: 29%, No: 59%, N/A: 12%)
- Help Users Recognize, Diagnose, and Recover From Errors (Yes: 19%, No: 62%, N/A: 19%)
- Error Prevention (Yes: 13%, No: 47%, N/A: 40%)
- Recognition Rather Than Recall (Yes: 32%, No: 63%, N/A: 5%)
- Flexibility and Minimalist Design (Yes: 44%, No: 50%, N/A: 6%)
- Aesthetic and Minimalist Design (Yes: 50%, No: 50%, N/A: 0%)
- Help and Documentation (Yes: 4%, No: 74%, N/A: 22%)
- Skills (Yes: 52%, No: 43%, N/A: 5%)
- Pleasurable and Respectful Interaction with the User (Yes: 36%, No: 35%, N/A: 29%)
- Privacy (Yes: 0%, No: 0%, N/A: 100%)

These percentages are calculated by the evaluator with observing Neuroogle FMIS and rating each sub items of main criteria according to satisfying degree by the system. When proportions of Yes and No options for each criterion was reviewed it was concluded that Neuroogle FMIS meets only 2 criteria, namely Skills (Yes: 52%, No: 43%, N/A: 5%) and Pleasurable and Respectful Interaction with the User (Yes: 36%, No: 35%, N/A: 29%). These criteria have greater proportion of Yes choices as compared to No choices. Skills heuristic emphasizes that system should support user's skills, background knowledge and expertise instead of requiring them to develop new skills (Xerox, 2012). Heuristic of pleasurable and respectful interaction with the user suggest that the system should enhance the quality of end-user's work (Xerox, 2012). Neuroogle FMIS fulfills skills heuristic's suggestion as well as the heuristic of pleasurable and respectful interaction with the user as it satisfies most sub items of these heuristics with a great proportion.

5.2.7. RQ 2.7. How do the users rate the perceived usefulness of the system and their satisfaction with using the system?

This question aimed to probe the user satisfaction dimension of usability. To measure users' satisfaction with the system and ratings of perceived usefulness of the system the post-survey was administered after the eye-tracking experiment sessions. Within this context, the System Usability Scale (SUS) with 10 likert scale items (see Appendix E) were given to participants to be filled. Before they filled this scale, they asked to record their immediate response to each item, rather than thinking about the items for a long time (Brooke, 1986). SUS results estimated for each participant by using the estimation rule stated in the method section in Chapter 3, and findings were given in the results section presented in Chapter 4. The results of SUS represented users' degree of satisfaction with the Neuroogle System, which indicate the degree of perceived usability of the system.

When all participants' ratings were calculated with the estimation rule, it can be seen that the usability score varied among participants. For instance, the usability score of the system was estimated to be 85 according to one participant of the study, whereas

it was estimated as 15 according to another participant. In order to estimate the overall system usability score, all participants' usability scores were averaged. This average value of the results represents the overall system usability score, which was estimated as 46.5 for the Neuroogle system. This overall system usability score shows that Neuroogle FMIS is rated as average in terms of perceived usability, which means neither poor nor perfect.

In order to address this research question, the interview analysis results were also examined and positive and negative aspects of the Neuroogle System were uncovered as follows:

Positive aspects;

- Estimations such as checking vaccination time, pregnant period follow-up were carried out by the system automatically
- The inventory information was listed by a system without effort, and this information was listed in detail; for instance, which day and to whom drugs were given and who were vaccinated.
- Family planning information is sent by the system.
- Templates for some operations such as reports and prescriptions.
- All operations are made without the need for paper and pencil.

Negative aspects;

- Complexity of the interface of the system
- Increased responsibility with using the system
- Increasing examination time that leads patients to wait in front of the doctor rooms compared to the past
- Increasing data entry with the system (e.g. registering new patients, updating records etc.)
- So many features are integrated into the system, some of which obscures the most frequently used features.

Moreover, interview results also revealed some design errors of Neuroogle FMIS as listed below:

- The drug list contains drugs which are not up-to-date. Some drugs are defined with different or incorrect names.
- When the drug name is entered incorrectly and when this situation is tried to be solved, the drug list completely disappears.
- In the system there is no information and help section about how to use the system.
- Drug list contains no information for some drugs.

In the light of the interview results, some expectations of family doctors from FMIS like Neuroogle were revealed. Expectations from FMIS can be described as a quick and simple interface design. Quickness refers to the speed of the connection to databases kept in servers of the Ministry of Health and Central Population Management Institution. Since most of their operations need quick connection with these institutions, family doctors expect an FMIS to work without trouble when connecting Ministry of Health and Central Population Management Institution. Simplicity refers to the overall organization of the interface where mostly frequently used operations should be placed on the main screen with a simple display of items and other infrequently used operations should be placed in the sub menus or auxiliary screens and reached with the demand of family doctors. One of the family doctors interviewed states this condition as follows;

> *"Programın çok fazla özelliği var ve bu özelliklerin çoğunu kullanmıyorum. Bu özellikleri öğrensem yeter."* (a family doctor interviewed)

> *"This program has so many features and I don't use most of them. It would be enough for me to learn these features"* (a family doctor interviewed)

To simplify an interface, the design team of the software should conduct site visits and observe family doctors in their daily task routines. With the light of these visits a

proper task analysis should be prepared to identify the information, which is important for end-users and which will enable them to perform almost all of their tasks (Nielsen, 1993). Based on this information collected from site visits and task analysis period, an interface should be designed with a single screen including only significant information, and less important information for end-users should be relegated to auxiliary screens instead of compressing all the information into a set of screens that will require end-users to switch screens for even most simple tasks (Nielsen, 1993). The design team can consider using some of the findings of this study to guide their design efforts.

5.2.8. RQ 2.8. What kinds of comments do the users make about the interface while they are engaged with the tasks?

In order to address this research question, the think-aloud method was conducted. When participants of the eye-tracking study were dealing with the specified tasks, they were asked to externalize their thoughts and their voice was recorded. The analysis results of the think-aloud data were reported in the results sections of the study. The results of the think-aloud procedure involves scripts of participants' expressions. These expressions gave some clues about the situations that can be accepted as a usability problem of the Neuroogle FMIS. These expressions were put in a written form by using 11 main categorizations defined by Kushniruk and Patel (2004) and stated in Chapter 4. For each category, problems found by the participants are listed below with key points:

Layout/Screen Organization;

- Warnings or information messages that are not clear or guiding enough
- Many screens presented in the same window in the Neuroogle FMIS that confuse end-users
- Many texts and colors that reduce the readability of the screen
- Lack of icons on data entering sections
- Flashing objects that distract the attention of the end-users of a system

- Irrelevant sections placed on the screens (information of the last three examinations)
- Crowded screens of the Neuroogle interface
- Every point can be clicked on some screens
- Opposite placements of Kaydet (Save) and Kapat (Close) buttons on some screens

Meaning of Labels;

- 'Address groups' link which confuses end-users
- Randomly encountered 'poliklinik defterine at' (assign to polyclinic book) button on the right click menu of the patient's icon.
- Uncertain information of buttons that make end-users think that they can close the program if they click on the exit button on some screens
- Some unclear buttons, such as 'seçili kaydı sil' (delete selected item) and 'Randevuları işlem kuyruğuna at' (assign appointments to operation queue)
- Unclear statements, such as report period entry box (no statements of time whether week or day) and 'boş tanılı muayene' (appointment with an empty diagnosis)

Lack of Indication of System Status (visibility of system status);

- Some operations that take place out of the control of end-users, such as warning messages on the right bottom corner of the screen.
- Uninformed waiting procedures of the system, such as waiting procedure of Mernis (a population management system) inquiry
- No information presented when a patient's information is added to "poliklinik defteri" (polyclinic book).
- No information messages when end-users click on items such as opening "poliklinik defteri" (polyclinic book) and print out prescription button.

Overall Ease of Use;

- Complexity of the Neuroogle FMIS interface
- Difficulty of finding related objects

Color;

- Different colored objects without guiding end-users about color codes
- No information about color codes among screens
- Some soft colored itesm are not legibile enough and hence easily missed by end-users

Graphics;

- Flashing objects
- Moving icons that distract attention

Navigation;

- Lack of a button that navigates end-users to the main page or to the home page on each screen
- Overlapping screens that cause screen complications
- Compartmentalized display of many sections on a single screen, whose functional relationships to each other are not obvious

Consistency of Operations;

- Duplicate buttons on some screens, such as two 'kaydet' (save) buttons on the drug dosage information screen.

Response Time;

- Some operations that take so much time without informing end-users

Error Prevention;

- Lack of confirmation messages after some operations

Resolution;

- Small font sizes on screens that decrease legibility

5.3. RQ 3. How can the Neuroogle interface be improved based on the usability issues identified?

With the help of several methods applied for this study many usability problems were revealed. To improve usability of the Neuroogle interface, these problems

should be fixed by the design team of the system. Some critical usability problems of the Neuroogle interface that should be given high proirty by the design team are as follow;

- Lack of help and documentation part
- Overall complexity of a system as a result of presenting so much information on same screen
- Small font sizes that make it difficult to read and realize important sections
- Indiscriminable search box on some screens
- Lack of messages that give information about what the system is doing at the moment or about processes being done by end-users and take confirmation of end-users on critical operations
- Non-systematic use of colors over screens

Recommendations for usability problems of Neuroogle interface also stated in chapter 6 of the study.

CHAPTER 6

CONCLUSION

Family medicine is a field of medicine which is becoming increasingly important in Turkey and receiving more demand day after day. In addition to this, an increasing number of doctors from other medical specialties are moving into the family medicine field by earning a family medicine certificate, and medicine schools are awarding increasingly more family medicine degrees.Therefore, software systems that are designed to help this growing branch of medical practice will have a big impact on the healthcare system in Turkey.

In an effort to deal with the implications of their new policy for promoting family medicine practice in Turkey, The Ministry of Health of Turkey contracted several software design projects to establish the Aile Hekimliği Bilgi Sistemi (Family Medicine Information System), which aim to serve family doctors on their daily tasks. Besides the official software released by the Ministry of Health of Turkey, some commercial software designed by companies has sprung up recently. Family doctors can individually decide to use which software they want among the state sponsored and professionally developed alternatives. Among these family medicine information systems (FMIS) designed for family doctors, Neuroogle has a great proportion of use, particularly in the Ankara region.

This study mainly focused on identifying the most important operations or tasks carried out by family doctors by using a FMIS like Neuroogle, and evaluating the system's interface by monitoring task completion times of novice users who had no prior training on Neuroogle. To achieve this goal, 20 novice subjects of Neuroogle FMIS participated in a usability experiment and their completion times of these tasks were observed. An eye-tracking study and a think-aloud method were employed to obtain both quantitative and qualitative results for assessing the usability of Neuroogle FMIS. The results of the experiment indicated how efficiently end-users (family doctors) carried out important tasks on the Neuroogle interface, and within these tasks which sections they experienced the most difficulty. In an effort to broaden to scope of the study, two heuristics evaluation guidelines by Nielsen (1993) and Xerox (2012) respectively were used to evaluate other features of Neuroogle, and a semi-structured interview was conducted with the family doctors to obtain contextual information. Overall, this study aimed to reveal the usability issues of the current Neuroogle interface, and suggest ways for improving the Neuroogle interface based on user-centered design principles. This aim was reached by the combination of usability evaluation methods used throughout the study.

The usability issues of the Neuroogle interface identified by the combination of usability evaluation methods can be summarized as, overall complexity of the system, uninformative warning messages, lack of information messages that report the system status, crowded information in screens, lack of navigation support, lack of help and documentation sections and the presence of error messages that involve terms belong to software terminology.

6.1. Recommendations to Improve Usability of Neuroogle FMIS

In the light of the usability evaluation methods used in this study, a number of significant usability problems were found and explained in the discussion section. To solve these problems some recommendations were made to the design team of the

software. These recommendations were organized in the light of KAKIS[3] (government institutions web-sites) standards and guidelines. For each guideline, usability issues related to the Neuroogle interface and recommendations for addressing these issues are provided below. Some key guidelines and their relationship to some of the usability issues identified by this thesis are listed as follows;

- The Neuroogle interface involves complex and crowded screens. To solve this issue, the interface should be refined and simplified to improve its learnability and efficiency. Complex and confusing pages should be avoided in the software, and end-users should be provided a simple page layout, especially for the most frequently carried out operations.

- The Neuroogle interface includes some texts that can hardly be read by elder people. So, font sizes should be made adjustable to improve legibility for users from different age groups. Also, font types should be selected according to end-users' familiarity.

- The Neuroogle interface involves some error and warning messages that contains phrases from software terminology. To solve this issue, these types of messages should be simplified and rephrased by using terms familiar to the target user group. Efficient and effective use of a system require end users to understand most essential components in the system. Thus, error or warning messages that appear in a system should be more sensible and guiding for the end-users.

- On the polyclinic screen an error message appears when users click on the "bölüm ekle" (add section) button that suddenly turns of the Neuroogle interface. Error messages that turn off the system like this message should be taken into consideration appropriately. The user should be clearly informed that the error requires a restart of the system and what might have caused the error. Data and session recovery should be provided in such circumstances.

- The Neuroogle interface involves a medicine list that contains incorrectly labeled drugs and drugs that are not available in the market. To solve this problem, the

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medicine list should be rearranged to eliminate drugs that are not up-to-date and incorrectly named.

- On the patient identity information entry screen of the Neuroogle interface, some of the text represented in different colors without specifiying their intended meanings and some of text is hard to be seen or noticed. Consequently, color codes should be redefined according to the importance of the information presented on the screen and should be explained to end-users (possibly in tool-tip messages). Moreover, in all sections of the interface, the most important information used for basic operations should be color-coded and presented with big font-size to improve awareness.

- The Neuroogle interface contains duplicate functions with different names such as "protocol defteri – poliklinik defteri" (protocol sheet – polyclinic sheet). To solve this type of issues, the same operation should not be defined with different names to improve consistency and to prevent ambiguity. Moreover, there should be consistency across and within pages.

- The Neurgoole interface lacks information messages that inform users about the system's status. To eliminate this problem, informative messages should be designed to inform end-users about what's going on with the system, especially while the system accesses remote databases such as MERNIS. Moreover, users should be informed when they need to wait while doing some operations.

- Some critical operations such as deleting a patient from the protocol section of the Neuroogle interface should be accompanied by confirmation messages to prevent possible serious errors.

- The Neuroogle interface contains so much information and so many sections on the same screen that makes users confused. To solve this issue, frequently used, fundamental and main operations should be placed on the main page and infrequently used operations should be placed on the auxiliary pages or sub-menus to reduce the complexity of the interface. For instance, frequently used diagnosis and drug section should be remodified to include only 2-3 items in polyclinic screen of the Neuroogle interface. Moreover, only the latest examination information should be placed on the diagnosis screen rather than information of the last three examinations.

- The Neuroogle interface presents multiple windows that overlap with each other, such as the drug and diagnosis screen which is often displayed over the polyclinic screen. To solve this issue, overlapping screens should be rearranged and each screen should be presented in full-screen mode to prevent possible confusion. In addition, the information presented in the screens of a system should be presented in a hierarcihal format. More important and useful information should be kept on the top of the screen and less important information should be kept on the lower side of the screen.

- Some buttons should be replaced according to established user interface norms/standards that shape user's expectations, such as non-conventionally placed save and close buttons on some screens on the medicine dosage information screen of Neuroogle interface.

- The Neuroogle interface does not contain help and documentation sections. The help and documentation sections should be urgently added into the system to improve troubleshooting.

- Moving icons and flashing objects such as patient icons in Neuroogle, should be redesigned to refrain from distracting end-users

- The Neuroogle interface does not contain main or home page button on the screens. As a solution for this problem, the home page button should be placed on each screen to enable end-users who are in trouble to turn into a page where they started the operation. Consequently, there should be an option that turns end-users to main page in every screen of a system.

- Some buttons or links like 'seçili kaydı sil' (delete selected item) and 'randevuları işlem kuyruğuna at' (assign appointments to operation queue) in Neuroogle should be redefined to be clearly understood by end-users and to prevent ambiguity.

- The Neuroogle system lacks for auto-checking property such as e-mail address entry. Thus, auto-checking or correction mechanisms should be designed for the data entering sections, such as e-mail entry box that checks a sign of '@' to be typed by end-users to eliminate mistyped information. When users type incorrectly formatted information into data entry fields, they should be informed by the system. System should also give information to users when they complete

data entry. In addition to auto-checking and informing, obligatory and optional data entry fields should be clearly stated.

- The Neuroogle system includes so many properties on screens that make users to hardly memorize items. To solve this issue, system should be designed according to short-term memory limits. Thus, end-users should not have to remember information from previous pages when they pass through new page in software.

- Software should be designed as it diminishes the cognitive workload of users as much as possible. To achive this, information organization, visual and audial items should be carefully used as they ease users' search behavior of what they need on the current screen.

6.2. Comparison of Usability Evaluation Methods Used in this Study

The usability evaluation methods used in this study complemented each other in terms of their relative strengths for identifying particular usability issues. Heuristics evaluation was more beneficial to discover basic design errors based on established usability principles. Semi-structured interview and video capturing were beneficial to reach information about the most important tasks for the family doctors and how these tasks are performed by them in their daily working routines. Semi-structured interview also revealed opinions of the family doctors towards Neuroogle FMIS. Cognitive modeling was useful to estimate expert users' task completion times, which was used as a rough baseline to approximate the time it would take to complete each task. However, if Cog-Tool program had a property of estimating task completion time for novice users, it could be even more useful by eliminating the need for running an usability experiment with human users. Eye-tracking experiment was helpful to uncover some statistical information such as fixation duration, fixation count, completion time and mouse click amounts. Eye tracking data allowed us to investigate how users' activity was mediated by the interface in greater detail and precision. Lastly, the think-aloud method was beneficial to examine what participants thought when they were dealing with tasks based on their comments related to interface design issues. If there is a matter of selecting one of these methods to make a usability evaluation of a system like Neuroogle, eye-tracking

study could be selected since it provides quantitative data that supports deep analysis of users' task performances and points out design issues explored by the target group of users of the system. A major disadvantage of an eye-tracking study is the cost of the equipment needed and the necessity to invite subjects to the lab setting. When such considerations make a usability evaluation impractable, one can opt for semi-structured interviews and heuristic evaluation methods to conduct a usability evaluation in a cost effective way.

6.3. Limitations of the Study

An important limitation of this study is that it could focus on a limited number features that are made available in the demo version of the Neuroogle FMIS. Since Neuroogle FMIS is an integrated system that contains some components connecting to the servers kept in the Turkish Ministry of Health in order to obtain laboratory examination results and some other data and the Central Population Management System to obtain address information of patients, the company that designed the Neuroogle FMIS could only provide the demo version of the system for security issues and for the prevention of permanent damage on these connected servers because of the actions done accidentally. As a consequence of using the demo version, some of the task scenarios designed may not reflect the exact sequence of events, such as a MERNİS (Merkezi Nüfus İdare Sistemi – Central Population Management System) connection during the rearrangement of the credentials of a specific patient. The system needed to connect MERNİS to save the updated information of a patient. After related changes were made by subjects of the study on the credentials of a specified patient in a task, subjects encountered a connection error to MERNİS when they tried to save the changes and they all assumed this connection was made and ended the task.

Another limitation of the study was the obligation of getting the subjects of the study to the HCI lab located in the METU Computer Center building due to the immobility of the eye-tracking device. As a result of this limitation, it was difficult to recruit medical experts as subjects since they have to come to the METU – HCI lab to

participate. Consequently, a small sample of medical experts could be included in the usability experiment. This problem was mitigated by including additional subjects who were IT professionals experienced in usability issues.

Yet another limitation was the sensitivity of the eye-tracking device for even small head movements of the participants. Although participants of the study were asked not to move or shake their heads during task performance in front of the eye-tracker device, some of them forgot to obey this rule. As a result of this situation, their eye-movement data consisted of small gaze point samples, and thus could not be used for further analysis, such as investigating fixation distributions on relevant items (Area of Interest) with the tasks.

6.4. Contributions of the Study

This study contributed to the investigation of most important tasks that family doctors in Turkey carry out on a FMIS like Neuroogle and how efficiently these tasks can be carried out by novice users who are new to Neuroogle. Another contribution of the study was the determination of the advantages and disadvantages of the Neuroogle FMIS as well as the identification of main usability issues of the existing Neuroogle interface. This study also quantitatively investigated how novice users handled the Neuroogle interface to carry out fundamental tasks along several dimensions, such as completion time, mouse click counts, time spent on relevant task objects, fixation and saccade distributions. Finally, based on the findings of the study, some solutions were recommended to improve the system's usability.

6.5. Recommendations for Future Research

Based on the discussion of the main findings, this study may be extended in several ways, such as;
- Comparison of two or more FMIS with respect to usability issues
- Age and computer literacy effect on learning to use a FMIS like Neuroogle

- Defining guidelines for designing an interface specific to Family Medicine practice
- Design and evaluation of an interface prototype that incorporates the findings of this study
- Devising an acceptance model of an interface designed for family doctors

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APPENDICES

APPENDIX A: INTERVIEW QUESTIONS

Neuroogle Family Medicine Information System (FMIS) – Interview Questions

1. Hangi Aile Hekimliği Bilgi Sistemini (AHBS) kullanıyorsunuz?

2. Bu sistemi ne kadar süredir kullanıyorsunuz?

3. Daha önce başka Aile Hekimliği Bilgi Sistemi (AHBS) kullandınız mı?

   a. Ne kadar süre kullandınız?

   b. Bu sistemi neden değiştirmek istediniz? / Sizce neden değiştirilmiş olabilir?

4. Şuan kullandığınız bu Aile Hekimliği Bilgi Sistemini (AHBS) kimler kullanabiliyor? Kimlerin kullanma yetkisi var?

5. Sistemde gerçekleştirdiğiniz başlıca işlemler nelerdir?

   a. Gün içinde en çok (sıklıkla) hangi işlemleri yapıyorsunuz?

   b. En az yapılan işlemler nelerdir?

6. Sistemde ulaşmanız gereken bilgilere kolaylıkla erişebiliyor musunuz?

   a. Birkaç örnek verebilir misiniz?

   b. En çok hangi bilgiye/bilgilere ulaşırken sorun yaşıyorsunuz?

   c. Yaşadığınız bu sorunlar nelerdir ve neden kaynaklanıyor?

7. Aile Hekimliği Bilgi Sistemini (AHBS) kullanırken bugüne kadar herhangi bir promlem veya hata ile karşılaştınız mı?

    a. Bu problem / problemler nelerdir?

    b. Bu hata(lar) kullandığınız yazılımdan mı kaynaklanıyordu yoksa kullanıcı hatası mıydı?

8. Olası bir hata ile karşılaştığınızda ne yapıyorsunuz? Hatayı gidermek için sistem size ne gibi bir destek sunuyor?

    a. Olası bir hatanın düzeltilmesi ne kadar süre alıyor?

    b. Düzeltilen hataların bir kaydı veya raporu tutuluyor mu?

9. Eğer sistemde bir değişiklik yapma imkanınız olsaydı neleri değiştirmek veya eklemek isterdiniz?

    a. Neden bu değişikliği / değişiklikleri yapmak isterdiniz?

10. Sistemi kullanmadan önce size bir eğitim veya seminer verildi mi?

    a. Bu seminer veya eğitim ne kadar sürdü?

    b. Kimler tarafından verildi?

    c. Memnun kaldınız mı?

    d. Verilen eğitimleri görevinizi yapma açısından yeterli buluyor musunuz?

11. Sistemi kullanırken ilk başlarda güçlük çektiğiniz durumlar veya özellikler oldu mu?

    a. Birkaç örnek verebilir misiniz?

    b. Daha sonra bu güçlükleri yenebildiniz mi ? Nasıl?

12. Sizce Aile Hekimliği Bilgi Sistemi (AHBS) kullanımı iş yükünü azalttı mı yoksa arttırdı mı?

    a. Bilgisayar ve Aile Hekimliği Bilgi Sistemi (AHBS) kullanılmadan önce temel işlemler (muayene, ilaç yazma vb.) tahminen ne kadar süre alıyordu?

    b. Aile Hekimliği Bilgi Sistemi (AHBS) kullanılmaya başlandıktan sonra bu işlemler yaklaşık ne kadar süre alıyor?

13. Aile Hekimliği Bilgi Sistemini (AHBS) kullanmaktan mutlu musunuz? Görüşlerinizi alabilir miyim?

APPENDIX B: INFORMED CONSENT FORM

Gönüllü Katılım Formu

Bu çalışma, Yrd. Doç Dr. Murat Perit ÇAKIR danışmanlığında Saba Öz tarafından yürütülen, AİLE HEKİMLİĞİ BİLGİ SİSTEMİNİN KULLANILABİLİRLİK TESTİ konusunu kapsamaktadır. Çalışmanın amacı Türkiye'de yaygın olarak kullanılan Neuroogle adlı Aile Hekimliği Bilgi Sisteminin kullanılabilirlik değerlendirmesinin yapılmasıdır. Bu değerlendirme kapsamında siz değerli katılımcılarımız Orta Doğu Teknik Üniversitesi Bilgi İşlem Bölümü – İnsan Bilgisayar Etkileşimi Labaratuarında bilgisayar kullanarak yapılacak olan bir teste dahil olacaksınız. Sizden değerlendirilecek olan bu sistemi kullanarak belirli görevleri yapmanız istenecektir. Çalışmaya katılımınız tamamiyle gönüllülük ilkesine bağlı olacaktır ve sizden kimlik belirleyici herhangi bir bilgi istenmeyecektir. Katılımınız değerlendirilen bu yazılımın kullanılabilirlik testi değerlerinin daha gerçekçi sonuçlara ulaşması bakımından bizim için çok değerli ve önemlidir. Değerli katılımınızla toplanan veriler (ses, görüntü kaydı) tamamen gizli tutulacak ve sadece araştırmacı tarafından etik kurallarına uygun şekilde değerlendirilecektir. Çalışmadan elde edilen bilgiler blimsel yayınlarda (tez, makale vb.) kullanılacaktır.

Test işleyişi ve kullanılan araç ve gereçler kişisel rahatsızlık verecek veya sağlığa zararlı olabilecek durumlar içermemektedir. Fakat, katılımınız süresince rahatsızlık duyduğunuz herhangi bir durum olduğunda veya isteğiniz dahilinde deneyi yarıda bırakabilirsiniz. Deney sonunda çalışma ile ilgili sorularınız olursa cevaplanacaktır. Çalışmaya katıldığınız için size şimdiden teşekkürlerimizi sunarız. Çalışma hakkında daha fazla bilgi almak için Enformatik Enstitüsü öğretim görevlilerinden Yrd. Doç. Dr. Murat Perit Çakır (ODTÜ – Enformatik Enstitüsü B Blok 205 nolu oda; Tel: 0312 210 77 06 ; e-posta: perit@metu.edu.tr) veya deney yürütücüsü ODTÜ – Enformatik

Enstitüsü – Tıp Bilişimi Bölümü yüksek lisans öğrencisi Saba Öz (ODTÜ – Temel İngilizce Bölümü – B Blok Zemin kat 05 Nolu oda; Tel: 0312 210 39 84; E-posta: saba@metu.edu.tr) ile iletişime geçebilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman çalışmayı yarıda bırakabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayınlarda kullanılmasını kabul ediyorum. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

Ad Soyad   Tarih   İmza

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APPENDIX C: DEBRIEFING FORM

KATILIM SONRASI BİLGİ FORMU

Bu çalışma, daha önce de belirtildiği gibi, Y. Doç Dr. Murat Perit ÇAKIR danışmanlığında Saba Öz tarafından yürütülen, AİLE HEKİMLİĞİ BİLGİ SİSTEMİNİN KULLANILABİLİRLİK TESTİ konusunu kapsamaktadır. Çalışmanın amacı Türkiye'de yaygın olarak kullanılan Neuroogle adlı Aile Hekimliği Bilgi Sistemi'nin kullanılabilirlik değerlendirmesinin yapılmasıdır. Bu değerlendirme kapsamında sizin katılımınızla elde edilen veriler dahilinde bu sistemi kullanarak günlük hayatta aile hekimleri tarafından kullanılan temel görevlerin ne kadar sürede gerçekleştirildiği, bu görevler yapılırken herhangi bir hata veya yazılımsal bir aksama gerçekleşip gerçekleşmediği tespit edilecektir.

Bu çalışmadan alınacak ilk verilerin Temmuz 2012 sonunda elde edilmesi amaçlanmaktadır. Elde edilen veriler sadece bilimsel araştırma ve yazılarda kullanılacaktır. Çalışmanın sonuçlarını öğrenmek ya da bu araştırma hakkında daha fazla bilgi almak için aşağıdaki isimlere başvurabilirsiniz. Çalışmaya katıldığınız için tekrar teşekkürlerimizi sunarız.

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ÇALIŞMA SONRASI KATILIM ANKETİ

Bu çalışma Orta Doğu Teknik Üniversitesi (ODTÜ), Enformatik Enstitüsü, Tıp Bilişimi Bölümü yüksek lisans öğrencisi Saba Öz tarafından yürütülmektedir. Bu anket genel olarak; bilgisayar kullanımınız ve Aile Hekimliği Bilgi Sistemine yönelik sorular içermektedir. Cevaplarınız kesinlikle gizli tutulacak ve sadece araştırmacı tarafından değerlendirilecektir. Elde edilen bilgiler sadece bilimsel yayımlarda kullanılacaktır.

1. İsminiz:

2. Yaşınız:

3. Cinsiyetiniz:
   □ E   □ K

4. Öğrenim Durumunuz:
   □ Lisans   □ Yüksek Lisans   □ Doktora   □ Tıp Doktoru

5. Uzmanlık Alanınız:

6. Çalıştığınız Kurum:

7. Kendinize ait bilgisayarınız var mı?
   □ Evet   □ Hayır

8. Bilgisayarı en çok nerde kullanıyorsunuz?
   □ Ev
   □ İş yeri
   □ Diğer……………….

9. Ne kadar zamandır bilgisayar kullanıyorsunuz?
  □ 6 aydan az
  □ 6 ay ile 1 yıl arası
  □ 1 yıl ile 2 yıl arası
  □ 2 yıl ile 3 yıl arası
  □ 3 yıl ile 4 yıl arası
  □ 4 yıl ile 5 yıl arası
  □ 5 yıldan fazla

10. Bilgisayarı en çok ne amaçla kullanıyorsunuz?
  ....
  ....
  ....

11. Bilgisayarda en çok yaptığınız işlemler nelerdir?
  ....
  ....
  ....

12. Şu an herhangi bir Aile Hekimliği Bilgi Sistemi kullanıyor musunuz ?
  □ Evet   □ Hayır

Cevabınız <u>evet</u> ise ;
Hangi Aile Hekimliği Bilgi Sistemini Kullanıyorsunuz?
  ....
Ne kadar süredir kullanıyorsunuz ?
  ....

13. *Neuroogle* Aile Hekimliği Bilgi Sistemini çalışmaya katılmadan önce duymuş muydunuz?
  □ Evet   □ Hayır

  Cevabınız evet ise;
  Kimden duymuştunuz ? (örnek: arkadaş, akraba, internet vb.)?
  ....

14. Neuroogle hakkındaki görüşleriniz nelerdir?
  ....
  ....
  ....
  ....

15. Çalışma esnasında görevleri yerine getirirken en çok hangi kısımlarda zorlandınız?

....
....
....
....

16. Neuroogle'da size karmaşık gelen bir durum oldu mu ?

....
....
....
....

KATILIMCI MEMNUNİYET ANKETİ

Bu çalışma Orta Doğu Teknik Üniversitesi (ODTÜ), Enformatik Enstitüsü, Tıp Bilişimi Bölümü yüksek lisans öğrencisi Saba Öz tarafından yürütülmektedir. Bu anket genel olarak; Neuroogle Aile Hekimliği Bilgi Sisteminde gerçekleştirdiğiniz işlemlerden ne derece memnun kaldığınıza yönelik sorular içermektedir. Cevaplarınız kesinlikle gizli tutulacak ve sadece araştırmacı tarafından değerlendirilecektir. Elde edilen bilgiler sadece bilimsel yayımlarda kullanılacaktır.

İsim – Soyisim :   e-posta:

	Kesinlikle Katılmıyorum				Kesinlikle Katılıyorum
1. Bu sistemi sıklıkla kullanacağımı düşünüyorum.	1	2	3	4	5
2. Sistemi karmaşık buldum.	1	2	3	4	5
3. Sistemin kolay kullanıldığını düşünüyorum.	1	2	3	4	5
4. Sistemi kullanırken teknik destek almak gerektiğini düşünüyorum.	1	2	3	4	5
5. Sistemin içinde çeşitli fonksiyonların iyi entegre edildiğini düşünüyorum.	1	2	3	4	5

6. Sistemde bazı tutarsızlıklar olduğunu düşünüyorum.

1	2	3	4	5

7. Bu sistemi ilk kez kullanan bir kişinin işlemleri kısa bir sürede gerçekleştirebileceğini düşünüyorum.

1	2	3	4	5

8. Sistemi kullanırken herhangi bir zorluk yaşamadım.

1	2	3	4	5

9. Sistemi kullanırken kendimden emindim.

1	2	3	4	5

10. Bu sistemi kullanmadan önce öğrenmem gereken şeyler olduğunu düşünüyorum.

1	2	3	4	5

Eye-Tracking Study - Fixation and Saccades Analysis of Tasks

Below the tables show Fixation, Saccades and Gaze Point analysis results for each task. Fixation count represents total fixation numbers collected during task perform and Area of Interest (AOI) columns represent fixations fell into relevant objects of tasks and Not area of Interests (NAOI) columns represent fixations fell into irrelevant objects of tasks. Saccades columns represent the number of fast eye-movements and gaze points columns represent total number of points fell into everywhere in the screens.

Task1:

Table F.1 Fixation, Saccade and Gaze Point Statistics of Task1

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	210	64	146	314	8685
P02	256	83	173	348	11281
P03	102	34	68	106	4246
P04	209	55	154	310	8498
P05	127	31	96	281	4590
P06	73	24	49	121	3505
P07	522	18	504	552	19914
P08	474	54	420	541	19083
P09	34	4	30	155	2087
P10	128	18	110	192	5056

Task2:

Table F.2 Fixation, Saccade and Gaze Point Statistics of Task2

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	447	68	379	772	19518
P02	724	264	460	1031	33614
P03	428	134	294	457	18608
P04	244	52	192	421	11057
P05	210	84	126	441	9122
P06	374	125	249	677	14068
P07	969	123	846	1473	35812
P08	786	141	645	1001	28864
P09	272	25	247	1085	13483
P10	169	51	118	283	7029

Task3:

Table F.3 Fixation, Saccade and Gaze Point Statistics of Task3

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	110	47	63	199	5498
P02	627	172	455	1094	28296
P03	117	34	83	125	5303
P04	456	82	374	785	16665
P05	237	65	172	452	8139
P06	336	60	276	560	11886
P07	100	7	93	177	3808
P08	222	54	168	276	8931
P09	100	10	90	541	7079
P10	276	30	246	419	10370

Task4:

Table F.4 Fixation, Saccade and Gaze Point Statistics of Task4

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	227	183	44	429	9173
P02	625	336	289	1100	24999
P03	622	445	177	703	26367
P04	513	446	67	895	22365
P05	417	338	79	921	15103
P06	701	622	79	1318	28965
P07	491	416	75	735	26130
P08	550	502	48	738	23578
P09	255	178	77	1162	13530
P10	251	182	69	618	13543

Task5:

Table F.5 Fixation, Saccade and Gaze Point Statistics of Task5

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	114	91	23	173	4904
P02	396	297	99	624	21262
P03	345	251	94	402	13630
P04	457	410	47	772	17969
P05	93	87	6	253	3551
P06	313	213	100	503	9250
P07	294	256	38	336	12101
P08	261	243	18	386	10701
P09	112	76	36	420	5324
P10	76	70	6	308	4319

Task6:

Table F.6 Fixation, Saccade and Gaze Point Statistics of Task6

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	43	7	36	78	1710
P02	63	3	60	99	3190
P03	62	2	60	66	2195
P04	71	11	60	139	2502
P05	129	25	104	271	4777
P06	48	8	40	94	1776
P07	108	0	108	120	4080
P08	134	21	113	209	4963
P09	114	1	113	475	5911
P10	41	14	27	101	1711

Task7:

Table F.7 Fixation, Saccade and Gaze Point Statistics of Task7

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	513	294	219	1030	22219
P02	514	329	185	736	25899
P03	243	118	125	304	9454
P04	1324	670	654	2135	47284
P05	493	271	222	1062	17842
P06	537	326	211	1091	18904
P07	358	269	89	570	12944
P08	1223	21	1202	1674	47759
P09	150	62	88	776	9172
P10	648	221	427	1374	25271

Task8:

Table F.8 Fixation, Saccade and Gaze Point Statistics of Task8

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	1036	132	904	2395	41700
P02	687	0	687	1486	27700
P03	251	50	201	295	9254
P04	975	0	975	1404	36175
P05	497	0	497	1062	17521
P06	886	51	835	1707	30719
P07	484	0	484	716	17674
P08	444	178	266	548	19991
P09	369	85	284	1530	18414
P10	494	109	385	1330	24393

Task9:

Table F.9 Fixation, Saccade and Gaze Point Statistics of Task9

Participant	Fixation Counts (FC)	Area of Interest (AOI)	Not Area of Interest (NAOI)	Saccades	Gaze Points
P01	285	199	86	776	11706
P02	918	405	513	1811	42023
P03	1059	373	686	1216	39268
P04	589	374	215	1002	22453
P05	430	270	160	870	15451
P06	318	190	128	651	12304
P07	788	347	441	915	33293
P08	231	153	78	323	11003
P09	302	126	176	1148	14668
P10	99	70	29	266	8314

APPENDIX G: XEROX HEURISTICS EVALUATION RESULTS

Xerox heuristics evaluation results of Neuroogle FMIS stated below;

Visibility of System Status

This heuristic emphasizes that system should always keep user informed about what is going on, through appropriate feedback within reasonable time and it has 29 criteria for evaluation. Evaluation results with respect to this heuristic illustrated with graph below;

Visibility of System Status
■ Yes ■ No ■ N/A

6	20	3
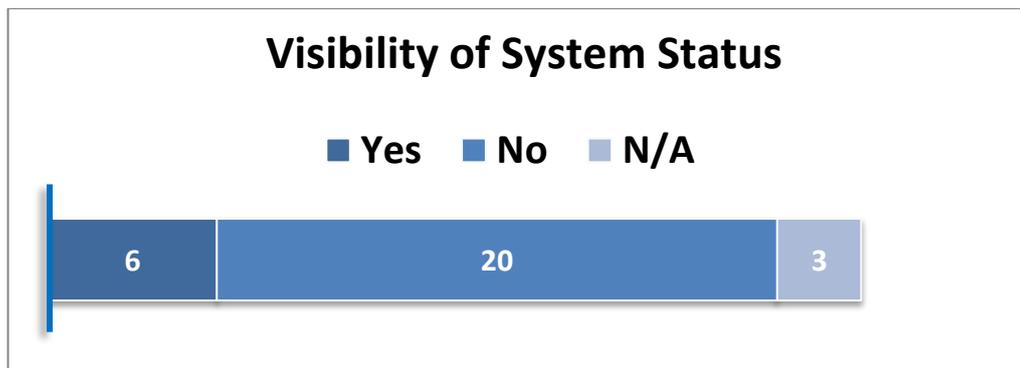
Figure G.1 Xerox – Visibility of System Status

Match Between System and the Real World

This heuristic includes 24 items and it emphasizes that the system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. The system should also follow real-world conventions, making information appear in a natural and logical order. Evaluation results of this heuristics stated below with chart;

Match Between System and the Real World

■ Yes   ■ No   ■ N/A

| 5 | 15 | 4 |
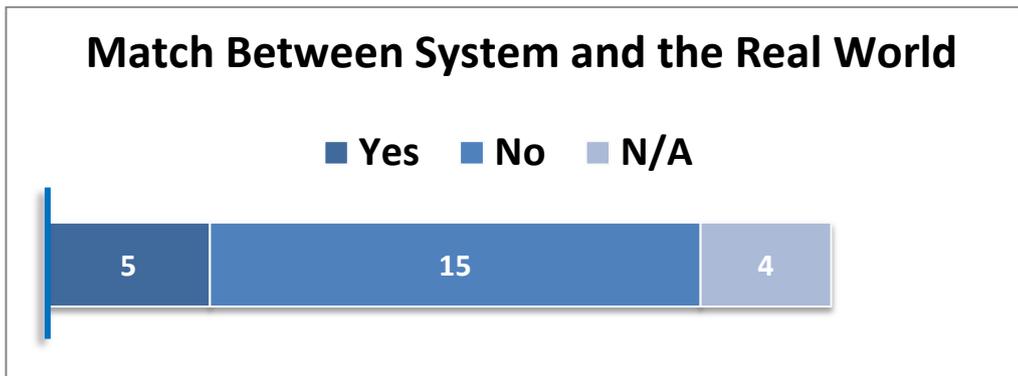
Figure G.2 Xerox – Match between System and the Real World

User Control and Freedom

User should be free to select and sequence tasks (when appropriate), rather than having the system does this for them. Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Users should make their own decisions (with clear information) regarding the costs of exiting current work. The system should support undo and redo. This heuristic has 23 items to check and evaluation results stated below;

User Control and Freedom

■ Yes   ■ No   ■ N/A

| 10 | 11 | 2 |
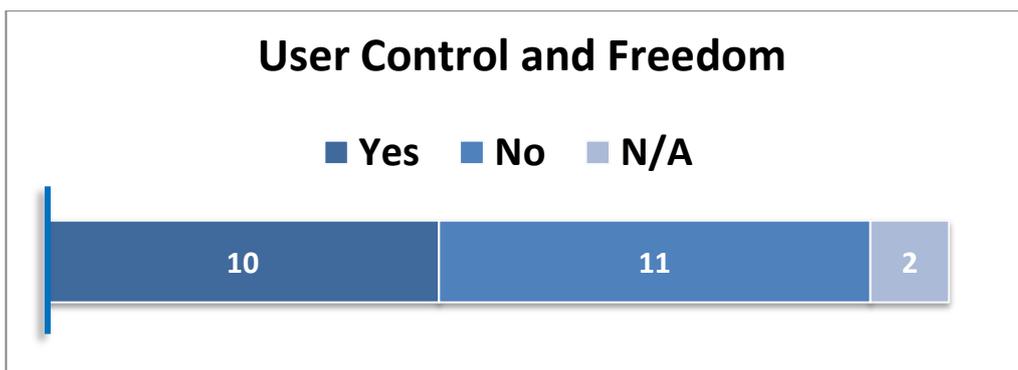
Figure G.3 Xerox – User Control and Freedom

Consistency and Standards

Heuristic of Consistency and standard has 51 items for evaluation of systems. This heuristic emphasizes that users should not have to wonder whether different words, situations, or actions mean the same thing. Evaluation of the system with respect to consistency and standards heuristic illustrated below with chart;
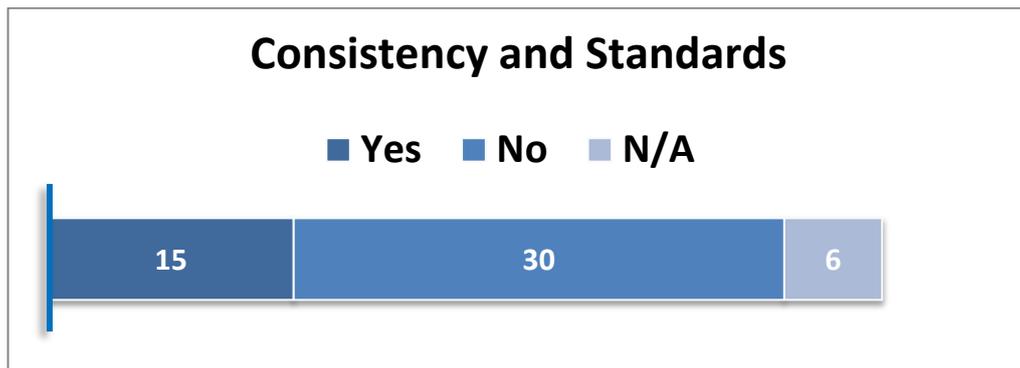
Figure G.4 Xerox – Consistency and Standards

Help Users Recognize, Diagnose, and Recover From Errors

Error messages appear in system should be expressed in plain and target group's languages. It should not contain any codes or phrases that belong to software terminology. This heuristic has 21 items to check and evaluation result stated below;
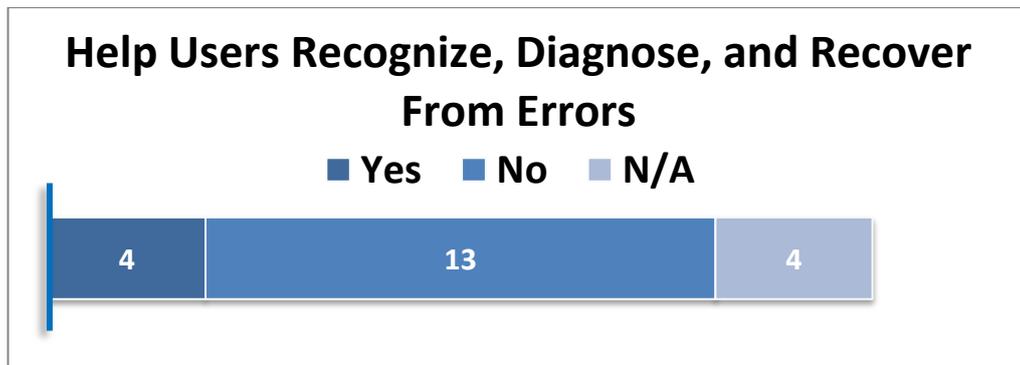
Figure G.5 Xerox – Help Users Recognize, Diagnose and Recover from Errors

Error Prevention

System should be carefully designed in order to prevent problems or errors before they occur in the first place. This heuristic has 15 items to check and evaluation of the system with respect to this heuristic illustrated below.
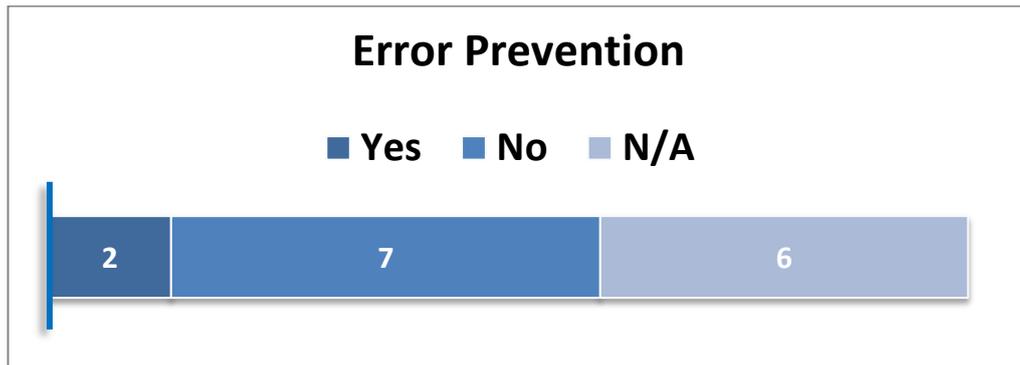
Figure G.6 Xerox – Error Prevention

Recognition Rather Than Recall

System should be designed that makes objects, actions and options visible. The user should not have to memorize procedures and remember information from one part of the system to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate. This heuristic has 40 items and evaluation result illustrated below;
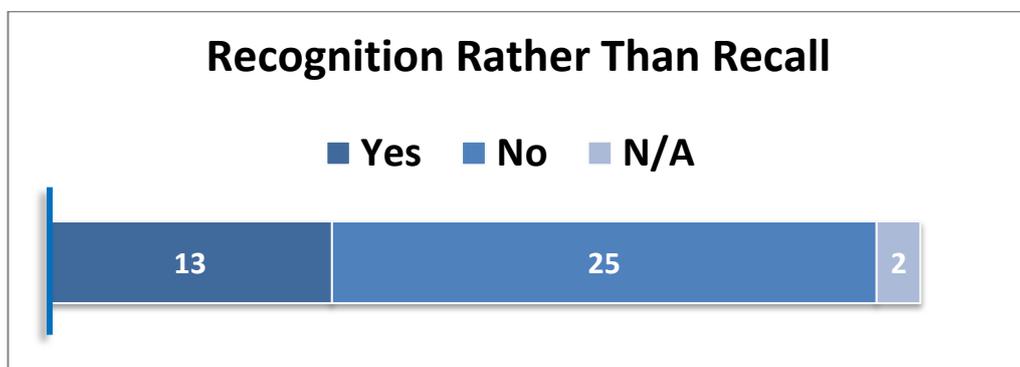
Figure G.7 Xerox – Recognition Rather than Recall

Flexibility and Minimalist Design

Accelerators-unseem by the novice user-may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. Provide alternative means of access and operation for users who differ from the "average" user (e.g., physical or cognitive ability, culture, language, etc.) This Heuristic has16 items to evaluate system and result given below;
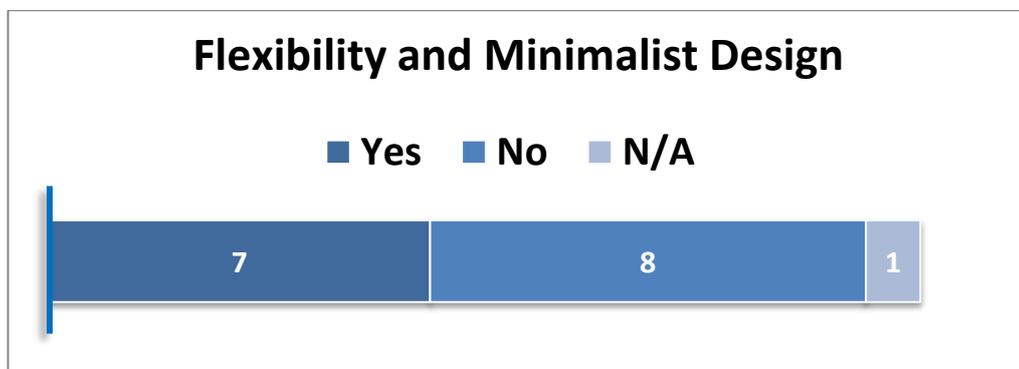
Figure G.8 Xerox – Flexibility and Minimalist Design

Aesthetics and Minimalist Design

This heuristic has 12 items and claims that Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility. Evaluation results stated below;
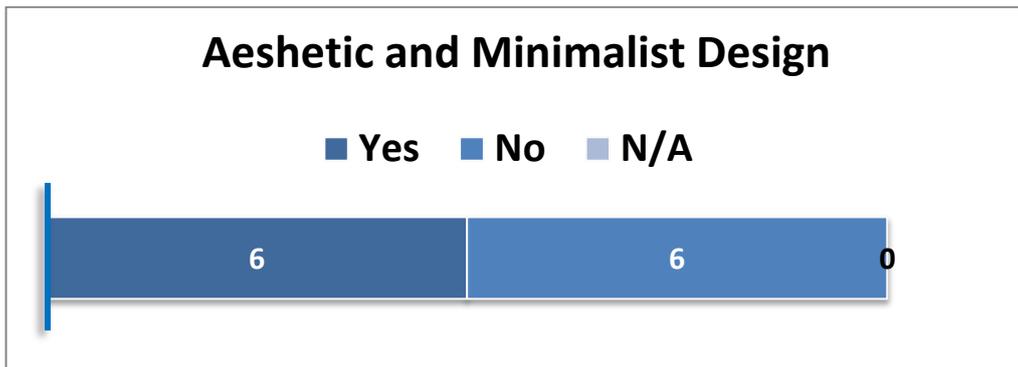
Figure G.9 Xerox – Aesthetic and Minimalist Design

Help and Documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large. With this heuristics evaluator evaluates the software or the system with 23 items, and results stated below;
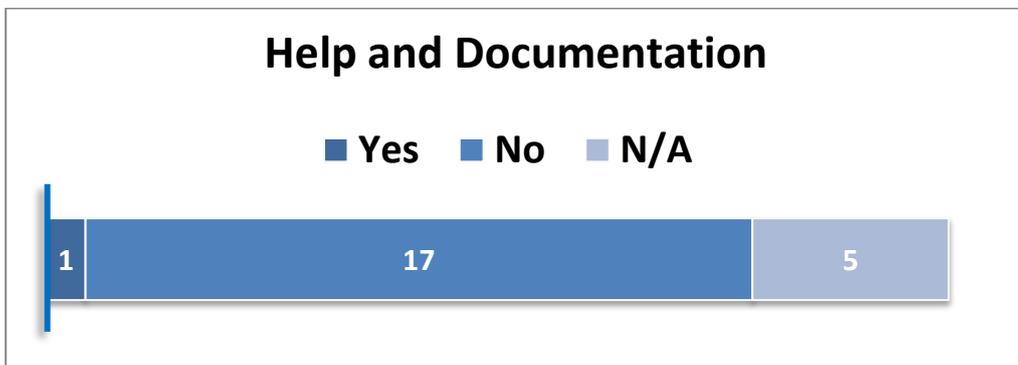
Figure G.10 Xerox – Help and Documentation

Skills

This heuristic emphasize that the system should support, extend, supplement, or enhance the user's skills, background knowledge, and expertise not replace them.

Heuristic of skills has 21 items and evaluations according to these items illustrated below;

Skills

■ Yes ■ No ■ N/A

| 11 | 9 | 1 |
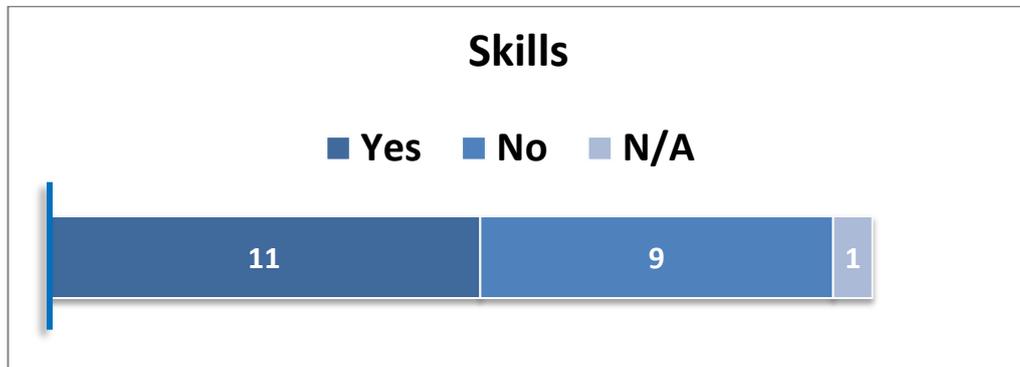
Figure G.11 Xerox – Skills

Pleasurable and Respectful Interaction with the User

The user's interactions with the system should enhance the quality of her or his work-life. The user should be treated with respect. The design should be aesthetically pleasing- with artistic as well as functional value. This Heuristic has 14 items totally and evaluation results illustrated below;

Pleasurable and Respectful Interaction with the User

■ Yes ■ No ■ N/A

| 5 | 5 | 4 |
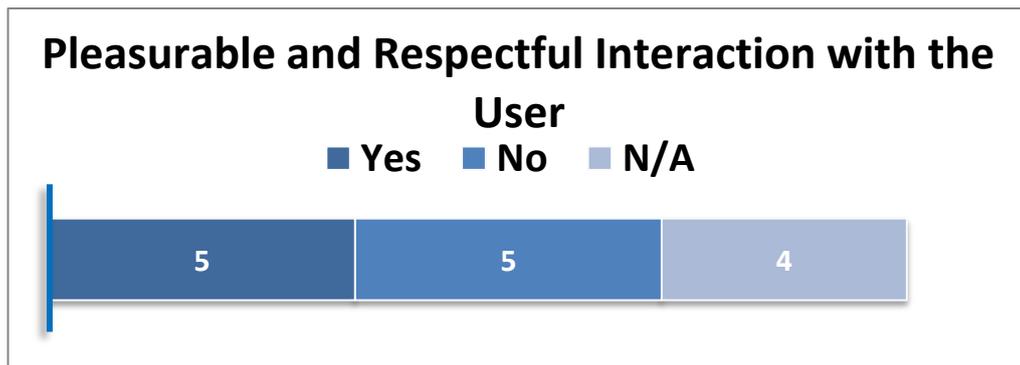
Figure G.12 Xerox – Pleasurable and Respectful Interaction with the User

Privacy

The system should help the user to protect personal or private information- belonging to the user or his/her clients. This heuristic has 3 items totally and none of them is acceptable or suitable for the Neuroogle FMIS results are formed by only N/A as stated below.
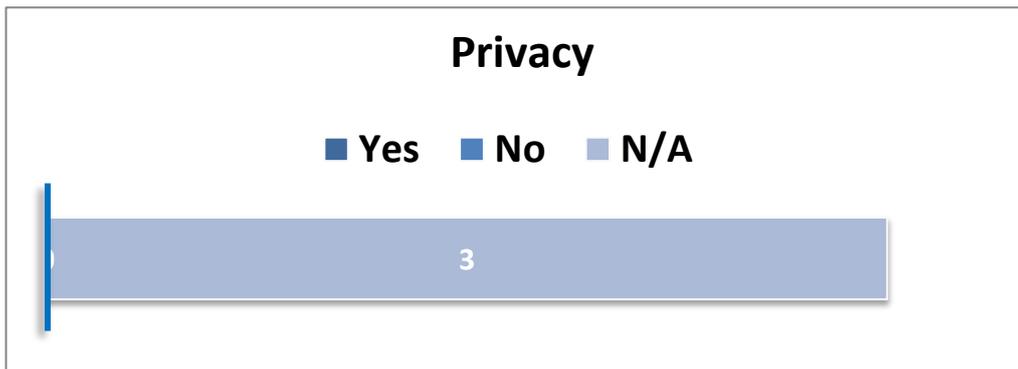
Figure G.13 Xerox – Privacy

Task1: Check whether a patient named Ahmet Ozturk is registered in the Neuroogle Family Medicine Information System

Step 1: Click into 'Arama' box on the middle top of the main screen	**Step 2:** Type first 2 – 3 chracters of patient being searched into box
Step 4: Click on 'Ara' button on the right side of 'Arama' box	**Step 3:** Select the patient name listed below the box (Auto-completion search)
Step 5: Select the patient being searched from search results	
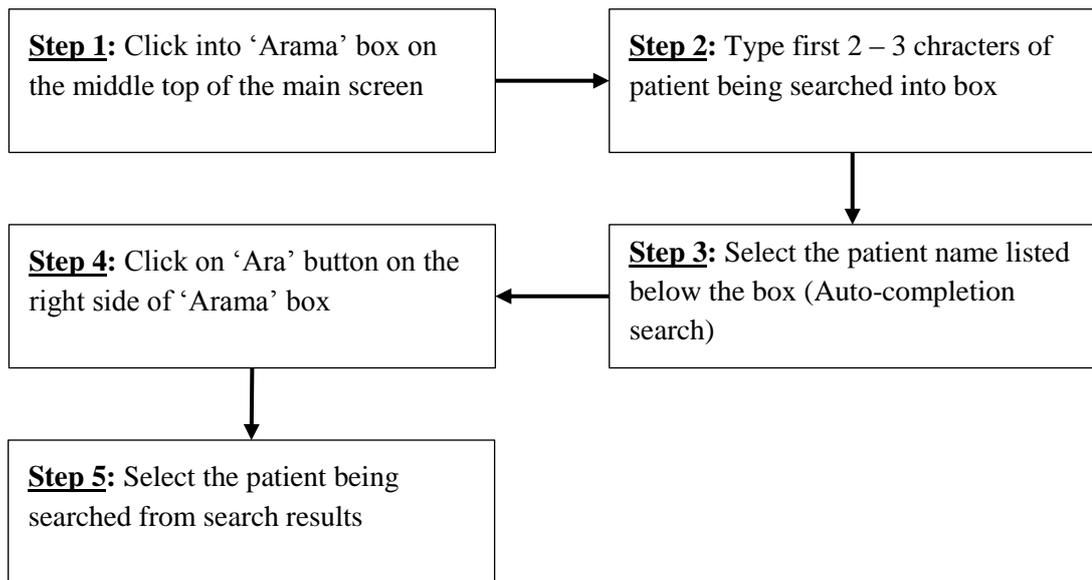
Figure H.1 Steps of Completing Task1 (1st way)

Step 1: Click on 'Kesin Kayıtlı' button on the main screen	**Step 2:** Search the patient with using navigation buttons
	Step 3: Select the patient being searched from search results
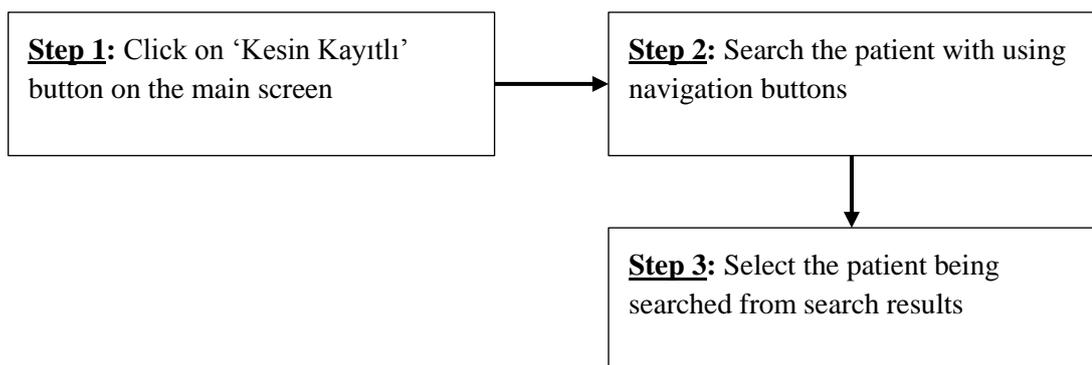
Figure H.2 Steps of Completing Task1 (2nd way)

Step 1: Click Poliklinik Defteri Button or Poliklinik text on the main screen	→	Step 2: Click into 'Arama' box on the top of the Poliklinik Defteri screen
Step 4: Select the patient being searched from search results	←	Step 3: Type first 2 – 3 chracters of patient being searched into box
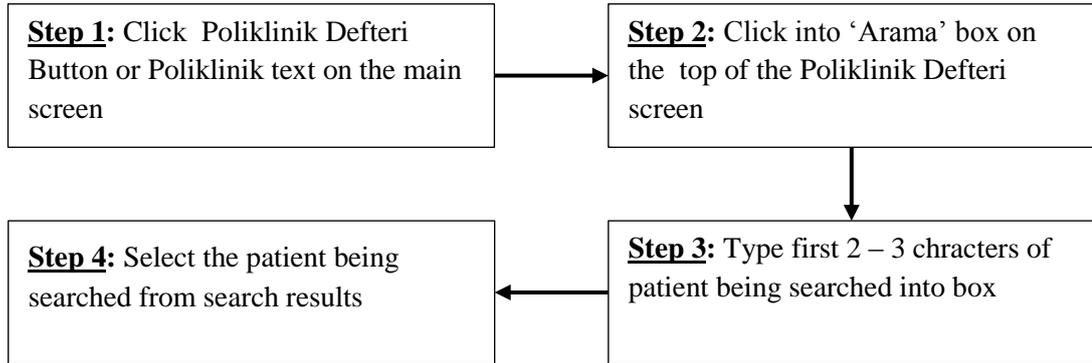
Figure H.3 Steps of Completing Task1 (3rd way)

Task 2: Open the registration information of the patient named Şükrü Yılmaz and do some changes on his registration information. Enter his e-mail address as 'sukruyilmaz@yahoo.com', select blood type as A-Rh+ and select social security type as 'Emekli Sandığı'.

Step 1: Click into 'Arama' box on the middle top of the main screen	Step 2: Type first 2 – 3 chracters of patient being searched into box
Step 4: Click on 'Ara' button on the right side of 'Arama' box	Step 3: Select the patient name listed below the box (Auto-completion search)
Step 5: Select the patient being searched from search results	Step 6: Click 'Kimlik Bilgilerini Düzenle' text on the left-top of the screen.
Step 8: Type 'sukruyilmaz@yahoo.com' as an e-mail address	Step 7: Click e-mail address on the 'Kimlik Bilgileri' Tab of the Registiration informaiton screen
Step 9: Click Blood Type drop-down list	Step 9: Click Blood Type drop-down list
Step 12: Select 'Emekli Sandığı' as social security type	Step 11: Click social security dorp-down list
Step 13: Click 'Kaydet ve Kapat (son)' button on the below	

Figure H.4 Steps of Completing Task2 (1st way)

Step 1: Click into 'Arama' box on the middle top of the main screen

Step 2: Type first 2 – 3 chracters of patient being searched into box

Step 4: Click on 'Ara' button on the right side of 'Arama' box

Step 3: Select the patient name listed below the box (Auto-completion search)

Step 5: Select the patient being searched from search results

Step 6: Right click on the patient name

Step 8: Click e-mail address on the 'Kimlik Bilgileri' Tab of the Regsitiration informaiton screen

Step 7: Select 'Hasta Detayını Aç' option on the menu

Step 9: Type 'sukruyilmaz@yahoo.com' as e-mail address

Step 10: Click Blood Type drop-down list

Step 12: Click social security dorp-down list

Step 11: Select A Rh+ for the blood type

Step 13: Select 'Emekli Sandığı' as social security type

Step 14: Click 'Kaydet ve Kapat (son)' button on the below

Figure H.5 Steps of Completing Task2 (2nd way)

Step 1: Click on 'Kesin Kayıtlı' button on the main screen	→	**Step 2:** Search the patient with using navigation buttons

Step 4: Click 'Kimlik Bilgilerini Düzenle' text on the left-top of the screen.	←	**Step 3:** Select the patient being searched from search results

Step 5: Click e-mail address on the 'Kimlik Bilgileri' Tab of the Registiration informaiton screen	→	**Step 6:** Type 'sukruyilmaz@yahoo.com' as e-mail address

Step 8: Click Blood Type drop-down list	←	**Step 7:** Select A Rh+ for the blood type

Step 9: Select 'Emekli Sandığı' as social security type	→	**Step 10:** Click social security dorp-down list

	Step 11: Click 'Kaydet ve Kapat (son)' button on the below

Figure H.6 Steps of Completing Task2 (3rd way)

Step 1: Click on 'Kesin Kayıtlı' button on the main screen	**Step 2:** Search the patient with using navigation buttons
Step 4: Right click on the patient name	**Step 3:** Select the patient being searched from search results
Step 5: Select 'Hasta Detayını Aç' option on the menu	**Step 6:** Click e-mail address on the 'Kimlik Bilgileri' Tab of the Registiration informaiton screen
Step 8: Select A Rh+ for the blood type	**Step 7:** Type 'sukruyilmaz@yahoo.com' as an e-mail address
Step 9: Click Blood Type drop-down list	**Step 10:** Select 'Emekli Sandığı' as social security type
Step 12: Click 'Kaydet ve Kapat (son)' button on the below	**Step 11:** Click social security dorp-down list

Figure H.7 Steps of Completing Task2 (4th way)

Task3: Assign patient named Kemal Çakır to 'Poliklinik Defteri' (Polyclinic Book)

Step 1: Click into 'Arama' box on the middle top of the main screen	**Step 2:** Type first 2 – 3 chracters of patient being searched into box
Step 4: Click on 'Ara' button on the right side of 'Arama' box	**Step 3:** Select the patient name listed below the box (Auto-completion search)
Step 5: Select the patient being searched from search results	**Step 6:** Right click on the patient name
	Step 7: Select 'Poliklinik Defterine At' option on the menu

Figure H.8 Steps of Completing Task3 (1st way)

Step 1: Click on 'Kesin Kayıtlı' button on the main screen	**Step 2:** Search the patient with using navigation buttons
Step 4: Right click on the patient name	**Step 3:** Select the patient being searched from search results
Step 5: Select 'Poliklinik Defterine At' option on the menu	
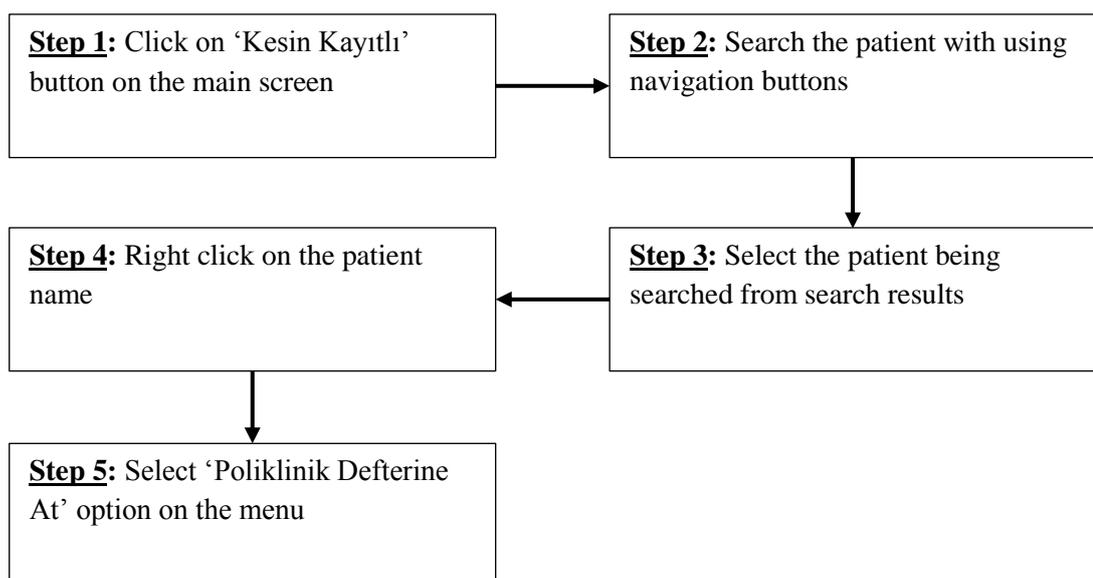
Figure H.9 Steps of Completing Task3 (2nd way)

Step 1: Click Poliklinik Defteri Button or Poliklinik text on the main screen	→	Step 2: Click into 'Arama' box on the top of the Poliklinik Defteri screen
Step 4: Select the patient being searched from search results	←	Step 3: Type first 2 – 3 chracters of patient being searched into box
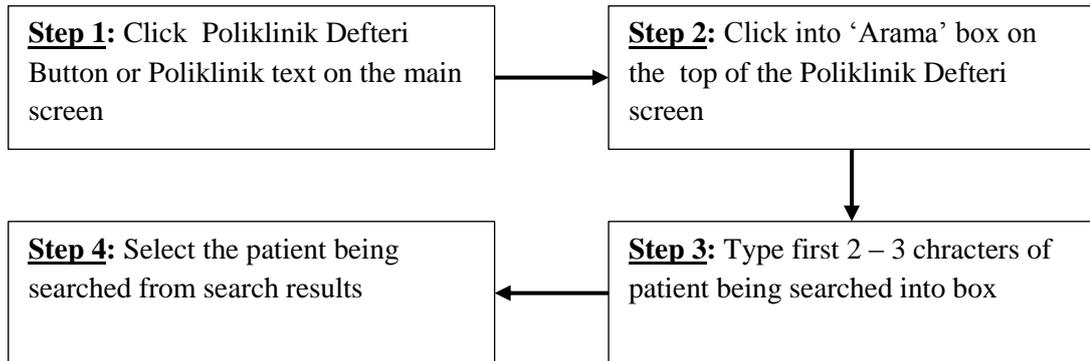
Figure H.10 Steps of Completing Task3 (3rd way)

Task4: Diagnose Gastro-Esofagial Reflux disease for the patient named Kemal Çakır and dose Gaviscon Advance 200 ml suspension with dosage 2x3x1 and Lansor 30 mg 28 Capsule with dosage 1x1x1.

Step 1: Click into 'Arama' box above the tanı seçimi tab(tanı seçimi tab shoul be selected first)	Step 2: Type first 2 – 3 chracters or full name of the diagnosis being diagnosed to patient into box
Step 4: Click on Reçete tab near tanı seçimi tab in order to see the list of drugs	Step 3: Select the diagnosis name listed below the tanı seçimi tab (diagnosis will be added to patient examination information)
Step 5: Type first 2 – 3 chracters or full name of the drug (gaviscon) being prescribed to patient into box	Step 6: Select the drug name listed below the reçete tab (drug will be added to patient examination information)
Step 8: Type '3' into second box on drug dosage screen	Step 7: Type '2' into first box on drug dosage screen
Step 9: Type '1' into third box on drug dosage screen	Step 10: Click 'kaydet' button on the bottom of the drug dosage screen
Step 12: Select the drug name listed below the reçete tab (drug will be added to patient examination information)	Step 11: Type first 2 – 3 chracters or full name of the drug (lansor) being prescribed to patient into 'Arama' box
Step 13: Type '1' into first box on drug dosage screen	Step 14: Type '1' into second box on drug dosage screen
Step 16: Click 'kaydet' button on the bottom of the drug dosage screen	Step 15: Type '1' into third box on drug dosage screen

Figure H.11 Steps of Completing Task4

Task5: Change the drug named Lansor with Nexium

Step 1: Click drug name on the 'Reçete İlaçları' section on the left bottom of the page	**Step 2:** Click 'seçili kaydı sil' link on the right buttom of the 'reçete ilaçları' section
Step 4: Type first 2 – 3 chracters or full name of the drug (Nexium) being prescribed to patient into Arama box	**Step 3:** Click 'Evet' button on the information message asking whether you are sure to delete drug or not
Step 5: Select the drug name listed below the reçete tab (drug will be added to patient examination information)	**Step 6:** Type dosage information for Nexium (1x1x1)
	Step 7: Click 'kaydet' button on the bottom of the drug dosage screen

Figure H.12 Steps of Completing Task5

Task6: Give prescription of the drugs prescribed to Kemal Çakır on previous tasks.

Step 1: On the poliklinik screen or diagnosis screen see the link of 'Reçete yazıdr (F5)' link	**Step 2:** Click 'Reçete Yazdır' link or press F5 key on the keyboard.

Figure H.13 Steps of Completing Task6

Task7: Diagnose Acute Bronchiolitis for the patient named Jale Hüzün and give her a three day medical report.

Step 1: Click 'Arama' box on the poliklinik defteri screen	**Step 2:** Type first 2 – 3 chracters or full name of patient being searched into box
Step 4: Select the diagnosis from the diagnosis list	**Step 3:** Clicke on the patient name from search results
Step 5: Exit from the diagnosis screen	**Step 6:** Click 'Raporlar' button on the upper right of the screen.
Step 8: Click on the report time box on the small screen	**Step 7:** On the sub menu, select the 'İstirahat Raporu' option.
Step 9: Type '3' into box and click on OK button.	

Figure H.14 Steps of Completing Task7 (1st way)

Step 1: Click 'Arama' box on the poliklinik defteri screen	→	**Step 2:** Type first 2 – 3 chracters or full name of patient being searched into box
Step 4: Select the diagnosis from the diagnosis list	←	**Step 3:** Click on the patient name from search results
Step 5: Exit from the diagnosis screen	→	**Step 6:** Click 'İstirahat Raporu' button from 'Hızlı İşlev Butonları' section on 'Poliklinik Defteri' screen.
Step 8: Type '3' into box and click on OK button	←	**Step 7:** Click on the report time box on the small screen

Figure H.15 Steps of Completing Task7 (2nd way)

Task8: A patient named Polat Çelik says that he has an appointment on current day. Check whether he has an appointment on current day or not. If he has not an appointment on current day, give an appointment to him two days after current date.

Step 1: Click into 'Arama' box above the main screen	**Step 2:** Type first 2 – 3 chracters or full name of the patient being searched into box
Step 4: Click on 'Ara' button on the right side of 'Arama' box	**Step 3:** Select the patient name listed below the box (Auto-completion search)
Step 5: Select the patient being searched from search results with two left mouse clicks	**Step 6:** Select 'Randevuları' option from the sub menu appears below the patient name
Step 8: Select Appointment date from date section	**Step 7:** Check the patient name on screen if patient name does not exist on the screen click 'Yeni'button for giving appointment
Step 9: Click 'İlgili Kişiyi Seçin' link above the date setion	**Step 10:** Type first 2 – 3 chracters or full name of the patient into box
Step 12: Click 'Seç' button below the screen	**Step 11:** Select patient from search result below the box
Step 13: Click 'Randevu Türü' drop down list near the date section	**Step 14:** Select 'Muayene' for the appointment type
Step 16: Click 'Kaydet' button to finish giving appointment process	**Step 15:** Adjust the appointment type by using arrow button near the time section

Figure H.16 Steps of Completing Task8 (1st way)

Step 1: Click on 'Kesin Kayıtlı' button on the main screen	→	**Step 2:** Search the patient with using navigation buttons
Step 4: Select the patient being searched from search results with two left mouse clicks	←	**Step 3:** Select the patient being searched from search results
Step 5: Select 'Randevuları' option from the sub menu appears below the patient name	→	**Step 6:** Check the patient name on screen if patient name does not exist on the screen click 'Yeni'button for giving appointment
Step 8: Click 'İlgili Kişiyi Seçin' link above the date setion	←	**Step 7:** Select Appointment date from date section
Step 9: Type first 2 – 3 chracters or full name of the patient into box	→	**Step 10:** Select patient from search result below the box
Step 12: Click 'Randevu Türü' drop down list near the date section	←	**Step 11:** Click 'Seç' button below the screen
Step 13: Select 'Muayene' for the appointment type	→	**Step 14:** Adjust the appointment type by using arrow button near the time section
		Step 15: Click 'Kaydet' button to finish giving appointment process

Figure H.17 Steps of Completing Task8 (2nd way)

Task9: Examine medical history of the patient named Şakir Sönmez and check his cigarette and alcohol consumption and obesity condition. In addition to this, check whether he has chronic disease or not. If not, define essential (primer) hypertension as chronic disease for him.

Step 1: Click into 'Arama' box above the main screen	**Step 2:** Type first 2 – 3 chracters or full name of the patient being searched into box
Step 4: Click on 'Ara' button on the right side of 'Arama' box	**Step 3:** Select the patient name listed below the box (Auto-completion search)
Step 5: Select the patient being searched from search results	**Step 6:** Examine medical history of the patient on the left side of the screen
Step 8: Check alcohol consumption of the patient by clicking drop down menu near the alcohol text	**Step 7:** Check cigarette consumption of the patient by clicking drop down menu near the cigarette text
Step 9: Click chornic disease text if there is no chronic disease defined	**Step 10:** Click 'Yeni' button on the medical history screen comes after clicking chronic disease text
Step 12: Select the disease from the list shows matching results below	**Step 11:** Type chronic disease name into box
Step 13: Click on 'Seç' button on the bottom	

Figure H.18 Steps of Completing Task9 (1st way)

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Step 1: Click on 'Kesin Kayıtlı' button on the main screen	Step 2: Search the patient with using navigation buttons

Step 4: Select the patient being searched from search results	Step 3: Select the patient being searched from search results

Step 5: Examine medical history of the patient on the left side of the screen	Step 6: Check cigarette consumption of the patient by clicking drop down menu near the cigarette text

Step 8: Click chornic disease text if there is no chronic disease defined	Step 7: Check alcohol consumption of the patient by clicking drop down menu near the alcohol text

Step 9: Click 'Yeni' button on the medical history screen comes after clicking chronic disease text	Step 10: Type chronic disease name into box

Step 12: Click on 'Seç' button on the bottom	Step 11: Select the disease from the list shows matching results below

Figure H.19 Steps of Completing Task9 (2nd way)

Figure I.1 Task1 – Completion Time Box-Plot Graph

Figure I.2 Task2 – Completion Time Box-Plot Graph

Figure I.3 Task3 – Completion Time Box-Plot Graph
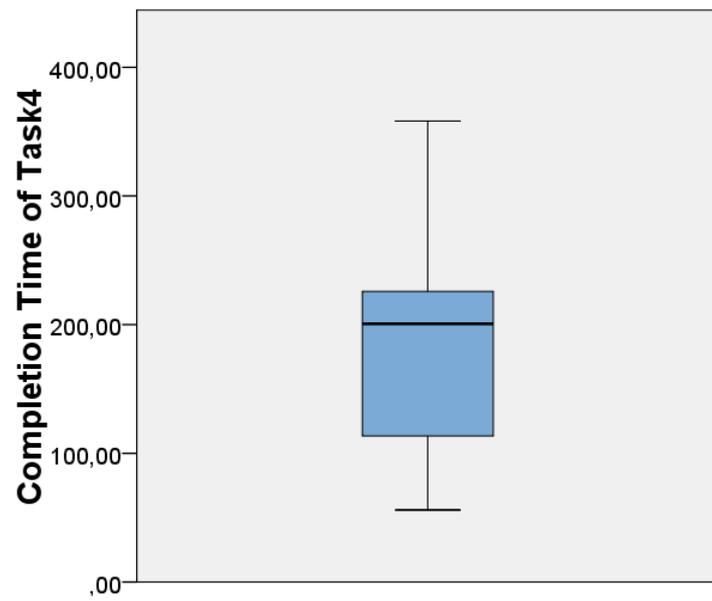
Figure I.4 Task4 – Completion Time Box-Plot Graph
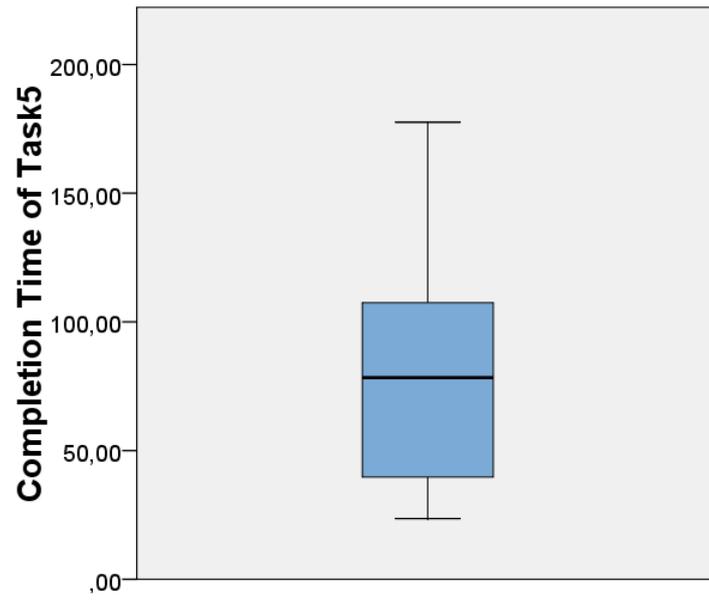
Figure I.5 Task5 – Completion Time Box-Plot Graph
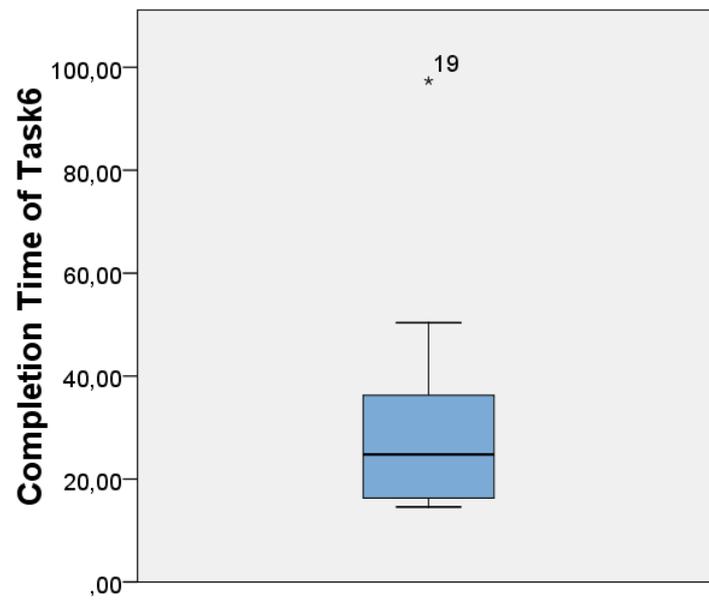
Figure I.6 Task6 – Completion Time Box-Plot Graph
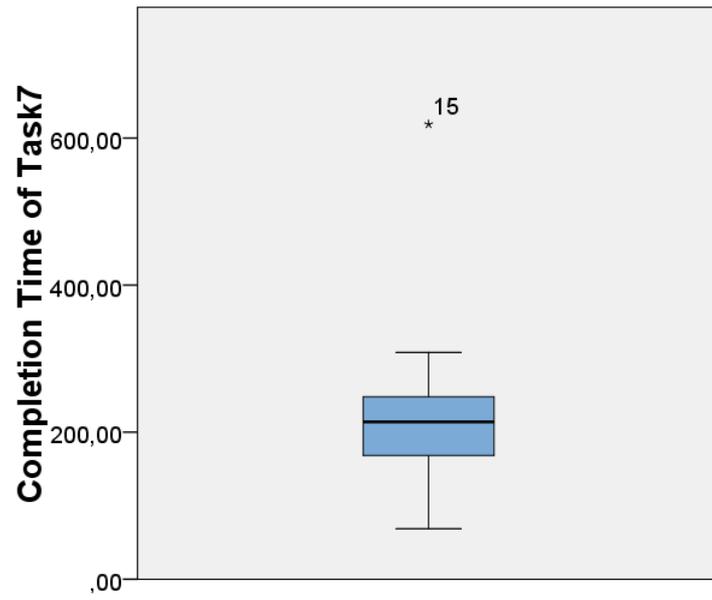
Figure I.7 Task7 – Completion Time Box-Plot Graph
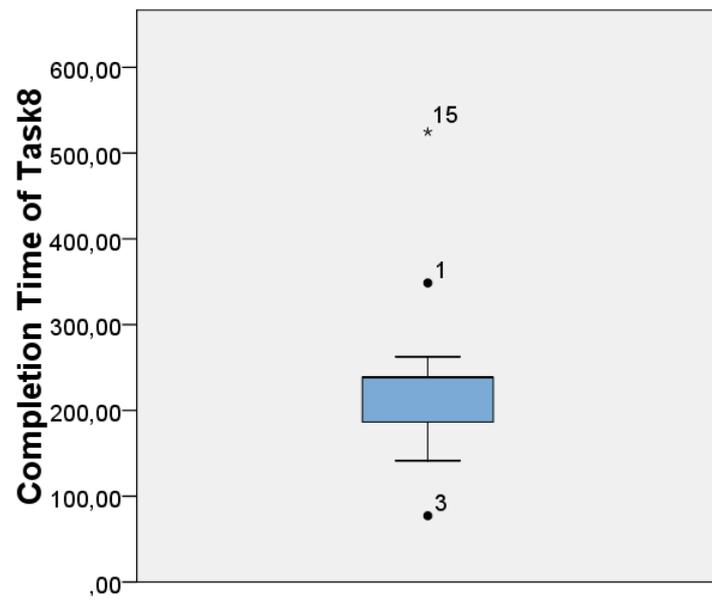
Figure I.8 Task8 – Completion Time Box-Plot Graph
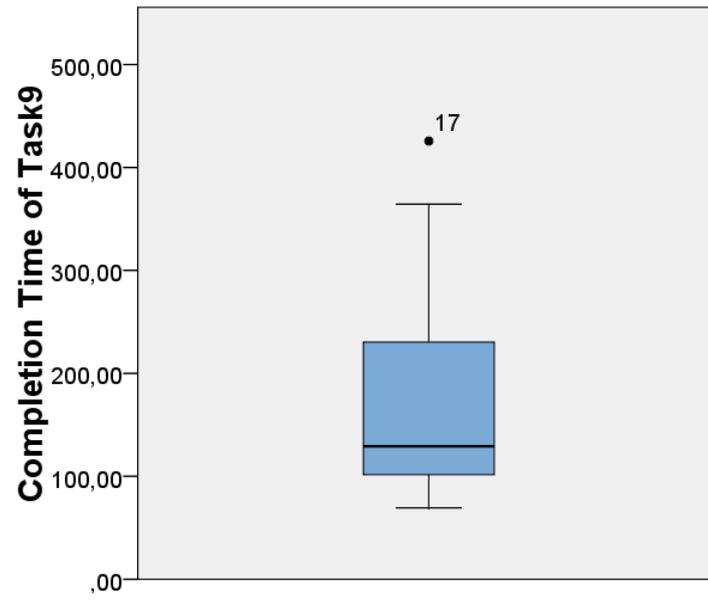
Figure I.9 Task9 – Completion Time Box-Plot Graph

APPENDIX J: APPROVAL LETTER OF PRACTICAL ETHICS RESEARCH BOARD

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B.30.2.ODT.0.44.12.00/418 — 6842

29.05.2012

GÖNDERİLEN: Prof.Dr.Belgin Ayvaşık
                     Rektör Danışmanı

GÖNDEREN: Prof.Dr.Nazife Baykal
                  Enformatik Enstitüsü Müdür

KONU: Saba Öz

Sağlık Bilişimi Anabilim Dalı Tıp Bilişimi Yüksek Lisans programı öğrencisi 1334804 no.lu Saba Öz'ün, 16 Nisan 2012 – 01 Ağustos 2012 tarihleri arasında "AİLE HEKİMLİĞİ BİLGİ SİSTEMİNİN KULLANILABİLİRLİK TESTİ" başlıklı araştırma çalışmasına ilişkin "ODTÜ Bilgi İşlem İnsan Bilgisayar Etkileşimi Laboratuvarı (HCI Lab)"nda uygulama yapmak için görevlendirme başvurusu incelenmiş, ilgili EABD Başkanlığı'nın görüşüne dayanarak adı geçen öğrencinin isteği doğrultusunda görevlendirilmesine Etik Komite onayı koşulu ile uygun görülmüştür.

Saygılarımla,

Ek: YKK
     EABD

Etik Komite Onayı

Uygundur

05../06/2012

Prof. Dr. Canan ÖZGEN
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkanı
ODTÜ 06531 ANKARA

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APPENDIX K: RESEARCH REQUEST LETTER TO METU MEDICAL CENTER TO WORK WITH GENERAL PRACTITIONERS

Orta Doğu Teknik Üniversitesi
Middle East Technical University

Enformatik Enstitüsü
Graduate School of Informatics

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Phone: +90 (312) 2103741
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B.30.2.ODT.0.44.12.00 1476 – 459   18.06.2012

SAĞLIK VE REHBERLİK MERKEZİ BAŞHEKİMLİĞİNE

Enstitümüz "Sağlık Bilişimi Anabilim Dalı Tıp Bilişimi Yüksek Lisans Programı öğrencilerinden Saba Öz, " Aile Hekimliği Bilgi Sisteminin Kullanılabilirlik Testi" Başlıklı araştırma çalışması ile ilgili olarak 20 Haziran – 30 Temmuz 2012 tarihleri arasında Başhekimliğinizde uygulama yapmak istemektedir. Saba Öz'e "Aile Hekimliği Bilgi Sisteminin Kullanılabilirlik Testi" başlıklı çalışması ile ilgili olarak Başhekimliğinizde uygulama yapması konusunda izin verilebilmesi için gereğini rica ederim.

Saygılarımla,

Prof. Dr. Nazife Baykal
Enformatik Enstitüsü Müdürü

Ek : ODTÜ Etik Kurul Onayı

Heuristic Evaluation - A System Checklist

1. Visibility of System Status

The system should always keep user informed about what is going on, through appropriate feedback within reasonable time.

#	Review Checklist	Yes	No	N/A	Comments
1.1	Does every display begin with a title or header that describes screen contents?	O	O	O	
1.2	Is there a consistent icon design scheme and stylistic treatment across the system?	O	O	O	
1.3	Is a single, selected icon clearly visible when surrounded by unselected icons?	O	O	O	
1.4	Do menu instructions, prompts, and error messages appear in the same place(s) on each menu?	O	O	O	
1.5	In multipage data entry screens, is each page labeled to show its relation to others?	O	O	O	
1.6	If overtype and insert mode are both available, is there a visible indication of which one the user is in?	O	O	O	
1.7	If pop-up windows are used to display error messages, do they allow the user to see the field in error?	O	O	O	
1.8	Is there some form of system feedback for every operator action?	O	O	O	
1.9	After the user completes an action (or group of actions), does the feedback indicate that the next group of actions can be started?	O	O	O	
1.10	Is there visual feedback in menus or dialog boxes about which choices are selectable?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
1.11	Is there visual feedback in menus or dialog boxes about which choice the cursor is on now?	O	O	O	
1.12	If multiple options can be selected in a menu or dialog box, is there visual feedback about which options are already selected?	O	O	O	
1.13	Is there visual feedback when objects are selected or moved?	O	O	O	
1.14	Is the current status of an icon clearly indicated?	O	O	O	
1.15	Is there feedback when function keys are pressed?	O	O	O	
1.16	If there are observable delays (greater than fifteen seconds) in the system's response time, is the user kept informed of the system's progress?	O	O	O	
1.17	Are response times appropriate to the task?	O	O	O	
1.18	Typing, cursor motion, mouse selection: 50-1 50 milliseconds	O	O	O	
1.19	Simple, frequent tasks: less than 1 second	O	O	O	
1.20	Common tasks: 2-4 seconds	O	O	O	
1.21	Complex tasks: 8-12 seconds	O	O	O	
1.22	Are response times appropriate to the user's cognitive processing?	O	O	O	
1.23	Continuity of thinking is required and information must be remembered throughout several responses: less than two seconds.	O	O	O	
1.24	High levels of concentration aren't necessary and remembering information is not required: two to fifteen seconds.	O	O	O	
1.25	Is the menu-naming terminology consistent with the user's task domain?	O	O	O	
1.26	Does the system provide *visibility:* that is, by looking, can the user tell the state of the system and the alternatives for action?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
1.27	Do GUI menus make obvious which item has been selected?	O	O	O	
1.28	Do GUI menus make obvious whether deselection is possible?	O	O	O	
1.29	If users must navigate between multiple screens, does the system use context labels, menu maps, and place markers as navigational aids?	O	O	O	

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2. Match between System and the Real World

The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

#	Review Checklist	Yes	No	N/A	Comments
2.1	Are icons concrete and familiar?	O	O	O	
2.2	Are menu choices ordered in the most logical way, given the user, the item names, and the task variables?	O	O	O	
2.3	If there is a natural sequence to menu choices, has it been used?	O	O	O	
2.4	Do related and interdependent fields appear on the same screen?	O	O	O	
2.5	If shape is used as a visual cue, does it match cultural conventions?	O	O	O	
2.6	Do the selected colors correspond to common expectations about color codes?	O	O	O	
2.7	When prompts imply a necessary action, are the words in the message consistent with that action?	O	O	O	
2.8	Do keystroke references in prompts match actual key names?	O	O	O	
2.9	On data entry screens, are tasks described in terminology familiar to users?	O	O	O	
2.10	Are field-level prompts provided for data entry screens?				
2.11	For question and answer interfaces, are questions stated in clear, simple language?	O	O	O	
2.12	Do menu choices fit logically into categories that have readily understood meanings?	O	O	O	
2.13	Are menu titles parallel grammatically?	O	O	O	
2.14	Does the command language employ user jargon and avoid computer jargon?	O	O	O	
2.15	Are command names specific rather than general?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
2.16	Does the command language allow both full names and abbreviations?	O	O	O	
2.17	Are input data codes meaningful?	O	O	O	
2.18	Have uncommon letter sequences been avoided whenever possible?	O	O	O	
2.19	Does the system automatically enter leading or trailing spaces to align decimal points?	O	O	O	
2.20	Does the system automatically enter a dollar sign and decimal for monetary entries?	O	O	O	
2.21	Does the system automatically enter commas in numeric values greater than 9999?	O	O	O	
2.22	Do GUI menus offer activation: that is, make obvious how to say *"now do it"?*	O	O	O	
2.23	Has the system been designed so that keys with similar names do not perform opposite (and potentially dangerous) actions?	O	O	O	
2.24	Are function keys labeled clearly and distinctively, even if this means breaking consistency rules?	O	O	O	

3. User Control and Freedom

Users should be free to select and sequence tasks (when appropriate), rather than having the system do this for them. Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Users should make their own decisions (with clear information) regarding the costs of exiting current work. The system should support undo and redo.

#	Review Checklist	Yes	No	N/A	Comments
3.1	If setting up windows is a low-frequency task, is it particularly easy to remember?	O	O	O	
3.2	In systems that use overlapping windows, is it easy for users to rearrange windows on the screen?	O	O	O	
3.3	In systems that use overlapping windows, is it easy for users to switch between windows?	O	O	O	
3.4	When a user's task is complete, does the system wait for a signal from the user before processing?	O	O	O	
3.5	Can users type-ahead in a system with many nested menus?	O	O	O	
3.6	Are users prompted to confirm commands that have drastic, destructive consequences?	O	O	O	
3.7	Is there an "undo" function at the level of a single action, a data entry, and a complete group of actions?	O	O	O	
3.8	Can users cancel out of operations in progress?	O	O	O	
3.9	Are character edits allowed in commands?	O	O	O	
3.10	Can users reduce data entry time by copying and modifying existing data?	O	O	O	
3.11	Are character edits allowed in data entry fields?	O	O	O	
3.12	If menu lists are long (more than seven items), can users select an item either by moving the cursor or by typing a mnemonic code?	O	O	O	
3.13	If the system uses a pointing device, do users have the option of either clicking on menu items or using a keyboard shortcut?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
3.14	Are menus broad (many items on a menu) rather than deep (many menu levels)?	O	O	O	
3.15	If the system has multiple menu levels, is there a mechanism that allows users to go back to previous menus?	O	O	O	
3.16	If users can go back to a previous menu, can they change their earlier menu choice?	O	O	O	
3.17	Can users move forward and backward between fields or dialog box options?	O	O	O	
3.18	If the system has multipage data entry screens, can users move backward and forward among all the pages in the set?	O	O	O	
3.19	If the system uses a question and answer interface, can users go back to previous questions or skip forward to later questions?	O	O	O	
3.20	Do function keys that can cause serious consequences have an undo feature?	O	O	O	
3.21	Can users easily reverse their actions?	O	O	O	
3.22	If the system allows users to reverse their actions, is there a retracing mechanism to allow for multiple undos?	O	O	O	
3.23	Can users set their own system, session, file, and screen defaults?	O	O	O	

4. Consistency and Standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

#	Review Checklist	Yes	No	N/A	Comments
4.1	Have industry or company formatting standards been followed consistently in all screens within a system?	O	O	O	
4.2	Has a heavy use of all uppercase letters on a screen been avoided?	O	O	O	
4.3	Do abbreviations not include punctuation?	O	O	O	
4.4	Are integers right-justified and real numbers decimal-aligned?	O	O	O	
4.5	Are icons labeled?	O	O	O	
4.6	Are there no more than twelve to twenty icon types?	O	O	O	
4.7	Are there salient visual cues to identify the active window?	O	O	O	
4.8	Does each window have a title?	O	O	O	
4.9	Are vertical and horizontal scrolling possible in each window?	O	O	O	
4.10	Does the menu structure match the task structure?	O	O	O	
4.11	Have industry or company standards been established for menu design, and are they applied consistently on all menu screens in the system?	O	O	O	
4.12	Are menu choice lists presented vertically?	O	O	O	
4.13	If "exit" is a menu choice, does it always appear at the bottom of the list?	O	O	O	
4.14	Are menu titles either centered or left-justified?	O	O	O	

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#	Review Checklist	Yes	No	N/A	Comments
4.15	Are menu items left-justified, with the item number or mnemonic preceding the name?	O	O	O	
4.16	Do embedded field-level prompts appear to the right of the field label?	O	O	O	
4.17	Do on-line instructions appear in a consistent location across screens?	O	O	O	
4.18	Are field labels and fields distinguished typographically?	O	O	O	
4.19	Are field labels consistent from one data entry screen to another?	O	O	O	
4.20	Are fields and labels left-justified for alpha lists and right-justified for numeric lists?	O	O	O	
4.21	Do field labels appear to the left of single fields and above list fields?	O	O	O	
4.22	Are attention-getting techniques used with care?	O	O	O	
4.23	Intensity: two levels only	O	O	O	
4.24	Size: up to four sizes	O	O	O	
4.25	Font: up to three	O	O	O	
4.26	Blink: two to four hertz	O	O	O	
4.27	Color: up to four (additional colors for occasional use only)	O	O	O	
4.28	Sound: soft tones for regular positive feedback, harsh for rare critical conditions	O	O	O	
4.29	Are attention-getting techniques used only for exceptional conditions or for time-dependent information?	O	O	O	
4.30	Are there no more than four to seven colors, and are they far apart along the visible spectrum?	O	O	O	
4.31	Is a legend provided if color codes are numerous or not obvious in meaning?	O	O	O	
4.32	Have pairings of high-chroma, spectrally extreme colors been avoided?	O	O	O	
4.33	Are saturated blues avoided for text or other small, thin line symbols?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
4.34	Is the most important information placed at the beginning of the prompt?	O	O	O	
4.35	Are user actions named consistently across all prompts in the system?	O	O	O	
4.36	Are system objects named consistently across all prompts in the system?	O	O	O	
4.37	Do field-level prompts provide more information than a restatement of the field name?	O	O	O	
4.38	For question and answer interfaces, are the valid inputs for a question listed?	O	O	O	
4.39	Are menu choice names consistent, both within each menu and across the system, in grammatical style and terminology?	O	O	O	
4.40	Does the structure of menu choice names match their corresponding menu titles?	O	O	O	
4.41	Are commands used the same way, and do they mean the same thing, in all parts of the system?	O	O	O	
4.42	Does the command language have a consistent, natural, and mnemonic syntax?	O	O	O	
4.43	Do abbreviations follow a simple primary rule and, if necessary, a simple secondary rule for abbreviations that otherwise would be duplicates?	O	O	O	
4.44	Is the secondary rule used only when necessary?	O	O	O	
4.45	Are abbreviated words all the same length?	O	O	O	
4.46	Is the structure of a data entry value consistent from screen to screen?	O	O	O	
4.47	Is the method for moving the cursor to the next or previous field consistent throughout the system?	O	O	O	
4.48	If the system has multipage data entry screens, do all pages have the same title?	O	O	O	
4.49	If the system has multipage data entry screens, does each page have a sequential page number?	O	O	O	
4.50	Does the system follow industry or company standards for function key assignments?	O	O	O	
4.51	Are high-value, high-chroma colors used to attract attention?	O	O	O	

5. Help Users Recognize, Diagnose, and Recover From Errors

Error messages should be expressed in plain language(NO CODES).

#	Review Checklist	Yes	No	N/A	Comments
5.1	Is sound used to signal an error?	O	O	O	
5.2	Are prompts stated constructively, without overt or implied criticism of the user?	O	O	O	
5.3	Do prompts imply that the user is in control?	O	O	O	
5.4	Are prompts brief and unambiguous.	O	O	O	
5.5	Are error messages worded so that the system, not the user, takes the blame?	O	O	O	
5.6	If humorous error messages are used, are they appropriate and inoffensive to the user population?	O	O	O	
5.7	Are error messages grammatically correct?	O	O	O	
5.8	Do error messages avoid the use of exclamation points?	O	O	O	
5.9	Do error messages avoid the use of violent or hostile words?	O	O	O	
5.10	Do error messages avoid an anthropomorphic tone?	O	O	O	
5.11	Do all error messages in the system use consistent grammatical style, form, terminology, and abbreviations?	O	O	O	
5.12	Do messages place users in control of the system?	O	O	O	
5.13	Does the command language use normal action-object syntax?	O	O	O	
5.14	Does the command language avoid arbitrary, non-English use of punctuation, except for symbols that users already know?	O	O	O	
5.15	If an error is detected in a data entry field, does the system place the cursor in that field or highlight the error?	O	O	O	

5.16	Do error messages inform the user of the error's severity?	O	O	O	
5.17	Do error messages suggest the cause of the problem?	O	O	O	
5.18	Do error messages provide appropriate semantic information?	O	O	O	
5.19	Do error messages provide appropriate syntactic information?	O	O	O	
5.20	Do error messages indicate what action the user needs to take to correct the error?	O	O	O	
5.21	If the system supports both novice and expert users, are multiple levels of error-message detail available?	O	O	O	

6. Error Prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place.

#	Review Checklist	Yes	No	N/A	Comments
6.1	If the database includes groups of data, can users enter more than one group on a single screen?	O	O	O	
6.2	Have dots or underscores been used to indicate field length?	O	O	O	
6.3	Is the menu choice name on a higher-level menu used as the menu title of the lower-level menu?	O	O	O	
6.4	Are menu choices logical, distinctive, and mutually exclusive?	O	O	O	
6.5	Are data inputs case-blind whenever possible?	O	O	O	
6.6	If the system displays multiple windows, is navigation between windows simple and visible?	O	O	O	
6.7	Are the function keys that can cause the most serious consequences in hard-to-reach positions?	O	O	O	
6.8	Are the function keys that can cause the most serious consequences located far away from low-consequence and high-use keys?	O	O	O	
6.9	Has the use of qualifier keys been minimized?	O	O	O	
6.10	If the system uses qualifier keys, are they used consistently throughout the system?	O	O	O	
6.11	Does the system prevent users from making errors whenever possible?	O	O	O	
6.12	Does the system warn users if they are about to make a potentially serious error?	O	O	O	
6.13	Does the system intelligently interpret variations in user commands?	O	O	O	
6.14	Do data entry screens and dialog boxes indicate the number of character spaces available in a field?	O	O	O	
6.15	Do fields in data entry screens and dialog boxes contain default values when appropriate?	O	O	O	

7. Recognition Rather Than Recall

Make objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

#	Review Checklist	Yes	No	N/A	Comments
7.1	For question and answer interfaces, are visual cues and white space used to distinguish questions, prompts, instructions, and user input?	O	O	O	
7.2	Does the data display start in the upper-left corner of the screen?	O	O	O	
7.3	Are multiword field labels placed horizontally (not stacked vertically)?	O	O	O	
7.4	Are all data a user needs on display at each step in a transaction sequence?	O	O	O	
7.5	Are prompts, cues, and messages placed where the eye is likely to be looking on the screen?	O	O	O	
7.6	Have prompts been formatted using white space, justification, and visual cues for easy scanning?	O	O	O	
7.7	Do text areas have "breathing space" around them?	O	O	O	
7.8	Is there an obvious visual distinction made between "choose one" menu and "choose many" menus?	O	O	O	
7.9	Have spatial relationships between soft function keys (on-screen cues) and keyboard function keys been preserved?	O	O	O	
7.10	Does the system gray out or delete labels of currently inactive soft function keys?	O	O	O	
7.11	Is white space used to create symmetry and lead the eye in the appropriate direction?	O	O	O	
7.12	Have items been grouped into logical zones, and have headings been used to distinguish between zones?	O	O	O	
7.13	Are zones no more than twelve to fourteen characters wide and six to seven lines high?	O	O	O	

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#	Review Checklist	Yes	No	N/A	Comments
7.14	Have zones been separated by spaces, lines, color, letters, bold titles, rules lines, or shaded areas?	O	O	O	
7.15	Are field labels close to fields, but separated by at least one space?	O	O	O	
7.16	Are long columnar fields broken up into groups of five, separated by a blank line?	O	O	O	
7.17	Are optional data entry fields clearly marked?	O	O	O	
7.18	Are symbols used to break long input strings into "chunks"?	O	O	O	
7.19	Is reverse video or color highlighting used to get the user's attention?	O	O	O	
7.20	Is reverse video used to indicate that an item has been selected?	O	O	O	
7.21	Are size, boldface, underlining, color, shading, or typography used to show relative quantity or importance of different screen items?	O	O	O	
7.22	Are borders used to identify meaningful groups?	O	O	O	
7.23	Has the same color been used to group related elements?	O	O	O	
7.24	Is color coding consistent throughout the system?	O	O	O	
7.25	Is color used in conjunction with some other redundant cue?	O	O	O	
7.26	Is there good color and brightness contrast between image and background colors?	O	O	O	
7.27	Have light, bright, saturated colors been used to emphasize data and have darker, duller, and desaturated colors been used to de-emphasize data?	O	O	O	
7.28	Is the first word of each menu choice the most important?	O	O	O	
7.29	Does the system provide *mapping:* that is, are the relationships between controls and actions apparent to the user?	O	O	O	
7.30	Are input data codes distinctive?	O	O	O	
7.31	Have frequently confused data pairs been eliminated whenever possible?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
7.32	Have large strings of numbers or letters been broken into chunks?	O	O	O	
7.33	Are inactive menu items grayed out or omitted?	O	O	O	
7.34	Are there menu selection defaults?	O	O	O	
7.35	If the system has many menu levels or complex menu levels, do users have access to an on-line spatial menu map?	O	O	O	
7.36	Do GUI menus offer affordance: that is, make obvious where selection is possible?	O	O	O	
7.37	Are there salient visual cues to identify the active window?	O	O	O	
7.38	Are function keys arranged in logical groups?	O	O	O	
7.39	Do data entry screens and dialog boxes indicate when fields are optional?	O	O	O	
7.40	On data entry screens and dialog boxes, are dependent fields displayed only when necessary?	O	O	O	

8. Flexibility and Minimalist Design

Accelerators-unseen by the novice user-may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions. Provide alternative means of access and operation for users who differ from the "average" user (e.g., physical or cognitive ability, culture, language, etc.)

#	Review Checklist	Yes	No	N/A	Comments
8.1	If the system supports both novice and expert users, are multiple levels of error message detail available?	O	O	O	
8.2	Does the system allow novices to use a keyword grammar and experts to use a positional grammar?	O	O	O	
8.3	Can users define their own synonyms for commands?	O	O	O	
8.4	Does the system allow novice users to enter the simplest, most common form of each command, and allow expert users to add parameters?	O	O	O	
8.5	Do expert users have the option of entering multiple commands in a single string?	O	O	O	
8.6	Does the system provide function keys for high-frequency commands?	O	O	O	
8.7	For data entry screens with many fields or in which source documents may be incomplete, can users save a partially filled screen?	O	O	O	
8.8	Does the system automatically enter leading zeros?	O	O	O	
8.9	If menu lists are short (seven items or fewer), can users select an item by moving the cursor?	O	O	O	
8.10	If the system uses a type-ahead strategy, do the menu items have mnemonic codes?	O	O	O	
8.11	If the system uses a pointing device, do users have the option of either clicking on fields or using a keyboard shortcut?	O	O	O	
8.12	Does the system offer "find next" and "find previous" shortcuts for database searches?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
8.13	On data entry screens, do users have the option of either clicking directly on a field or using a keyboard shortcut?	O	O	O	
8.14	On menus, do users have the option of either clicking directly on a menu item or using a keyboard shortcut?	O	O	O	
8.15	In dialog boxes, do users have the option of either clicking directly on a dialog box option or using a keyboard shortcut?	O	O	O	
8.16	Can expert users bypass nested dialog boxes with either type-ahead, user-defined macros, or keyboard shortcuts?	O	O	O	

9. Aesthetic and Minimalist Design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

#	Review Checklist	Yes	No	N/A	Comments
9.1	Is only (and all) information essential to decision making displayed on the screen?	O	O	O	
9.2	Are all icons in a set visually and conceptually distinct?	O	O	O	
9.3	Have large objects, bold lines, and simple areas been used to distinguish icons?	O	O	O	
9.4	Does each icon stand out from its background?	O	O	O	
9.5	If the system uses a standard GUI interface where menu sequence has already been specified, do menus adhere to the specification whenever possible?	O	O	O	
9.6	Are meaningful groups of items separated by white space?	O	O	O	
9.7	Does each data entry screen have a short, simple, clear, distinctive title?	O	O	O	
9.8	Are field labels brief, familiar, and descriptive?	O	O	O	
9.9	Are prompts expressed in the affirmative, and do they use the active voice?	O	O	O	
9.10	Is each lower-level menu choice associated with only one higher level menu?	O	O	O	
9.11	Are menu titles brief, yet long enough to communicate?	O	O	O	
9.12	Are there pop-up or pull-down menus within data entry fields that have many, but well-defined, entry options?	O	O	O	

10. Help and Documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

#	Review Checklist	Yes	No	N/A	Comments
10.1	If users are working from hard copy, are the parts of the hard copy that go on-line marked?	O	O	O	
10.2	Are on-line instructions visually distinct?	O	O	O	
10.3	Do the instructions follow the sequence of user actions?	O	O	O	
10.4	If menu choices are ambiguous, does the system provide additional explanatory information when an item is selected?	O	O	O	
10.5	Are data entry screens and dialog boxes supported by navigation and completion instructions?	O	O	O	
10.6	If menu items are ambiguous, does the system provide additional explanatory information when an item is selected?	O	O	O	
10.7	Are there memory aids for commands, either through on-line quick reference or prompting?	O	O	O	
10.8	Is the help function visible; for example, a key labeled HELP or a special menu?	O	O	O	
10.9	Is the help system interface (navigation, presentation, and conversation) consistent with the navigation, presentation, and conversation interfaces of the application it supports?	O	O	O	
10.10	Navigation: Is information easy to find?	O	O	O	
10.11	Presentation: Is the visual layout well designed?	O	O	O	
10.12	Conversation: Is the information accurate, complete, and understandable?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
10.13	Is the information relevant?	O	O	O	
10.14	Goal-oriented (What can I do with this program?)	O	O	O	
10.15	Descriptive (What is this thing for?)	O	O	O	
10.16	Procedural (How do I do this task?)	O	O	O	
10.17	Interpretive (Why did that happen?)	O	O	O	
10.18	Navigational (Where am I?)	O	O	O	
10.19	Is there context-sensitive help?	O	O	O	
10.20	Can the user change the level of detail available?	O	O	O	
10.21	Can users easily switch between help and their work?	O	O	O	
10.22	Is it easy to access and return from the help system?	O	O	O	
10.23	Can users resume work where they left off after accessing help?	O	O	O	

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11. Skills

The system should support, extend, supplement, or enhance the user's skills, background knowledge, and expertise ----not replace them.

#	Review Checklist	Yes	No	N/A	Comments
11.1	Can users choose between iconic and text display of information?	O	O	O	
11.2	Are window operations easy to learn and use?	O	O	O	
11.3	If users are experts, usage is frequent, or the system has a slow response time, are there fewer screens (more information per screen)?	O	O	O	
11.4	If users are novices, usage is infrequent, or the system has a fast response time, are there more screens (less information per screen)?	O	O	O	
11.5	Does the system automatically color-code items, with little or no user effort?	O	O	O	
11.6	If the system supports both novice and expert users, are multiple levels of detail available.	O	O	O	
11.7	Are users the initiators of actions rather than the responders?	O	O	O	
11.8	Does the system perform data translations for users?	O	O	O	
11.9	Do field values avoid mixing alpha and numeric characters whenever possible?	O	O	O	
11.10	If the system has deep (multilevel) menus, do users have the option of typing ahead?	O	O	O	
11.12	When the user enters a screen or dialog box, is the cursor already positioned in the field users are most likely to need?	O	O	O	
11.13	Can users move forward and backward within a field?	O	O	O	
11.14	Is the method for moving the cursor to the next or previous field both simple and visible?	O	O	O	

#	Review Checklist	Yes	No	N/A	Comments
11.15	Has auto-tabbing been avoided except when fields have fixed lengths or users are experienced?	O	O	O	
11.16	Do the selected input device(s) match user capabilities?	O	O	O	
11.17	Are cursor keys arranged in either an inverted T (best for experts) or a cross configuration (best for novices)?	O	O	O	
11.18	Are important keys (for example, ENTER , TAB) larger than other keys?	O	O	O	
11.19	Are there enough function keys to support functionality, but not so many that scanning and finding are difficult?	O	O	O	
11.20	Are function keys reserved for generic, high-frequency, important functions?	O	O	O	
11.21	Are function key assignments consistent across screens, subsystems, and related products?	O	O	O	
11.22	Does the system correctly anticipate and prompt for the user's probable next activity?	O	O	O	

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12. Pleasurable and Respectful Interaction with the User

The user's interactions with the system should enhance the quality of her or his work-life. The user should be treated with respect. The design should be aesthetically pleasing- with artistic as well as functional value.

#	Review Checklist	Yes	No	N/A	Comments
12.1	Is each individual icon a harmonious member of a family of icons?	O	O	O	
12.2	Has excessive detail in icon design been avoided?	O	O	O	
12.3	Has color been used with discretion?	O	O	O	
12.4	Has the amount of required window housekeeping been kept to a minimum?	O	O	O	
12.5	If users are working from hard copy, does the screen layout match the paper form?	O	O	O	
12.6	Has color been used specifically to draw attention, communicate organization, indicate status changes, and establish relationships?	O	O	O	
12.7	Can users turn off automatic color coding if necessary?	O	O	O	
12.8	Are typing requirements minimal for question and answer interfaces?	O	O	O	
12.9	Do the selected input device(s) match environmental constraints?	O	O	O	
12.13	If the system uses multiple input devices, has hand and eye movement between input devices been minimized?	O	O	O	
12.14	If the system supports graphical tasks, has an alternative pointing device been provided?	O	O	O	
12.15	Is the numeric keypad located to the right of the alpha key area?	O	O	O	
12.16	Are the most frequently used function keys in the most accessible positions?	O	O	O	
12.17	Does the system complete unambiguous partial input on a data entry field?	O	O	O	

13. Privacy

The system should help the user to protect personal or private information- belonging to the user or the his/her clients.

#	Review Checklist	Yes	No	N/A	Comments
13.1	Are protected areas completely inaccessible?	O	O	O	
13.2	Can protected or confidential areas be accessed with certain passwords.	O	O	O	
13.3	Is this feature effective and successful.	O	O	O	

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Heuristic Evaluation
A System Checklist

Primary Source
Making Computers-People Literate. © Copyright 1993.
By
Elaine Weiss
ISBN: 0-471-01877-5

System Title:_____

Release #:   _____

       Evaluator:

_____

Secondary Source
Usability Inspection Methods. © Copyright 1994.
By
Jakob Nielsen and Robert Mack
ISBN: 1-55542-622-0

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APPENDIX M: NEUROOGLE FAMILY MEDICINE INFORMARION SYSTEM (FMIS) SCREENS

Figure M.1 Neuroogle FMIS – Main Screen

Figure M.2 Neuroogle FMIS Poliklinik Defteri (Polyclinic Sheet) Screen

Figur M.3 Neuroogle FMIS Diagnosis & Prescription Screen

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YAZARIN

Soyadı : **ÖZ**
Adı   : **SABA**
Bölümü : **Tıp Bilişimi (Medical Informatics)**

TEZİN ADI (İngilizce) : **USABILITY TESTING OF A FAMILY MEDICINE INFORMATION SYSTEM**

TEZİN TÜRÜ : Yüksek Lisans ▨   Doktora ☐

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2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

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