InterPARES Trust Project
Research Report

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TIMELINE

1-3 months	3-6 months	6-9 months	9-12 months
Literature reviews	Developing questions and questionnaires. Survey application in Hacettepe University.	Determination of usability test participants.	Application of Usability test
Analysis of EDMS	Defining the tasks which will be given to the users during usability test.	Rehearsal of usability test. Reorganize the usability test according to the rehearsal test results.	Analysis of test results and reporting.

InterPARES Partners to be involved in this research:

- Hacettepe University, Turkey
  - o Hacettepe University Faculty of Letters
    - ▪ Hacettepe University Department of Information Management

A. Rationale:

Electronic Document Management Systems are used in many public institutions since these systems are categorizing, archiving, enabling authorized access and tracking documents via secure software architectures. Availability and effectiveness became the main purpose of transparent and democratic organizations. The rapid developments in information and communication technologies are reached the adequate maturity to achieve this purpose. EDMSs criteria and standards are defined in TSE 13298 in Turkey but it should not be ignored that these system are used and administered by human. There occurs an interaction between human and the computer when using software products . Qualitative and quantitative outputs of this interaction shows us if the software is user friendly or not. Usability of EDMSs' should be tested in terms of Human Computer Interaction before its being used by users.

B. Description of the research project:

The study called "EDMS benefits and architecture road map" has been conducted to share the probable problems will be faced in the usage of EDMSs and suggestions on EDMS architectures. The study report summarizes the most probable problems of EDMS's in following list:

- Resistance of the staff who is used to do his/her job on paper.
- Low computer literacy level of staff
- Low executive support
- Undefined and unstandardized document management business processes
- Role and authority conflicts
- Usability and performance problems, unhandled exceptions of the EDMS's.
- Being not experienced and not aware of EDMS's.

The most emphasized problems are staff resistance, low computer literacy of the staff and low usability of the EDMS in this study report. There are some standards and sanctions on EDMS interoperability in the world but usability is as important as interoperability for EDMS too. Easy access to documents, a clear terminology, learnability of the document process tool, adequate info and error messages and availability are the factors which affects usability of EDMSs. Therefore, reluctant and resistant users and the low computer skills makes usability of the EDMS even more important. If it is not user friendly, the system is doomed to remain idle.

The purpose of this study is to conduct a three-stage usability test to uncover the factors affecting the usability of EDMSs and expose suggestions to fix the problematic interface design elements. In addition, the EDMS system usability criteria in the results of this study will be made into a book which will be accessible to the software developers. Thus emphasizing the importance of EDMS usability will be an important step towards raising awareness and standardization of HCI. This study may be used also as a source for how to test the usability of an EDMS system.

Usability is the ease of use and learnability of a human-made object. The object of use can be a software application, website, book, tool, machine, process, or anything a human interacts

with. A usability study may be conducted as a primary job function by a usability analyst or as a secondary job function by designers, technical writers, marketing personnel, and others. It is widely used in consumer electronics, communication, and knowledge transfer objects (such as a cookbook, a document or online help) and mechanical objects such as a door handle or a hammer.

The primary notion of usability is that an object designed with a generalized users' psychology and physiology in mind is, for example:
• More efficient to use—takes less time to accomplish a particular task
• Easier to learn—operation can be learned by observing the object
• More satisfying to use

Effects of Education and Standards on Usability
In 2013 a survey conducted on 256 software professionals who worked in Ankara and Istanbul Technology zones
(Koyuncu Tunç, 2014). The results of the survey indicated that:

• 53.9 percent of the software professionals have not received an HCI training at all. In addition most software professionals were not aware of any new user interface design standards.
• Most of the software professionals do not know how to use colors or how to test the usability of their products.
• End user involvement is at minimum in design and development phases of the software life cycle.
• Modern usability testing methods are not popular among software professionals.
• 71% of the respondents believe that they need training in HCI.

These results show that there is a serious lack of knowledge and awareness of the HCI concept among software professionals in Turkey. To evaluate the HCI education adequacy in Turkish universities, we have reviewed all related department course catalogs from 171 university websites, which are listed on the Higher Educational Council website as of 5 May 2013 (Higher Educational Council, 2013). Based on HCI definitions for software systems, the following keywords were searched in the course catalogs of the universities: "Human Computer Interaction", "Usability", "Interactive User Interfaces", "User centered Design".

Our findings reveal that only 28 out of the 89 computer engineering undergraduate programs in Turkey have HCI related courses (31%). This numbers are significant as only 31% of the computer engineering undergraduate programs teach HCI and they are the major source of education for software professionals. Furthermore, only 7 of these courses are even required as a part of the major or for obtaining the appropriate degree. The other 21 courses listed in these universities are only electives and are not even offered every semester, which can be limiting for software professionals while receiving their training. There are 9 software engineering undergraduate programs and 7 of them teach HCI. 4 of the 7 undergraduate Informatics programs include HCI related courses. Other departments such as electrical and electronics engineering, mathematical science programs do not have any HCI courses in any levels.

Another factor affecting usability is existence of standards, government sanctions and regulations. There are some international usability standards. TS EN ISO 9241-151 is a standard which draws a road map to develop usable user interfaces for information technologies. WCAG 2.0 and ISO/IEC 40500:2012 is handling the usability rules should be considered for elderly or disabled people's computer usage. This standard includes 61 criteria.

In Turkey there is a criteria list which is not yet an obligation for usability of e-government websites. TSEK 194 is a guidebook for software professionals who design user interfaces. It is an important step to induct awareness of usability (KAMİS, 2014).

Usability Evaluation Methods
Early usability tests allow us to reveal the unforeseen usability problems and user requirements before it is being published. Therefore even these test are expensive and time consuming they are indispensable. Usability tests measure the functionality and efficiency of the systems. Usability professionals test each part of system to achieve the best user interface design.

Usability can be done at any stage of the design process, but tests should be applied as early as possible with actual users of the system. (Preece, Rogers, Benyon, Holland, Carey, 1994)

Evaluating user interface in terms of usability can be done in different ways. These include:
• Formative tests: users specify their ideas about the design prepared, ask questions and express their suggestions. This method allows designers refining and reformatting his/her design. (Preece, Rogers, Benyon, Holland, Carey, 1994)
• Usability Testing: A group of potential users try to use software in order to complete the given tasks over a period of time in this test process. Think aloud, video recording, image capture and eye tracking methods are used to obtain information about the usability of software.
• Analysis Methods: Usability experts test and use the system to evaluate the user interfaces in terms of usability principles Intuitive Assessment and Cognitive Animation is one of these methods.
• Interrogation Methods: This method is based on to observe users while working, face to face interviews and questionnaires. (GURSES, 2006)
• Alpha test: Prototype design is tested and evaluated by the users in this method.
• Beta testing: Before deploying final version system is made available to the potential users and more test data obtained in this way. (Shneiderman, 1998)

D. Usability Test Plan
To test usability of an EDMS quantitative and qualitative methods should be used together. Data will be collected via user surveys, observation and think aloud method. The quantitative data like performance parameters for example task completion times, click count, wrong click count will be collected via observation technique. Think aloud method will be used to collect the user's feelings in the process of system usage. This data is important in measuring the user satisfaction. (Ericson and Simon, 1993). When user try to do a given task he/she will express himself simultaneously in this method. (Boren & Ramey, 2000) The output of think aloud technique gives us the quality of the interaction between the system and the user. The research includes 7 steps:

1. Analysis of EDMS
2. Preparation of survey questions.
3. Survey application to the users
4. Defining the tasks which will be given to the users
5. Determination of survey participants
6. Rehearsal of usability test
7. Usability test

- Collecting demographic data

- Task completion (sound, video click count, task completion times)

- Asking opinions about the systems

E. Team Turkey Case Study Expectations

As part of the InterPARES Trust Project case studies "infrastructure domain" considers issues relating to system architecture and related infrastructure as they affect records held in online environments. During the following 12 months Team Turkey will firstly focus on literature review, examining sample questionnaires and analysis methods and test bed organization, Hacettepe University. According to the data that will be gathered through the analytical studies Team Turkey aims to develop an original usability test that would be usable in any kind of university organization internationally in "infrastructure domain" studies of InterPARES Trust Project. As a second stage Team Turkey will determine the participants. After the analysis of the organizational hierarchy stratified or random sampling methods will be used among the personnel who are responsible or use the electronic records management system as participants of the tests. Team Turkey is planning to share the case study results in 12 months with international team members. This case study would be successful if an original usability test developed, used in Hacettepe University, and reaching the results that is also usable for system development studies in records management area internationally.

Abstract: Electronic Document Management Systems (EDMS), which have been established to manage the processes of sorting, classifying, archiving, accessing based on authority and tracking access has become the main target of modern and democratic institutions today. The features and the functions that an EDMS software should have are determined by TSE 13298 standard in Turkey. But it should not be ignored that these systems are managed and used by humans. The qualitative and quantitative outputs of interaction between human and computer show us whether a system is usable. The purpose of this research is to provide Heuristic Analysis and Server Log Analysis for EDMS to find out the factors that affect the usability of the EDMS and to propose suggestions to correct the problematic interface design elements. The most commonly used usability guidelines for heuristic evaluation were put together and 30 screens were evaluated against usability principles. 16 million lines of Error and Access Log record in apache server were processed and analyzed to handle system usage information.

Keywords: *Human Computer Interaction, Usability, Factors affecting Usability of Electronic Document Management Systems*

Introduction

It is an inseparable part of institutional activities to record institutions' activities and share them with stakeholders. For organizations to have a sound institutional information management system, it is necessary to take measures for the development and continuity of the systematic work and approaches to the production, filing, transfer, use, storage and sorting of the documents which constitute the working area of the document management (ISO 15489, 2001). Many public institutions and universities now use Electronic Document Management Systems (EMS) intensively for this purpose. In TS 13298, which is a reference to document management practices in electronic media in Turkey, the document is defined as recorded information that is taken or produced to fulfill any individual or organizational function and constitutes evidence for the function to which the content, relationship and format belongs (Külcü, 2007) The features that an electronic document management system should is not limited with the performance, security and functionality of the software. EDMSs that are expected to enable the effective and efficient use of documents in the time period from the creation of the most valuable assets of the institutions to the destruction are required to be robust in terms of usability as well. Because non-usable systems will first reduce efficiency by slowing down operations in the corporations, and then they will be left idle by users. The purpose of this study is to analyze the usability data obtained by heuristic walkthrough and server log analysis for EDMS, to propose the factors that affect the usability of the HU-EDMS and to provide suggestions for correcting the problematic interface design elements.

Literature Review

Bayram, Ozdemirci and Güvercin analyzed the functionality of the EDMS system developed by Turksat in 2012 in three different institutions It is determined that one of the most important features that EDMS software should carry is an infrastructure that is easy to adapt and flexible to meet the needs of different operation, management,

organization structure and different information infrastructure. (Bayram, Özdemirci, Güvercin, 2012)

The evaluation of performance in EDMSs is very important in determining sustainability of the system by determining the functions that have problems and suggesting solutions for them. It is known that international and national standards are being developed on EDMSs, which form the backbone of enterprise information systems, which play an important role in information and document management processes. The structural conditions of EDMS programs are defined within the framework of TS 13298 Standard in Turkey. However, the inadequacy of the legal sanctions related to the enforcement of the enacted regulations and the lack of knowledge about the subject of the institutions can leave program development activities at the mercy of companies providing software services. It is revealed that the studies, evaluations and tests related to the subject should be repeated regularly in the literature (Bailey, 2011; Gunnlaugsdottir, 2008; Li Xie, 2006; NARA, 2011). The improvement of the systems and the solutions to be developed and the problems to be experienced with the feedbacks from the users are encouraged in terms of the sustainability of the electronic document management (Umut & Külcü, 2014). It is very important to analyze the existing capacity for making institutional assessments in terms of the effectiveness and continuity of document management activities and for applying information and documents in the administrative structure.

EDMSs have structures that differ from institution to institution. The necessity of establishing standards has arisen in order to eliminate interoperability problems caused by different structures. One of these standards is TSE 13298, which is based on Electronic Document Management System Criteria Reference Model (EBYSKRM). The TS 13298 standard specifies the functional, infrastructural and safety criteria that EDMS should carry. However, the TS 13298 standard does not have any criteria for usability as a quality and efficiency parameter that is as important as interoperability. There is no part of TS 13298 that contains rules that must be followed in order to provide usability, information about the ways and methods to be tested for usability. In the study entitled "Benefits of EDMS and a road map for EDMS structuring within the institution", the major problems that are likely to be encountered during the course of EDMS structuring work within the institution and which should be solved are listed as follows:
• Personnel resistance (Personnel's habit of doing business on paper for years
It is judged to be one of the most important problems).
• Low computer literacy and computer fear
• The absence of full support from the top management (the top management does not want to use the EDMS for different reasons and requests exceptions for the operations to be done in the paper environment).
• Business processes for unspecified and / or non-standardized document management.
• Role conflicts (experience conflicts in which tasks and responsibilities are not clearly defined in the EDMS structuring process).
• Problems with application software (EDMS is considered to be one of the most important problems because it does not work fast enough, it causes frequent problems, it is not interoperable and it is not user-friendly).

• Increased workload (Continuing to perform document-oriented operations in physical environment with electronic media).
• Inexperience (EDMS is inexperienced of institutional staff and company personnel) (Öncan, Civilian, Özkanlı, 2012)

The most highlighted problems on the list are that the user is resistant to the new system and EDMS is not user friendly.

Among the most probable problems encountered in EDMS, the first is the resistance of the staff to the new system, the second is the low computer literacy of the staff, and the third is that the system is not user-friendly (Öncan, Civilian, Sacred, 2012). Therefore, the reluctance of users, the resistance and low computer skills make EDMS usability even more important. It is very important for both software developers and users to reveal the factors affecting the usability of EDMS systems which are used in many public institutions and universities in the near future and to develop them considering the user factor in the context of EDMS. This study aims to contribute to increase the usability of EDMS in our country by revealing problems, complaints, suggestions and new opinions about EDMS.

A study of usability in our country is a research called "e-GOVERNMENT PUBLIC INSTITUTIONS INTERNET SITES IN THE PUBLIC" by the Turkish Court of Accounts in 2006. "Is the institution internet (portal) structured so as to provide public services better in electronic environment?" question tried to be answered by this study. The design, navigation, content and accessibility were determined as evaluation criteria. At the same time, a preliminary interview and questionnaires were conducted with the institutions in the research. At the same time, a test work was done with 8 people in a group of 25-30 age, graduated from a social sciences undergraduate, who can use Internet at a good level based on the determined criteria. The most design mistakes are the lack of proper home page design, the use of unnecessary web tools, and the lack of clarification on information sheets. Direction links are not sufficient, menus are not used correctly and relevant and accessible links are not enough. In terms of content, when looking at the situation of public sites, printable page conversion, member registration, update date, phone information, search functions were found to be a problem. It has been found that only 9% of public sites are accessible to the visually impaired in examining the availability of public sites by people with disabilities.

A more up-to-date evaluation of the public institutions web sites is the "Public Institutions Web Sites and Usability" dated 2011 by Durmuş and Çağıltay. In this survey, 33 public institutions websites were evaluated through content analysis, and they were interviewed with the responsible units of web sites of 8 public institutions. (Durmuş&Çağıltay, 2011) As a result of the research, the worst institutional site is the website of the Ministry of Finance and the best institutional site is the e-Government Gate. The following problems were emphasized in the research results.
• User-focused service mentality is not established.
• Terms and abbreviations that foreigners may use are used for the user,
• At 51% of the services available to citizens are not easily accessible,

- Nearly 30% of websites do not have search functionality, while most of the remaining websites do not search effectively,
- There are inoperative and misdirected connections,
- The header information on the opened pages contains deficiencies and mistakes,

The evaluation results of the accessibility section are 60.5%. Frequently encountered accessibility issues on evaluated websites are listed below:

- The appropriate font size is not used.
- Subtext is not used.
- Scripts and applets cannot be read by the screen reader.
- Form use is a problem.
- Feedbacks are not enough (Durmuş and Çağıltay, 2011)

In the study entitled "Determining the Availability of Search Fields in Public Internet Sites" (Çinar, İnal, Çağıltay, Güngör, 2014), 21 ministries in Turkey analyzed in terms of usability and functionality of the search areas of the internet sites. The study has been evaluated separately for 6 basic criteria of 3 usability specialists, "Search Area Placement", "Search Function", "Search Information", "Search Options", "Search Location" and "Display of Search Results". According to the findings of the study, the ministry internet sites have problems related to the functioning of the search areas, and problems are also found in the layout and design of search areas.

A survey (Koyuncu Tunç, 2014) of 256 software developer working in Ankara and Istanbul technology development regions in 2013 revealed that 54% of the software developers did not receive any HCI training in their academic and professional lives. According to the survey results, only 21% of the developers evaluates themselves as competent in HCI while 71% stated that they need HCI training. Considering that the research was done in advantageous cities in terms of access to information such as Ankara and Istanbul, we can say that the results of a study covering all cities are going to be even more negative for HCI consciousness and awareness. In the same research, the curriculums of 171 Turkish universities' software program development departments were scanned and the number of HCI courses was revealed. According to this study, in 89 computer engineering department, only 28 HCI courses are taught and these courses are given as must courses in only 7 departments. Therefore, students' access to HCI courses is rather limited. So first of all, the lack of training needs to be eliminated.

Another factor affecting usability is ensuring usability standards are set and compliance with the standards by law. There are some usability standards followed worldwide. TS EN ISO 9241-151 (Ergonomics of Human System Interaction - Guide to the World Wide Interfaces) is an international standard that guides the development of easy-to-use interfaces for information systems. This standard is a guideline document for the development of interfaces that can be used easily and effectively by all users. WCAG 2.0 and ISO / IEC 40500: 2012 (Web Content Accessibility Standards and Criteria) address the criteria for making website content more accessible to disabled and elderly citizens.

The WCAG 2.0 guideline consists of 61 criteria that have been defined by the World Wide Web Association (W3C) and have international validity.

In Turkey Public Internet Sites Guide (KAMİS), was prepared by TÜBİTAK BİLGEM Software Technologies Research Institute (YTE) with the support of the Ministry of Development. The guide aims to facilitate the understanding of the information and scales in the international standards related to usability (TS EN ISO 9241-151) and accessibility (WCAG and ISO / IEC 40500: 2012) with detailed information and examples. It is planned that the criteria to be fulfilled for the ISO 9241-151 and ISO / IEC 40500 certificates issued by the Turkish Standards Institution (TSE) Information Technologies Commission will be clarified. It is expected that the guide will provide guidance for all public service providers, as well as public internet sites, to make their internet sites compliant with the standards. Public Internet Sites Directory consists of 5 basic parts as "Usability of Internet Sites", "General Features", "Visual Design and User Interface Features", "Accessibility" and "Usability Tests and Applications". (KAMİS, 2014)

The TSEK 194 criterion has been put into effect very recently in Turkey. It has not yet become compulsory to comply with the 205-item usability check list prepared for internet sites, but it can still be regarded as a good starting point for awareness-raising. (KAMİS, 2014)

Research
Heuristic Evaluation
The usability of the HU-EDMS was assessed using the heuristic method during this study. Heuristic evaluation (HE) is described as a fast, low cost and effective method among usability tests. HE is classified as 'evaluation by expert analysis' and is separated from 'evaluation by user participation' because it is not implemented by real users. Throughout the process, several expert evaluators apply their predefined, representative tasks under the guidance of specific usability guidelines (Blandford, Keith, Connell, Edwards, 2004; Gray & Salzman, 1998; Nielsen, 1994; Preece, 1993). Researchers are using the HE to test the usability of software in many different areas. Educational websites are examples. It is recommended that field experts and usability and human-computer interaction experts be included in a balanced evaluator team. The 'dual expert' term is used for expert assessors in both field knowledge and usability (Karoulis, Pombortsis, 2003). The conclusion of the HE is a list of usability problems in the system according to the heuristic methods used or the other items defined by the evaluators (Dix, Finlay, Abowd and Beale, 2004).

According to Nielsen, the intuitive assessment consists of the following stages:

- Determination of evaluation criteria
- Selecting and informing evaluators
- Evaluation
- Reporting of problems

In order to determine the severity of the problems, it is necessary to classify them according to their importance level with likert scale of 3 or 5. We use likert scale 3 in this study.

Usability Check List Creation for Heuristic Evaluation

The below-mentioned usability criteria in guidelines,lists and principles with the most references in the literature are compiled and a checklist is created for heuristic evaluation.

Usability guidelines help the evaluators identify interface problems while helping designers choose between design alternatives. One of the most popular guidelines for user interface design today is proposed by Jacob Nielsen. According to this so-called usability criterion, the points to be considered in designing user interfaces and their usability are examined in this framework (Nielsen, 1994). Nielsen's eligibility criteria are described below.

1. System status visibility: The system should keep users informed of what is happening in relation to the current situation, on a continuous basis and in the context of appropriate feedback. Are you using the URL and status line to provide effective feedback? One of the most important elements for the users is that they know the answer of the question "Where am I?", "What's next?"

2. System and real world match: The system should be able to speak with the users and understand the terms, words and concepts used by the users. Can the website reflect the user's language, tasks and goals? Since publicly available public websites come from different levels (age, education, interests, etc.), the system needs to be addressed to all users.

3. User control and freedom: In order for users to feel lost in their websites, if the user follows a wrong path on the site, they must be able to easily return to the point they were before. Putting the «home page» key on the web pages gives the user the feeling that the website is controlling his or her own.

4. Consistency and standards: Users should not consider whether different words, situations and actions have the same meaning. So the application should be consistent within itself. Does the website work in different browsers? Can the user change the size of the windows as desired? Can you change browser properties? One of the most common problems with inconsistency is the use of contradictory words in links, page titles and headings.

5. Preventing errors: Rather than encountering an error message, users should avoid the occurrence of a fault with careful design. Does the website have sufficient guidance and assistance to the user? If it fails, can the user easily get rid of it?

6. Recognition rather than remembering (or minimizing the memory burden): Objects, activities, and options are made visible. If users can tell where they are by looking at the page they are on, they will be less likely to disappear on the site. The correct

labels, bread crumbs method and explanatory links are very important for easy understanding of the elements on the screen.

7. Flexibility and utilization efficiency: Accelerators not visible to novice users should be used. Generally, experienced and inexperienced users of the system show different usage behaviors. It is important to address both groups. Do connections take users where they want to go? Is visual elements and data loading easy? Some of the best accelerators are the bookmarks provided by the browser.

8. Aesthetic and simple design: Dialogues should not contain information that is irrelevant or very unlikely. If an object is removed from the interface and is causing a problem in terms of usage, it is unnecessary. If necessary, the principle of use should be followed. Has the most appropriate and high quality media and pictures been used to convey some message? The unnecessary information used on a page is interesting and slows the user down. Rather than putting less needed information on the page, this information can be linked.

9. Error Messages: Users should be able to identify, repair and rescue the fault if they encounter an error. Error feedbacks should be straightforward, the problem should be clarified and a constructive solution proposal should be presented. Any error message should be able to provide a solution or establish a solution connection. If nothing is found in a search result, it is not enough to tell the user to expand the search, and the link and suggestion to expand the search must be provided.

10. Help and documentation: Although it is more preferable to use the system without documentation, it may be necessary to provide documentation and assistance to the user. For websites, it is an important feature to link to a specific help page.

Shneiderman's eight designs in his book "Software Psychology: Human Factor in Computer and Information Systems" in 1980 and "Strategies for Interfacing: Effective Human-Computer Interaction" in 1987 are as follows.
1. Design must be consistent
2. Include short cuts and tips
3. Provide information messages about the transactions
4. Process sequence for each process group must be specific and sequential
5. The user should be able to make the most mistake, should be descriptive in case of error
6. Allow to undo transactions
7. Should give the impression that the operations that are happening are under the control of the user
8. Resources should be used efficiently, memory space should not be occupied too much (Shneiderman, 1987)

The user-centered design rules of Donald Norman published in 1988 are as follows.
1. It should be obvious what the user can do at any time.

2. The general structure of the user system should be shown so that the user can navigate himself.
3. The user needs to be informed about the current status of the system.
4. The user's head should not be confused with designs that are out of general use. (Norman, 1988)

Norman, unlike Shneiderman, noted the importance of user habits in the 4th article and stated that no design contrary to habits should be made.

Christopher Wickens categorized design principles and dealt with them in detail under separate headings. Unlike Wicken's, Norman and Shneiderman, readiness, confusion of perceptions, reminders, information, purposes of pictures, cost of access to information and alternative information channels have been raised. The principles given by Wickens in 2004 are:

Perceptual Principles:

1. The items on the screen should be legible,

2. The user should not be asked open questions (color, loudness, size etc.)

3. It should be avoided from designs contrary to the user's expectation,

4. Compatibility between forms allows the user to learn faster,

5. Confusion should be eliminated by providing distinctive signals for different situations.

Logical Model Principles

1. The images / icons used are similar to the objects they represent.

2. The movement of moving items must conform to the logic model of the user.

3. Principle of attention

4. The cost of accessing information should be minimized. Ex: Number of clicks

5. It is possible to detect the information more quickly by giving the user more than one channel. Ex: Both in picture and in writing. Principles:

6. The user should not have to remember some information. The information to the user should be presented in options.

7. The user should be provided with some predictive information to help him make plans for the future. Ex: "10 minutes left to finish"

The behavior of the items on the screen should also be used on similar screens to maintain compatibility with the old information in the user's memory. (Wickens, Christopher D., John D. Lee, Yili Liu, and Sallie E. Gordon Becker., 2004)

Hick Law

British psychologist William Edmond Hick suggested that as the number of options offered to the user increases, the duration of the selection also increases. (Hick, 1952) In a study that explains this situation fairly well, two benches with 24 and 6 different jams are used. While 60% of the customers are standing on the counter with more choices, only 3% of the shoppers are shopping. On the bench where there are 6 choices, 40% of the customers are standing while 31% of the customers are buying from the jams. When we look at the collection, we see sales of 1.8% in the bench with 24 options and sales of 12.1% in the bench with 6 options. When the user gives more options and more information, the user gets more confused as the work is not easy. This rule should be considered when designing user interfaces.

Fitt Law

According to Paul Fitts' thesis from Ohio State University, the time required to reach a goal is the function of the distance and the magnitude of the target. If a target is large and large, and the distance is short, we can determine if we can reach the target in a shorter time. (Fitts, 1954)

We scan and merge all the criterias in usability guidelines, principles and laws in the following checklist.

	Usability Criterion
1	System state visibility
2	Matching the system with the real world
3	User control and freedom
4	Consistency
5	Preventing errors
6	Remember instead of recognition
7	Flexibility and utilization efficiency
8	Aesthetic and simple design
9	Error Messages
10	Help and documentation
11	Include short cuts and tips
12	Do not allow undo transactions
13	Contrary to general usage design
14	Readability of items on the screen
15	Open question to user comment
16	Better fit between forms and faster user learning
17	Elimination of confusion by providing distinctive signals for

	different situations
18	The images and icons used are similar to the objects they represent
19	Minimizing the cost of accessing information. Er: Number of clicks
20	Giving information to the user from multiple channels (eg picture and text)
21	Do not provide more information to the user
22	Screen elements that are expected to be clicked are large enough and coexist

Table 1: Heuristic Evaluation Criterion List

Server Log Analysis

One of the biggest problems in front of the usability studies is to gather fast, accurate and high quality information including user behavior. (Pierrakos et al., 2003) The fastest way to obtain user data is to use server logs because all HTTP (Hypertext Transfer Protocol) servers record the following information as standard in the format called "Common Log Format":

• remotehost: IP address
• rfc931: user's remote log name
• authuser: username in authorized entries
• date: The time and date when your request is made
• request: the request the user made
• status: The HTTP status code sent to the user.
• Bytes: The length of the document content sent to the user (W3C, 1995)

However gage caching on the Web, HTTP protocol, data transmission networks, internet service providers and browsers limits the amount of information in the server logs which reduces the quality of information.

How does WEB work?

It is also important to understand how the web works in order to better understand the data that server logs can provide.

HTTP protocol (Hypertext Transfer Protocol) is tasked with performing the transmission of files, web page and web page components on internet and other computer networks. At the same time, http determines the method and rules for transferring computers, servers, and browsers over the web. It works in a stateless structure with no HTTP status information. The http connection to a website is discontinuous and consists of the following stages:

1. The user writes the web page address in the browser address bar.
2. The scanner is located at the page request.
3. The server returns the page.
4. The connection between the user computer and the web server is broken.

At this point the session between the user and the website is complete. Each new request follows the steps mentioned above as a new session. (Berners-Lee, 1999)

Caching is to store the remote data locally to reduce network traffic to increase data download speed. It can also be described as storing it on the user's computer so that it can be quickly presented to the user when needed again. Caching is indispensable for today's very fast computers and despite the speed of the internet. For example, even in a very simple web site with 2 images and one style file per page, each page sends 4 requests to the server (1 page, 1 style file, 2 images). Caching relieves these incidents by relieving server traffic and ensuring that only new requests reach the server. Browser, proxy and internet service provider level caching is available (Houston, 1998). When this information is evaluated on the light, it is difficult to get the following usability data from the server logs:

It is not possible to gain the knowledge of "who visited the web page" as long as the user does not log in with a username on the system. The IP address can be an IP address that a proxy server, an Internet cafe, or Internet service provider (ISP) jointly provides to all users. It is doubtful whether the events recorded on the server belong to a single user.

The navigation path of users in websites is incomplete if they are cached by browsers or ISPs. Visits made to pages sent from the front page and page information accessed with the "back" button cannot be logged because they are not sent to the server. This creates cavities in the path that the user follows. The amount of time the user spent on each page is not recorded in logs because HTTP is stateless and is in a discontinuous structure. Only the time when the page request is made is recorded in the logs, the time from the page is not recorded. However, it is possible to roughly calculate the period of time between the page requests. (Tech-Ed Inc, 1999)

Web server logs are the main source of data for Web Usage Mining (WUM) tools. (Pierrakos et al., 2003). WUM is defined as the mining of data from user activities to reveal and interpret users' access patterns to web information systems (Shahabi & Banaei-Kashani, 2001). Data mining is the process of analyzing the complex relationships of large data sets and analyzing them in order to summarize them in an easy-to-use format. (Hand et al., 2001; Tan et al., 2006). Web server logs are less costly than other usability tests in that they involve a large number of user traffic, require no changes in client code, and display error codes correctly, but since these logs contain very limited types of information and do not contain reliable and complete data on a user basis, it is difficult to interpret (Matera, Rizzo, Carughi, 2006). For this reason, server logs are not the most suitable method for obtaining usability data. Server logs are more about server traffic than meaningful data about specific users. (Groves, 2007)

In this research 16 million lines of Access Log and 8064 lines of Error log records stored for 29 days on the apache server of EDMS were processed and analyzed to handle system usage data.
Expected Outputs of Server Log Analysis are:
• Page view statistics
• Input and output pages
• Error messages
• User Density by Time

• User-based usage frequency

Results – Heuristic Walkthrough
Hacettepe University HU-EDMS system was analyzed via Heuristic Walkthrough by 4 different user type over proxy connection. All the pages were categorized according to their functionality.

1. *Basic, primary functionality pages*
   - Business List
   - Unit Incoming Documents List
   - Unfiled Documents List
   - Unit Outgoing Documents List
   - Unit Incoming Documents Transactions
   - Unit Correspondence Incoming Documents List
   - Unit Correspondence Outgoing Document List
   - Document correspondence Text / annotation Tab
   - Document correspondence Text / Text editing screen
   - Document correspondence Text / Additional Information Tab
   - Creating a Template from Template

2. *Auxiliary, secondary functionality pages*
   - Assign Work
   - Statistical Unit Document
   - File Documents List
   - Search Documents
   - Detailed Search
   - Incoming Document List
   - Outgoing Document List

3. *Frequent settings / maintenance procedures pages*
   - Unit List
   - User List
   - File List
   - Topic List
   - Unit Parameter Definition
   - Distribution Plans
   - Signature Plans
   - Document Templates
   - Contact Plans
   - Role Selection
   - Appointment of Power of Attorney

4. *Initial setup and settings pages*
   - E-Signature authorization selection

5. *Periodic maintenance and regulations pages*
   - File Operations
   - File Merge

In heuristic evaluation of HU-EDMS, four different user roles were used. These roles were faculty secretary, faculty dean, department chair and department secretary. The user was changed depending on the business rules since each role has different authorities and responsibilities like defining parameters, creating, signing, sharing and filing documents. According to their functionality all the pages were analyzed by Heuristic walkthrough and the usability checklist was filled for each page separately. The findings were recorded to an excel file which contains the usability checklist. Found problems were documented and the screenshot of the problematic interfaces were taken.

At the end of the heuristic walkthrough evaluation, the most common usability mistakes in the system are shown in the table below.

No	Criterion	# of mistakes
3	User control and freedom	7
17	Elimination of confusion by providing distinctive signals for different situations	7
5	Preventing errors	6
8	Aesthetic and simple design	6
11	Include short cuts and tips	6
13	Out-of-order design	6
22	Screen elements that are expected to be clicked are large enough and coexist	6
9	Error Messages	5
18	The images and icons used are similar to the objects they represent	5
21	Do not provide more information to the user	5
1	System state visibility	5
4	Consistency	4
14	Readability of items on the screen	3
2	Matching the system with the real world	2
7	Flexibility and utilization efficiency	2
10	Help and documentation	2
12	Do not allow undo transactions	2
19	Minimizing the cost of accessing information. Eg: Number of clicks	2
15	Open question to user comment	1
20	Giving information to the user from multiple channels (eg picture and text)	1
6	Remember instead of recognition	1
16	Better fit between forms and faster user learning	1

Table 2: Usability Problems List

According to the Heuristic Evaluation most common problems are lack of user control and freedom and lack of distinctive signals for different situations to eliminate confusion. The most common mistakes in each criterion are explained below.

Criterion 3: User control and freedom
When we look at the "User control and freedom" related notes we can see that none of the pages contain a breadcrumb which shows the path where the user is coming from. So user feels lost in this type situations. Another problem related to this criterion is reloading the page, although there is no change in the screen when some page elements are selected. It can make users confused when the page reloaded aimlessly.

Criterion 17: Elimination of confusion by providing distinctive signals for different situations
The second most frequently observed problem is about "Elimination of confusion by providing distinctive signals for different situations" criteria. For example colors in all type of the messages texts (success, fail, warning messages) are red in HU-EDMS. Red actually triggers the pituitary gland and accelerates the heart rate, causing the person to see that he is breathing faster. This instinctive reaction makes red aggressive, vibrant, stimulating and remarkable. A word of caution - red is associated with danger and indebtedness (Izzo, 2012). So using red in after a fail or alert is suitable but using red after a successful operation or for an information message text worries the user unnecessarily.

Another problem observed in general is that disabled and enabled form entry fields cannot be distinguished because all the fields are seemed to be active. Users attempt to type even to disabled fields and after that attempt they can realize that some of the fields are closed. The same problem is seen on the buttons. It is not clear whether a button is active or inactive, so you can see which functions are available only when you click on the buttons. New users who are not accustomed to the system will feel confused because of another mistake related to the criterion

The document creation page has two kind of navigation. Via blue next/back buttons you can navigate between multiple documents you create simultaneously. And via tabs in the page you can navigate between different data areas of the document like main text, attachments, sharing info etc. Since there is no clue around the blue buttons like a title or an image expressing the navigation of multiple documents, in first sight user cannot understand the purpose of the next/back buttons. Moreover it looks like an element to navigate between the document tabs until looking to the user manual.
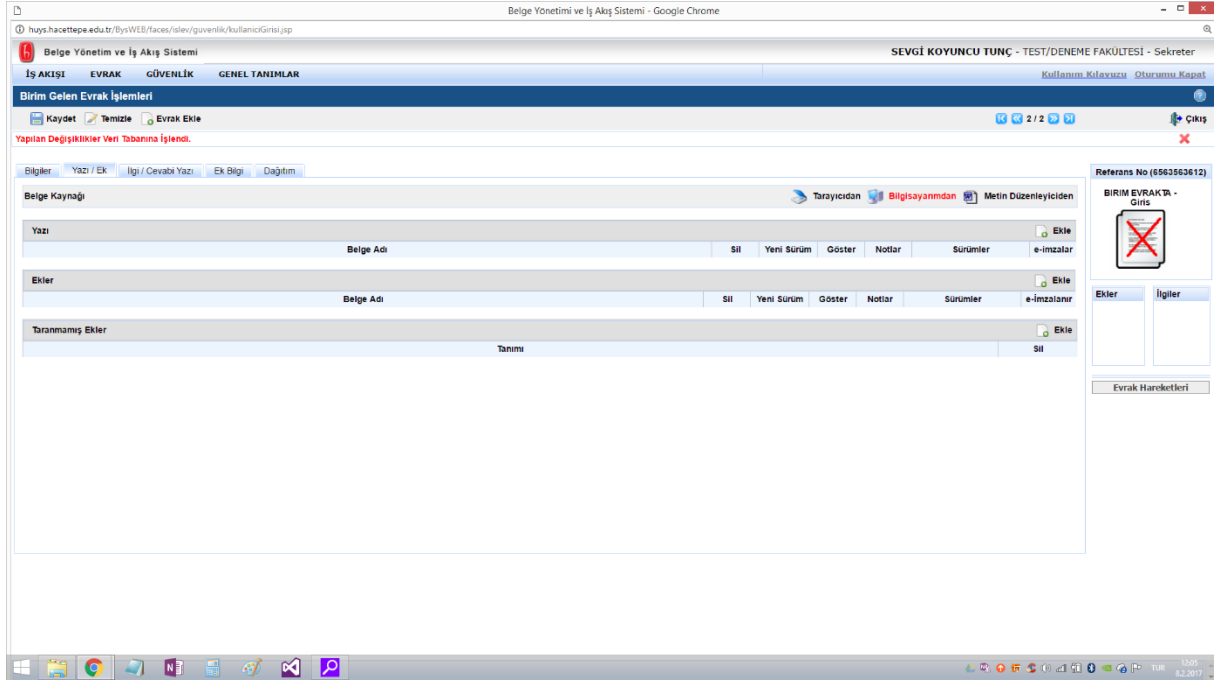
Figure 1: Confusion in Navigation Buttons

Criterion 5: Preventing errors

"Preventing Errors" criterion suggests designers to make it difficult to take incorrect actions, invalid actions, irreversible actions and plan for the unexpected situations in the software design (Quesenbery, 2001). We encounter situations that are in conflict with this criterion. For example in some pages user is not asked if she/he wants to save the changes when he/she attempt to exit the system without saving his/her work or user is not asked if she/he is sure to delete a record when he/she attempt to delete records. So user can easily lose his/her work or delete an important record by mistake.

We can also see that there is no plan for unexpected situations like system errors. For example there is no custom system error page and a "back to previous page button". So when a system error occurs, users should log out and log in to the HU-EDMS and it is not a deserved user experience for users.

Using unclear language also can cause mistakes like unclear button titles. In document creation page there is a button titled "Add Document". But it is unclear that if you are adding a new document to the system or you are adding an attachment to the current open document by clicking this button. So it should be changed as "Add New Document" to prevent errors.

Criterion 8: Aesthetic and simple design

Aesthetic designs are easier to use, are accepted and used more easily over time, encourage creative thinking and problem solving. Aesthetic designs also provide positive tolerance to problems related to designs by creating positive relationships with people

(Anon, 2017). There were many cases which were contrary to this criterion during the evaluation process. There are inconsistencies and differences between images, sizes and positions of icons used for the same purpose on some pages in the system. For example there are two different icon for clear button and two different looking button group for "save, query, add, delete" operations.
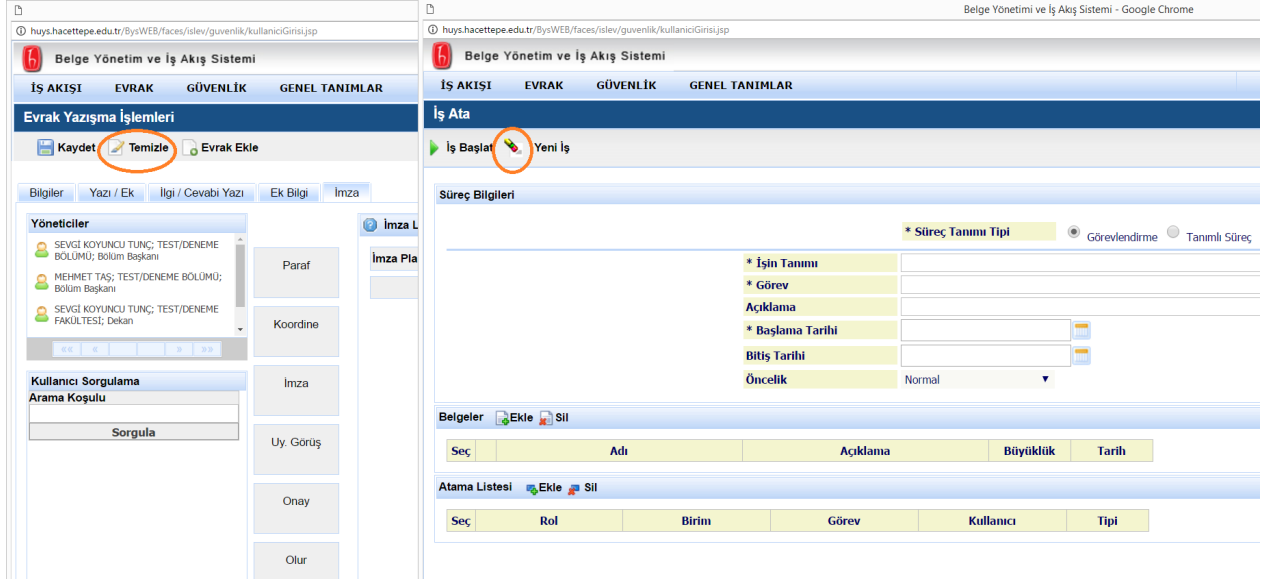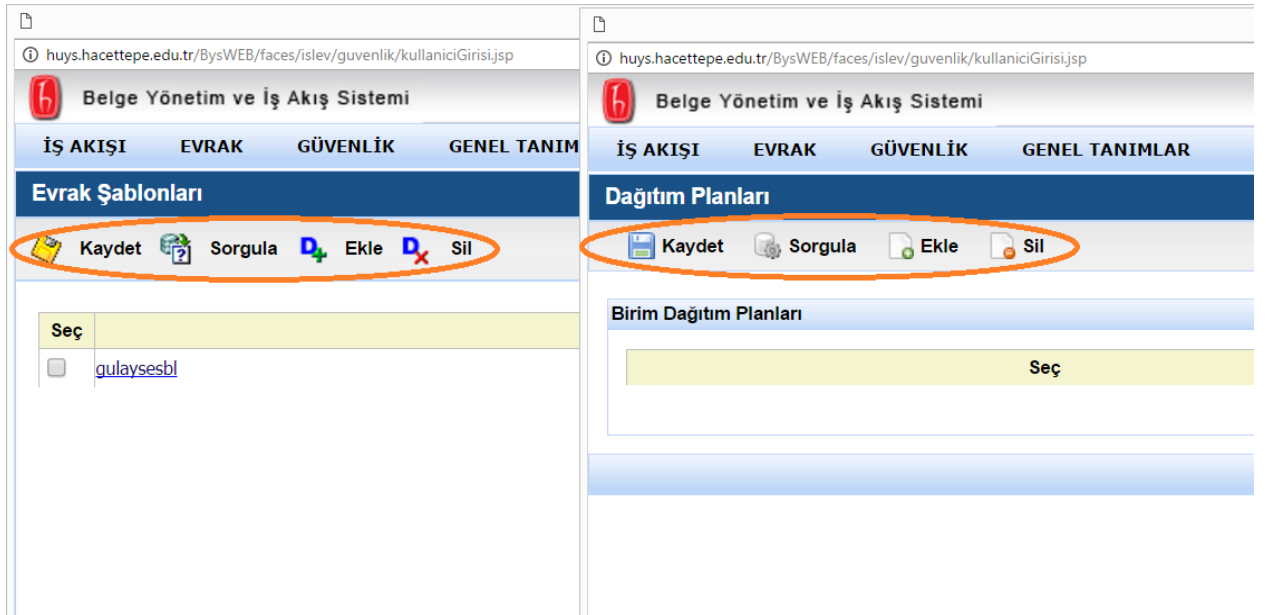

Figure 2: Icons Inconsistencies

Figure 3 Button Groups

The best interfaces are almost invisible to the user. They avoid unnecessary elements and are clear in the language they use on labels and in messaging. In HU-EDMS some important, primary functionality pages are very crowded and disorganized. The process steps are not clear because buttons, checkboxes, drop down lists are not arranged to guide the users. For example there 2 different "save" buttons that it is not clear in which order users should click to these buttons. If the user clicked to the button on the header and exit he/she loses the main text of the document and system does not warn the user for that situation.
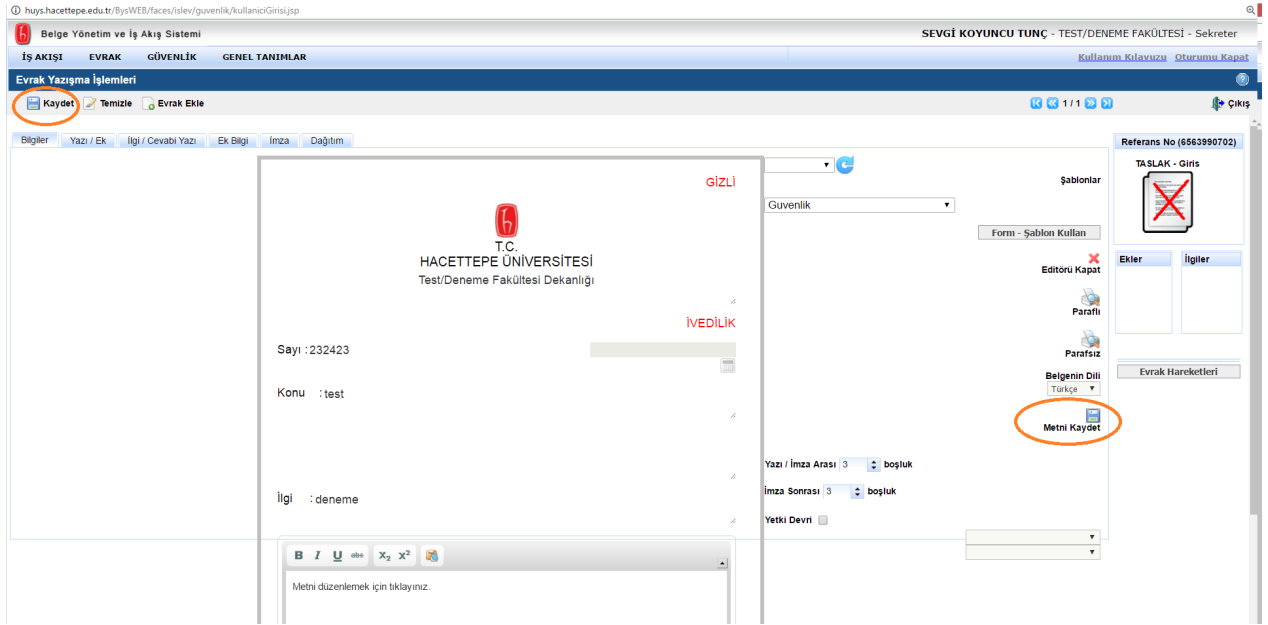

Figure 4

Criterion 11: Include short cuts and tips

There is not enough short cuts and tips in HU-EDMS. For example when user creates a document, filled the first form and clicked to the "Text Editor" button nothing happens and system does not give any information why user cannot open the text editor. User cannot guess he/she should click to "save" button in first time so there should be more clues to help users. Another example is detected in the user selection page. After querying the users, a list showed to the user but there is no "select" button or icon in the list. User should guess and try to find how to select a user.

In the file merging page after you select the first file to merge it is not clear how to select the second file. Because the button which put for this purpose titled "add detail". So it is so difficult to understand the real purpose of the button for users in first use.

Criterion 13: Contrary to general usage design

When user wants to add text to the document there are three options which are represented as image buttons "From scanner", "from file explorer", "from text editor". But when user clicks to one of the buttons nothing happens because after that user should click to another button titled "Add". It is contrary to the general use because clicking a button cannot be an option selection method. There can be radio buttons or if there is too many options, dropdown list can be used.
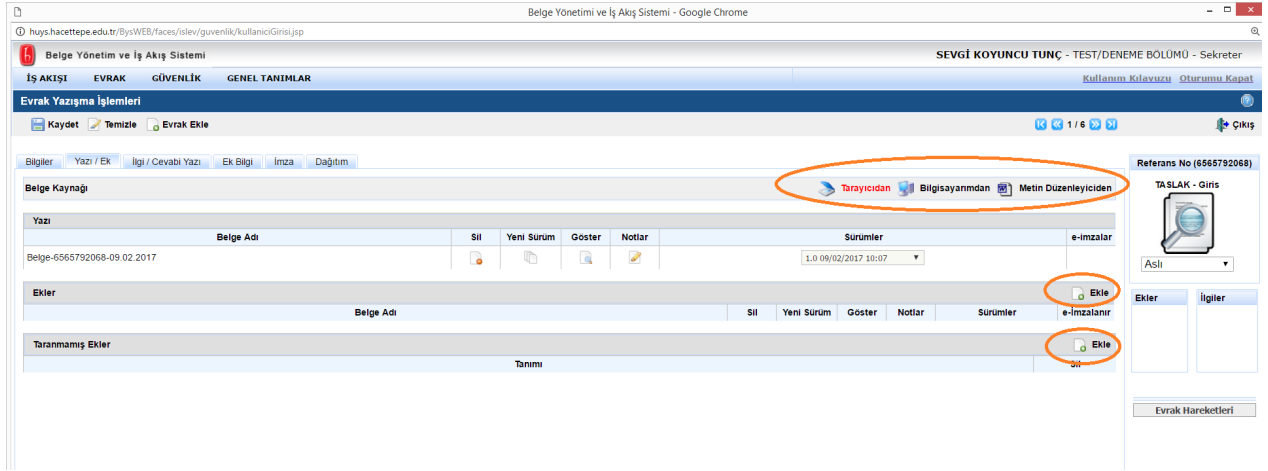
Criterion 22: Screen elements that are expected to be clicked are large enough and close to each other

In some pages user should click exactly to the image of the icon since the text is not clickable. Units of the university is shown hierarchical via tree view and user should click to the "+" sign to expand a node. Focusing mouse to the tiny areas is hard for users. It can be easier to expand the node by clicking to the unit name.
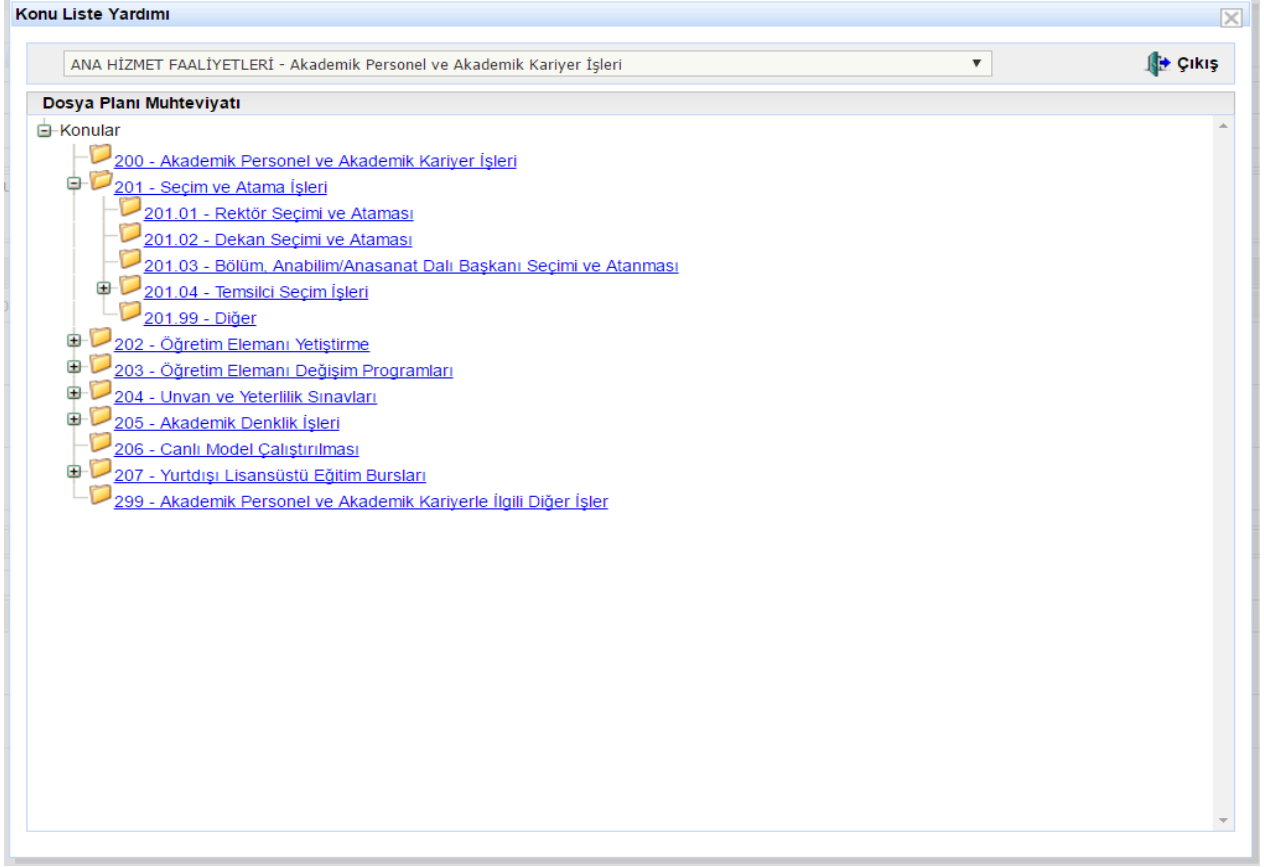
Figure 5: Clickable Area

System messages are shown in left side of the page and the X icon which closes the message is in right side of the page. Titles of the data fields and the data fields are very far from each other.
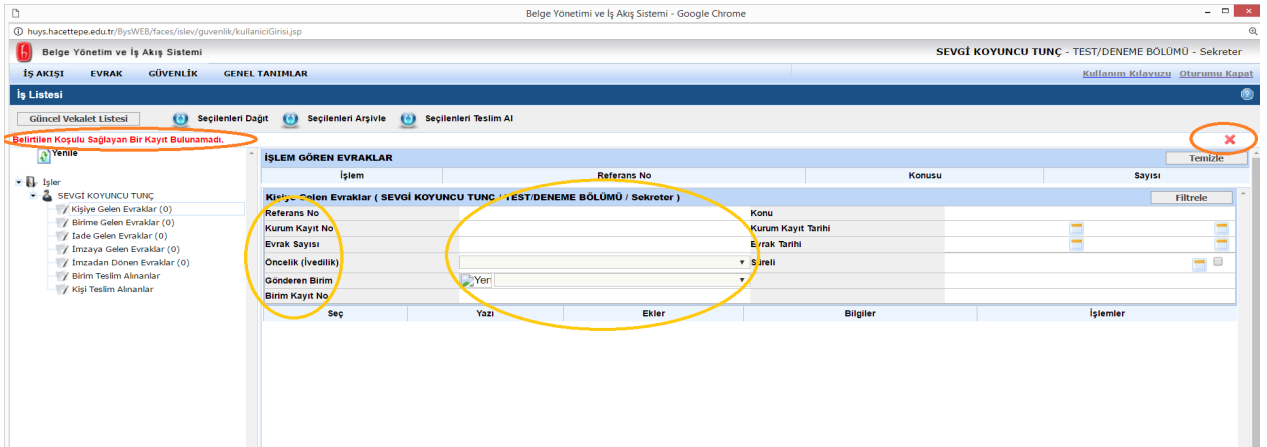

Figure 6: Element Placement

Criterion Error Messages:

Error messages remain in the page until the user close the message by X button or until a new message appears. So user confused about the message after a successful action because error messages does not disappear.

Unhandled exceptions are showed in a system error page and since the messages are not user friendly and there is no back button user loses his/her work. Custom error page should be used for unhandled exceptions.
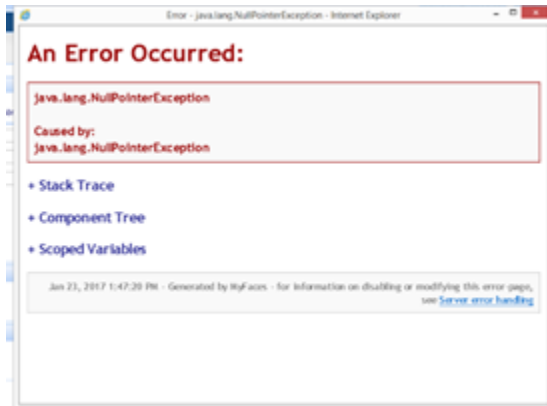

Figure 7: Error Messages

The validations on the form pages have been developed differently, but no form has indicated the problematic fields directly. On some pages, the message "Check the fields" appears and in some pages if form is not valid, nothing happens and no message is displayed when submit button is clicked.

Criterion 18: The images and icons used are similar to the objects they represent

"Exit" button which is used to exit from a page or turn back to previous page has a hardly understood icon. Also "Select All" and "Deselect All" icons are not understood in first sight.
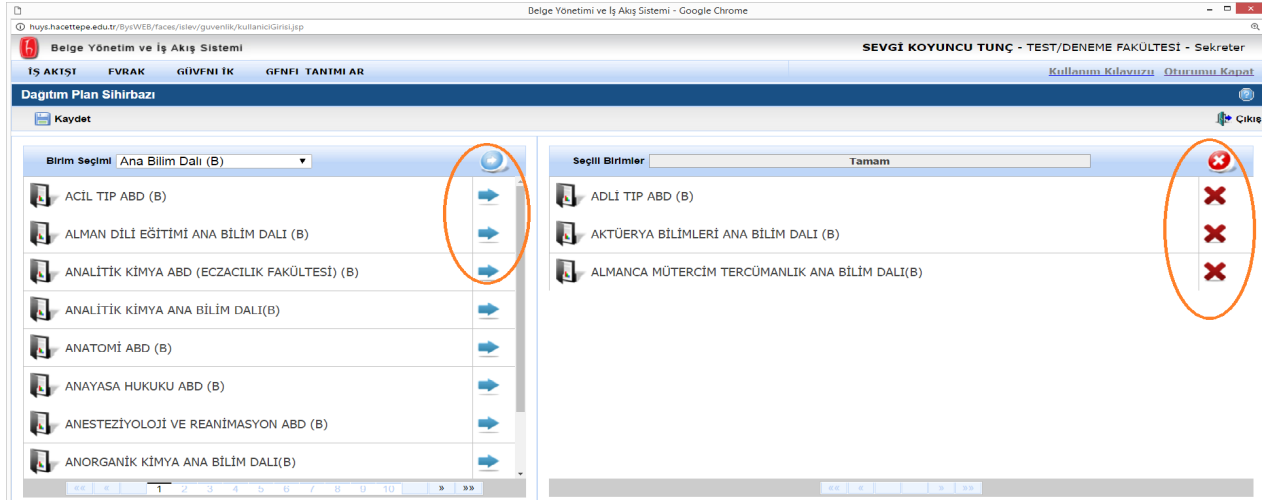

Figure 8: Exit Button

Figure 9: Common Icons

In some pages warning icon is used for success messages so users are disappointed about result of the operation in first sight.
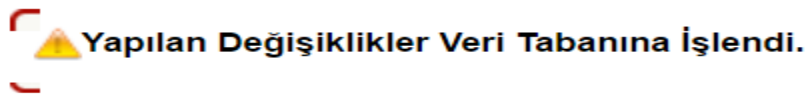

Figure 10: Inappropriate Icon-Message combination

Results – Server Log Analysis
In this research 16 million lines of server access log and 8064 lines of server error log which was gathered in 29 days have been analyzed and processed. Log data has been provided to us from Hacettepe University Computer Center Management. The amount of the total log data was 12 GB.

Server log analysis and data process consists of 4 stages.
1. Log file analysis.
2. Data tables design and creation in SQL Server.
3. Development of log file transfer program in .NET platform to read the log file, to clean and parse every line according to the data types and to write every data field to the database.
4. Transfer of the log data to the database
5. Data query on database to handle meaningful data.

The information we have obtained by filtering through sql queries is presented below.

# of Unique IPs which have logined to the EDMS: 3416
# of EDMS Requests in Log Files: 13904802
# of Mobile Clients Requests:960051

Client Browser Types:

Most used browser is Internet Explorer by %39 percent. It is meaningful because EDMS web application is developed to work best with IE. Some parts of the pages are not displayed properly in other browsers.

Browser Type	%
Internet Explorer	58,7
Safari	19,3
Chrome	18,5
Firefox	3,5
Opera	0,1

Table 3: Client Browser Types

User Density by Time:

When we query the user density by hours we saw that 11:00-12:00, 10:00-11:00, 15:00-16:00 and 16:00-17:00 time intervals are the busiest intervals. We can say that EDMS users prefer to work on the system, one or two hour after they get to work.

# of Requests	Hours
2102260	11:00-12:00
2101877	10:00-11:00
2041954	15:00-16:00
1985085	14:00-15:00
1782176	16:00-17:00
1605817	09:00-10:00
998461	13:00-14:00
883535	12:00-13:00
554108	17:00-18:00
396863	08:00-09:00
48982	18:00-19:00
34455	20:00-21:00
34260	21:00-22:00

33165	19:00-20:00
32294	22:00-23:00
26732	23:00-24:00
20977	00:00-01:00
12204	07:00-08:00
10754	01:00-02:00
4779	02:00-03:00
3970	03:00-04:00
3129	06:00-07:00
3028	04:00-05:00
1852	05:00-06:00

Table 4: User Density by Time

Page view statistics:
According to the server logs most visited page is "birimEvrakYazisma.jsp" which users prepare a document. Second most used page is the "isakisGelenIsler.jsp" that users can see the incoming works and notifications about documents. Third most used page is "birimEvrakOlusturma.jsp" which users create a document as a reply for an incoming document.

# of Requests	Page
1139674	birimEvrakYazisma.jsp
441439	isakisGelenIsler.jsp
299659	birimEvrakOlusturma.jsp
189640	genelGelenEvrak.jsp
131636	kullaniciGirisi.jsp
128229	birimYazismaGidenEvrakListesi.jsp
86286	sablon/frameSec.jsp
47772	uygulamaGiris/logout.jsp
47476	login/frameKapat.jsp
44723	sablon/frameGiris.jsp
43865	birimGelenEvrakListesi.jsp
36706	evrakBelgeEkle.jsp
21929	birimGidenEvrakListesi.jsp

19358	evrakArama.jsp
14579	genelGidenEvrak.jsp
10723	evrakDetayliArama.jsp
10133	birimYazismaGelenEvrakListesi.jsp
7396	birimEvrakOlusturmaGiden.jsp
5919	birimDosyaListesi.jsp
4774	birimEvrakYazismaCoklu.jsp

Table 5: Page View Statistics

Help page view statistics:
Access logs shows that "isakisGelenIsler.htm" is the most used help page which describes the "incoming works and notifications" page usage. Help Menu and index pages are the following most accessed help pages. In first 10 help pages the interesting page is "dosyaBirlestirme.htm" which is about merging two folders. We have found some problems about the misunderstood terminology that affects as well.

# of Request	%	Help Page
162	22,32	yardim/isakisGelenIsler.htm
154	14,94	yardim/BysYardimMenu.htm
138	14,21	yardim/BysYardimIndex.htm
66	12,73	yardim/genelGelenEvrak.htm
60	6,09	yardim/birimEvrakYazisma.htm
40	5,54	yardim/birimGidenEvrakListesi.htm
21	3,69	yardim/birimEvrakOlusturma.htm
20	1,94	yardim/genelGelenEvrakListesi.htm
20	1,85	yardim/genelGidenEvrak.htm
18	1,85	yardim/dosyaBirlestirme.htm
18	1,66	yardarm/evrakArama.htm
16	1,66	yardim/genelGidenEvrakListesi.htm
15	1,48	yardim/dagitimPlanListesi.htm
15	1,38	yardim/birimDosyaListesi.htm
12	1,38	yardim/dosyaEvraklari.htm
9	1,11	yardim/dagitimPlanSihirbazi.htm
9	0,83	yardim/genelEvrakPostalama.htm
8	0,83	yardim/imzaPlanSihirbazi.htm
7	0,74	yardim/birimYazismaGelenEvrakListesi.htm
6	0,65	yardim/birimGelenEvrakListesi.htm
6	0,55	yardim/imzaPlanListesi.htm
5	0,55	yardim/evrakDetayliArama.htm
5	0,46	yardim/ilgiliKisiPlanListesi.htm

4	0,46	yardim/birimYazismaGidenEvrakListesi.htm
3	0,37	yardim/birimEvrakOlusturmaGiden.htm
3	0,28	yardim/ilgiliKisiPlanSihirbazi.htm
1	0,28	yardim/listeYardimiBirimToplu.htm
1	0,09	yardim/guvenlikVekalet.htm

Table 6: Help Page view statistics

User-based usage frequency:
According to the server access logs most of the users enters to the document management system less than 6 time in a day. Since there are some IP's which has login to the system 8019 time in a day we can say that these IPs can be an IP address of a proxy server, an Internet cafe, or IP of an Internet service provider (ISP) which jointly provides to all users. So this is the negative part of server logs that differentiating real users and user sessions is not possible for this kind of IPs.

# of Login (daily)	# of unique IPs	%
0-5	1639	47,98
5-10	418	12,24
10-20	320	9,37
20-30	208	6,09
30-40	129	3,78
40-50	113	3,31
50-60	77	2,25
60-70	59	1,73
70-80	44	1,29
80-90	53	1,55
90-100	43	1,26
100-120	58	1,70
120-150	56	1,64
150-200	60	1,76
200-300	73	2,14
300-501	46	1,35
501-874	17	0,50
874-8019	3	0,09

Table 7: User-based usage frequency

Error Messages:
Majority of the errors in error log file are 404-not found errors. When user load a website in his/her browser, a lot happens in the background to render and display that website to the user. The computer makes a number of requests, one for each file that is somehow

linked on the site. This can be images or multimedia contents for instance. Whenever a file cannot be retrieved because it does not exist, a 404 not found error is created for that file in the log. This may not affect the person loading the website, but it very well may provide the webmaster with information that something is not working correctly.

There is another case where 404 errors happen. When you enter a link into your browser or a program directly that is not existing. This may be an image that you want to load, a feed url or any other form of link that points to a non-existing element on the web server.

The primary reason for analyzing error logs is to resolve all, or at least the most popular causes for errors. If you notice that half of your users want to access a page that does not exist, you may want to redirect them to an existing page instead, and especially so if that page has been moved or is available under a different address.

When we look at the error log statistics 404-not found is the most occurred error. When we look deep to that error we can see that a big part of the 404 – not found errors are related to some png and javascript files. So developers should find and place the missing png and js files. The second most occurred error is 500-internal server error.

# of Requests	HTTP Status Code
148463	404 – Not Found
347	500 – Internal Server Error
3	400 – Bad Request
4	401 – Unauthorised (RFC 7235)
1	403 – Forbidden

Conclusion

The main goal of heuristic evaluations is to identify any problems associated with the design of user interfaces. After heuristic evaluation, we found some weaknesses or areas to consider for improvement in Hacettepe University HU-EDMS. We detected 85 interface mistake in terms of usability and human – computer interaction. 47 of the mistakes were serious and should be fixed urgently, 26 of the mistakes should be fixed in mid-range and there were 12 uncritical mistakes which are related to look and feel of the pages. According to our evaluation we propose the following actions for improving the usability of HU-EDMS.

- Common page elements should be made similar looking to make users remember the usage.
- Useless page elements should be made invisible according to the user role.
- Design of the active and inactive page elements should be changed.
- Inappropriate button titles should be made more understandable.
- Warning and information messages should be added to the required pages.
- Elements in a page should be arranged in order to guide the user.
- Images on the icons should be change to express the meaning of the buttons.
- Custom error page should be used for unhandled exceptions.

Heuristic evaluation is cheap, it is intuitive and it does not require advance planning. But if there is only one evaluator, this evaluator should be double expert which means evaluator should have domain information and should have the wide knowledge of usability science for an affective usability evaluation.

To be effective in a knowledge and information based society, individuals need tools that allow them to collect manipulate, and distribute the products of their own or others work. The problem for authors and maintainers of such distributed resources is that to measure the utility of information in such a process and the question is: How do you analyze that the information you have placed on the web is being accessed in a significant way? (Microsoft.com, 2017)

Server log analysis process provides us some statistical data like system usage frequency, usage density by hour, help page usage, error types and messages, browser preferences, device preferences etc. These information can be very useful. For example:

- If number of mobile users is too much, providing a mobile user interface will make a big difference in terms of usability in EDMS.
- According to the user density if there is a performance problem some extra servers can be employed in busiest hours and we can limit maintenance of web site with the least busy hours.
- If our EMDS works well in Internet Explorer but most of the users use other browsers we should solve the problems related to the browsers to increase usability as soon as possible.
- Help statistics shows us most used help pages and therefore most difficult pages for users. So we should focus and improve that pages.
- Error logs analysis finds out most occurring exceptions and errors so developers can see and handle that issues immediately.

Server log analysis gives some general information about the system usage but cannot show specific usability problems. Because of the caching mechanism it is not possible to handle user path for completing a task or we cannot know which page elements are problematic to the user by using only server logs. Server log analysis may also show less users than the site actually had because multiple users could potentially use the same IP address. The data on entry and exit points will be unreliable. Users will look like they've left when they've simply gotten a new IP address. Their next page view will make look like a new user. The data on length of visit and time on each page will also be unreliable. As a conclusion combining server logging analysis with heuristic evaluation not only allows the cross validation of the data, but also provides a better picture of users' behavior than either one of the methods applied alone.

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