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# The Impact of EHR Usability Issues on the Perceived Efficiency of Non-Clinical Hospital-Based EHR Users

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The Impact of EHR Usability Issues on the

Perceived Efficiency of

Non-Clinical Hospital-Based EHR Users


by

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# Contents

Abstract

A survey-based study of the impact of the EHR systems usability issues on the perceived efficiency of work among non-clinical users in the hospital settings was performed June 20th to July 24th 2015. There were 160 valid responses. The results were processed in SPSS (IBM statistical application) and I determined the usability dimensions with the greatest impact on efficiency, for all EHRs and for the major EHRs (Meditech, Epic and Cerner). Helpfulness was the most frequent problem for users of all EHRs.

The survey is experimental and cross-sectional. The format was 20 Likert-type questions, along with screening and demographic questions. Due to the nature of data collected (ordinal) the non-parametric analysis was performed in SPSS.

The goal of the study was to figure out the main usability issues among non-clinical users of the EHR systems and to generate actionable insights for designers and developers of EHR systems.

1. Introduction

I have used an EHR (Meditech) in my work as a Decision Support Analyst in the Care Management Department of a Los Angeles hospital for about 4 years. I have to train both clinical and non-clinical users. I have observed a lot of usability issues in the Meditech EHR system. I have also had an opportunity to discuss usability with professionals who have hands on experience with other EHR systems. I have personally found that my work is less efficient due to the EHR usability issues.

So, when I had to pick a subject for my thesis I decided to perform a survey among non-clinical users of EHR systems. I chose to focus on non-clinical users because my personal experience has been with non-clinical use, and because there have been several published studies about EHR usability issues experienced by clinical users. The primary purpose of any EHR is to support immediate patient care. However, many non-clinical users in hospital departments such as medical records, case management, medical staffing, admission, administration, business, finance, information services, etc. use EHR systems in their everyday work.

Therefore, I would like to measure the impact of usability problems on the productivity and the perceived efficiency of non-clinical users of EHR systems in the hospital settings.

Usability is the important feature of the software design. Usability increases user satisfaction and overall the efficiency of work. Development of software applications in different fields of business and every day humans' life cause the business necessity for the usability or ease of use of software applications, websites and gadgets. The usability theory had started developing in 90s of the last century and very soon usability became the essential requirement for any software product development.

There has been some research done to evaluate the usability issues among the clinical users of EHR systems, but there is almost no research on the same subject among non-clinical users of the EHR systems.

The usability issues of the clinical users are different from the issues which create problems for non-clinical EHR users, due to the difference in their workflow nature. Non-clinical users play an important role in the supporting the healthcare process. Their efficiency and productivity influence the efficiency and quality of healthcare delivery.

In my study I am going to investigate the usability issues among non-clinical users of the EHR systems and their effect on the perceived efficiency of work.

Usability is divided into dimensions in order for better objective evaluation of design and functional usability issues. The objective results of the perceived efficiency will create the actionable insight for the EHR systems' designers and developers. The goal of the study is to reach the awareness of the EHR developing companies of the usability issues among non-clinical users and consideration this problem in the future EHR releases.

2. Establishing the focus of the study

2.1. Formulate Hypothesis /Research question:

The usability issues significantly and negatively impact the work efficiency of non-clinical EHR users in the hospital setting. I will try to answer the following research questions:

The research question is how usability issues of the EHR systems impact the perceived efficiency of work of non-clinical users in the hospital settings. There could be 2 answers: 1) the perceived efficiency of work is decreased because of usability issues of the EHR systems. 2) There is no influence of the usability issues on the perceived efficiency of work.

## 2.2. Identifying the specific objectives of the study

The objective of the study is to explore 14 usability dimensions: Consistency, Findability, Ease of Navigation, Simple Design, Minimal Memory Load, Match the Outside World, Minimal Action, Flexibility, Feedback, Helpfulness, Learnability, Memorability, User Control, and Customizability. I want to figure out which dimensions, in case of a problem have the significant effect on the perceived efficiency of work among non –clinical users.

I've read several publications on the usability dimensions. There were general publications on the usability theory, usability dimensions in the business world and several publications which focus on the usability dimensions for the EHR systems Based on my research I developed the usability dimensions list which have influence on the efficiency of work. I made several rounds of developing the final list; in the initial versions of the usability dimensions list there were dimensions overlapping each other. I grouped overlapping dimensions under the dimension which covers the several dimensions. Finally, I generated the 14 dimensions list which all has the direct impact on the efficiency of work of non - clinical users of the EHR systems.

The goal of the study is to find out is there any statistically significant difference between the measured impact of usability issues in the study and in similar published studies done on clinical users (e.g. physicians and nurses using the EHR at point-of-care).

The analysis of the usability issues and finding the dimensions with the highest impact on the efficiency can help developers of the EHR systems to fix the usability issues and therefore improve the work of the EHR systems.

Usability issues can cause the delays in performing different tasks for the user. Tasks will take more time to conclude the task. The lower efficiency leads to the lower productivity and quality of work. Also, usability issues can cause user frustration and less satisfaction after using the EHR systems. The user satisfaction is the usability category which is difficult to measure because of its subjective nature.

One of the goal of the survey is to find the most problematic usability issues which can produce the negative effect on the productivity of non – clinical EHR users. Based on the results of the survey the usability dimensions can be scaled from the worst possible impact on the efficiency to the least.

3. Introduction – Literature Review

Usability is the important feature of the software design. Usability increases user satisfaction and overall the efficiency of work. Development of software applications in different fields of business and every day humans' life cause the business necessity for the usability or ease of use of software applications, websites and gadgets. The usability theory had started developing in 90s of the last century and very soon usability became the essential requirement for any software product development.

There are some researches done to evaluate the usability issues among the clinical users of EHR systems but there is almost no research on the same subject among non-clinical users of the EHR systems. I am going to do the Literature review of publications on usability issues among clinical users.

I am interested in the available researches of usability dimensions issues which mostly affect the efficiency of work.

I decided to do the research on the usability issues of the EHR systems among non-clinical users due to the lack of research done on this matter.

An extensive search of relevant literature was performed using PubMed database, Google Scholar search engine, HIMSS and available publications online.

Search guidelines  were similar for different sources and included keywords and phrases, such as Usability, Usability dimensions, categories, subcategories, usability issues, usability principles, usability measurements , SPSS, quantitative analysis ,EHR usability issues, usability issues among clinical and non –clinical users of EHR, EHR training and on -going training..

This literature review sought to include articles that were published in the years 1997 to 2015, written in English, and focus on usability theory, usability issues in business and commercial worlds, and specific usability issues of the EHR systems among clinical and non-clinical users, and their influence on the efficiency of work.

I investigated the impact of the EHR usability issues on the efficiency of work of EHR users in the hospital settings. There are several publications that discuss EHR usability issues faced by physicians and bedside nurses (O'Connell, Cho, Shah, Brown, & Shiffman, 2004). These articles discuss the effect of EHR usability on both productivity and quality of care. However, there are just a few publications on the EHR usability issues among non-clinical users. Therefore, it is important to get an insight of usability issues among non-clinical users as they are essential part of health care delivery process.

There are a lot of articles on the EHR usability issues and their negative impact on the physicians and nurses productivity but almost no studies have been made among the non-clinical users.

4. Research Question: What is Usability?

There are several usability definitions in different sources and there is no universal definition accepted by everyone.  After doing research on the usability of software and usability issues of EHR systems I created my own Usability definition.

4.1. Defining Usability

4.1.1. Ease of Use

According to Jakob Nielsen, one of the pioneers of software usability theory, usability is a quality attribute that assesses how easy user interfaces are to use. (2003) The word "usability" also refers to methods for improving ease-of-use during the design process.(Jakob Nielsen, 1995)

Nielsen defines usability in terms of five "quality components":

- Learnability: How easy is it for users to accomplish basic tasks the first time they encounter the design?
- Efficiency: Once users have learned the design, how quickly can they perform tasks?
- Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
- Errors: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
- Satisfaction: How pleasant is it to use the design?

Usability means making products and systems easier to use, and matching them more closely to user needs and requirements.

This short and precise definition reflects the ability of a user to achieve his or her goal efficiently.

### 4.1.2. Simple and Intuitive

In "Don't Make Me Think," Steve Krug writes:

Usability really just means that making sure that something works well: that a person of average (or even below average) ability and experience can use the thing - whether it's a Web site, a fighter jet, or a revolving door - for its intended purpose without getting hopelessly frustrated. (Krug, 2005)

Krug's definition of usability gives a broad definition of a product or a website and stresses the "don't think" approach of the user role, that the user without knowing the product can intuitively find the required information and successfully accomplish his task.

### 4.1.3. Meeting User Requirements

Usability starts with a philosophy - a belief in designing to meet user needs and to focus on creating an excellent user experience - but it is the specific process and

methodology that produce the real goal of usability. A new usability process starts by looking at who uses a product, understanding their goals and needs, and selecting the right techniques to answer the question, "How well does this product meet the usability requirements of our users?"(Quesenbery, 2006)

I think that Quesenbery's definition is deeper and have scientific and psychological understanding of users' needs and their final goals. The distinction of this definition from others is the describing usability as methodology.

There is a similar definition of product usability from (Dumas & Redish, 1999)

Usability means that the people who use the product can do so quickly and easily to accomplish their own tasks. This definition rests on four points: (1) Usability means focusing on users; (2) people use products to be productive; (3) users are busy people trying to accomplish tasks; and (4) users decide when a product is easy to use.

Authors of this definition focus on productivity, efficiency and ease of use of a product. All these usability characteristics are extremely important in the business environment. The key characteristic of the usability in this definition is quickly and easily accomplish the task. In the business world the efficiency of work is essential to the success.  Quickly and easily are parts of efficiency equation

### 4.2.    Epistemological Aspects of Usability
#### 4.2.1.    Usability Is Multidimensional

It is important to realize that usability is not a single, one-dimensional property of a user interface. Usability has multiple components (See Appendix A) and is traditionally associated with these five usability attributes: learnability, efficiency, memorability, errors, satisfaction.(Jakob Nielsen, 1994a)

Nielsen pointed out on the components of usability and gave his definitions of each dimension. I think the definition mentioning components is heuristic and shouldn't be accepted as the "official" definition.  Any classifications, further descriptions of

components and dimensions of usability shouldn't be mentioned in the general definition.

A review of dimensions in different usability definitions found that five dimensions accounted for approximately 77% of the concepts used in the definitions. (Chen, Germain, & Rorissa, 2009)  The five most emphasized elements of usability identified in the Chen review were:

- Learnability
- Effectiveness
- User characteristics
- Users' attitude/satisfaction
- Efficiency

This emphasis was not found to depend on the subject area of the definition. Even though, the efficiency is mentioned separately, all these attributives of usability have direct effect on the efficiency and productivity of work. I am going to exclude users' satisfaction due to the subjective nature of the evaluation of this attribute.

### 4.2.2.    Usability Is Measurable

Usability is a measurable characteristic, which is present to a greater or lesser degree that describes how effectively a user can interact with a product. It can also be thought of as how easy a product is to learn and how easy it is to use.(Axup & Viller, 2005)

Basically, Axup just paraphrased Nielsen's definition but he mentions the effectiveness of a product and the important point in his definition that usability is a measurable characteristic. My research is focused on measurable aspects of usability issues and the perceived effect on the efficiency of work.

### 4.3.   Usability Is both Objective and Subjective

Usability has two aspects, subjective and objective:

Usability is a relative property of the system; being relative in relation to its users, therefore evaluation is context dependent; resulting in a subjective perception of the product. The other side of usability relates to objective measures of interaction. (Shackel, 1991)

The focus of my study is the usability issues among non-clinical EHR users and how they affect the perceived efficiency of work. Efficiency-related usability dimensions are possible to measure objectively, as opposed to satisfaction, which is entirely subjective. User satisfaction is an important factor to know but there is no way to fix the problem, but my goal is generate actionable insight for EHR developers. It is possible for a manager at an EHR development company to go to his or her designers and programmers and say "Make the error messaging more helpful," but difficult for the manager to tell his team, "Make the interface more satisfying."

Usability - ISO 9241 definition is the most official and well known. ISO definition talks directly about efficiency, effectiveness and for the first time about the importance of user satisfaction. This definition points attention on the user's comfort and acceptability of the work system. It is very important the user's attitude, satisfaction and desire to use the system again. This is the subjective category which is very difficult to measure but user satisfaction is the essential component of creating efficient work processes.

Effectiveness, efficiency and satisfaction with which specified *users* achieve specified *goals* in particular *environments*.

- effectiveness: the accuracy and completeness with which specified users can achieve specified goals in particular environments
- efficiency: the resources expended in relation to the accuracy and completeness of goals achieved
- satisfaction: the comfort and acceptability of the work system to its users and other people affected by its use

### 4.3.1.    Focusing on Efficiency (Objective) Rather Than Satisfaction (Subjective)

Business applications have more usability issues compare to commercial products. Commercial users in case of disliking the product can switch to another, similar one; however, business users do not have a luxury of switching or buying new product in case of serious usability issues. They have to work and trying to find workarounds in case of usability problems in order to be productive.

### 4.4.    Business to Commercial vs Business to Business

If your business is focused on selling products or services to other companies, your model is called B2B, or business-to-business. (Arline, 2015)

While the term e-commerce refers to all online transactions, B2C stands for "business-to-consumer" and applies to any business or organization that sells its products or services to consumers over the Internet for its own use. (CIO, 2007)

EHR vendors' relations to hospitals are business to business interaction.

Health care facilities are forced to follow the law and implement EHR systems at their full capacity to meet the requirements of meaningful use as a part of Healthcare reform. There are not too many EHR companies on the market and the choice is not big. So, on one side we have a customer who is forced to buy a product, on the other side we have a vendor who does not have the essential requirements to develop a user friendly product. Compared B2B market to B2C, the choice of products for customers in the consumer market is very big. In case a customer is not satisfied with the product quality and its usability, he can easily search and find the similar user-friendly product with better quality. Hospitals cannot switch from one EHR system to a better one as easy as a customer can switch between different products and choose the most suitable for him.

There are six differences between B2B and B2C (Sauro, 2014).They are:

- User is not the buyer: The process of buying a product by business pass several stages of approval by managers and different committees and finding the qualified vendors.  Businesses have to prioritize many competing interests, including budgets and existing software that it has to integrate and the consideration of users' requirements can be on the second or third places in this process.

- Customization: Businesses need a lot of customization due to the nature of business and many types of users' involvement.

- Harder to find users it is hard to find users for usability tests for B2B. Professional users are very busy and their time is precious. That is why usability tests with users very often replace on the heuristic evaluation and expert reviews.

- Switching costs are high:

- Even executives know there's a usability issue costing time and money; it's hard to make a change. If it takes long time to customize and train personnel on a new system, switching to a new system will be a very difficult decision because it will take more time and money again; new servers and staff with different skills

- Training users:

Most B2C websites are meant to be used by consumers without requiring any specialized skills.  It is impossible to imagine the usage of some corporate application without proper training, taking classes and reading manuals.  The usability is usually worse:

There were performed 24 usability tests with problem frequencies and found out that B2B applications had almost 10 times the number of usability problems that websites had and 2 times as many as consumer software. (Sauro, 2010)

 In B2B users don't make the purchasing decision, the users' feedback is usually slow and that is why usability suffers.

Author predicts that the more software moves to the cloud it becomes easier to test and update software to improve the B2B user experience

Sauro expresses the hope that more organizations invest more time in the usability testing and  improving the usability issues for their end users; so there will be no necessity to switch software providers every.

Nielsen (2006) points out that many business-to-business (B2B) sites are stuck in the 1990s in their attitude toward the user experience. Most B2B sites, fail to meet customer needs.

Nielsen mentions that B2B projects are long time investments with the long, sufficient planning stage. The business projects are planned and use for a longer time in general than on the consumer market. Usually, software business applications are very big with a lot of data and the huge storage options.

According to Nielsen user testing results show that usability of business-to-business websites is significantly lower than mainstream consumer sites.

EHR is a typical example of Business-to-Business product with many usability problems and far from being user-friendly. EHR systems have many usability issues and negative effect of it among clinical users has been the focus of many studies.

4.5.    Perceived Efficiency

Perceived efficiency is the user understanding of his time and effort in order to finish the task. Perceived efficiency is the subjective category.

Efficiency is defined as the speed with which a user can complete a task or accomplish a goal. It is typically measured by the length of time required to complete a task, task success, number of keystrokes, and number of screens visited. Efficiency may also be measured by objective measures of mental effort, such as the percentage of mental steps over all steps (mental and physical)  (Johnson et al., 2011)

In a study of EHR users following an EHR implementation at a community health center, the researchers asked users how the implementation impacted their work (McAlearney, Robbins, Hirsch, Jorina, & Harrop, 2010). Specifically, the users were

asked whether they saw any improvement in their workflow and the time required to finish tasks.

The authors explored perceived efficiency and divided answers into two groups: perceived efficiency gains and perceived inefficiency introduced.

In terms of efficiency gains, with the EHR implementation two discoveries were made: Workflow efficiency and laboratory turn-around efficiency showed improvement.

On the other hand, perceived inefficiency followed the EHR implementation was characterized by extra steps users should do to finish their tasks. A lot of respondents from all three community health centers noted that the result of the EHR implementation was more work for them. Extra work was related to the new work as a result of EHR implementation, work to address EHR related errors and discover workarounds due to the EHR limitation...

Looking at usability generally, Norman discusses perceived usability and real (measurable) usability (2006). He concludes that users have a holistic view of their experience, and that perceived usability is more important to them than real usability.

Perceived efficiency is closely related to ease of use. Often the design that seems fastest is not the one that actually takes the least time, but is the one that requires users to do the least amount of thinking.

In a study of EHR impact on the time efficiency for physicians and nurses state that time efficiency is one of the benefits of the EHR implementation (Poissant, Pereira, Tamblyn, & Kawasumi, 2005). The result of the study appeared that time inefficiency is recognized as a major barrier for the EHR implementation. However, time efficiency is evaluated from the user's perspective. The efficiency is assessed through one process and not looking on the set of processes in the EHR systems. The study results happened to be different from the expectations connected with the EHR implementation that the documentation time will be decreased is unlikely. Some processes in the EHR systems like CPOE have a potential for time savings; like accessing a patient records or

maintain the report form. Authors suggest that it should be the shift from accessing the user perceived efficiency to the organization or a system efficiency as a whole unit.

### 4.6. Summary

Most of the usability definitions mentioned above emphasize the relationship between usability and efficiency. Any of these definitions can be appropriate for a study of EHR usability.

Some definitions are focused on the usability of a product, some on usability of software applications or websites. I started the research from the most standard and more general definitions first and then I did my research on the software systems usability, and the lastly on the EHR systems usability.

EHR systems usability as a general definition with the future clarification of usability dimensions affecting quality and efficiency of many stages health care delivery process.

After the usability is defined the next step is the usability measurement.

### 5. Research Question 2: How Can We Measure Usability?
### 5.1. Usability Measurement Methods

Usability evaluation process is divided into 5 groups:

- Interview/Focus Groups (Structured and Semi-Structured)
- Usability Inspection (Cognitive Walkthrough and Heuristic Evaluation)
- Usability Testing (Laboratory and Field Testing)
- Questionnaires/ Surveys (Likert Rating and Semantic Differential)
- Observations. (1994b; "Usability Evaluation Method," 2015)

I considered Usability Testing/Field Testing, Interviews/Focus Groups, Usability Inspection and Questionnaires/ Surveys possible methods for my research. I could apply these methods at my work in a hospital, among my colleagues.  I decided to use

the Web based Survey method due to much bigger possible sample of target population and not biased, neutral responses. If I would use other methods at my work they can be more difficult to apply due to the nature of work in a hospital, more time consuming for both parties (researcher and respondents) and the main turning point against it was that this survey would be biased. I wanted to have statistically correct, not biased, reliable results.

There are several methods to measure usability such as Cognitive Load, Thinking Load, User Testing, interview/Focus Groups and different types of usability Questionnaires/ Surveys.

### 5.1.1.    Comparison of methods

Jaspers (2009) compares different methods of usability measurement. He defines two categories:

- Expert-Based (Heuristic Evaluation and Cognitive Walk Through)
- User-Based (Think Aloud)

The Heuristic Evaluation and Cognitive Walk Through methods require experts to perform the usability evaluation. This makes these methods more costly and more complicated to perform. Also, the heuristic evaluation method is not structured and user focused, Heuristic-type methods, in general, is not easy to define and hard to decide which guidelines should be used in a certain context. In addition, number of evaluators can affect results.

In the Cognitive Walkthrough method, results are affected by the users' background details and task description details.

The disadvantages in the Think Aloud method is that this method is very time consuming, Verbal protocols method do not tap all thinking, and results are affected by the skills of evaluators and representativeness of users, and the choice of task.

Nielsen (1994b) also compared different advantages and disadvantages of usability evaluation methods.

He compares Laboratory Testing, Thinking Aloud, Formal Modelling, Guidelines/Checklists and Heuristic Evaluation. These methods identify serious and recurring problems, and provide some objectivity. Thinking Aloud and Heuristic evaluation are low cost and Guidelines can be used by non-specialists. At the same time all these methods have serious disadvantages, such as:

- Laboratory Testing: have high cost, require expertise, large number of users and can miss consistency problems.
- Thinking Aloud are hard for expert users and unnatural to them.
- Formal Modelling requires expertise, very complex and tend to focus on one dimension.
- Guidelines/Checklists can miss severe problems, difficult to follow and can be misapplied.
- Heuristic Evaluation requires expertise, several evaluators and has some degree of subjectivity. (Jakob Nielsen, 1994b)

### 5.1.2. Using surveys to measure usability

In the Health Informatics course of usability questionnaires and surveys are presented as a common method of collecting users' opinion on different matters. They usually consist of close-ended questions and can reach large group of participants. Likert scale is often used as an answers' scale in the surveys. It rates responses on continuum from one extreme to another. From lowest disagreement to the highest agreement with the question and provide the range of responses.

Semantic Differential is the example of another scale. This scale explores the range of bipolar attitude about particular item. The respondent should put a mark in a number between 2 extreme positions. Semantic Differential scale is less convenient for the future analysis vs. Likert scale revealed that the top five most emphasized elements/attributes of Usability are learnability, effectiveness, user characteristics,

users' attitude/satisfaction, and efficiency, regardless of the subject area of the sources. These five elements/attributes (about half of the 11 attributes) account for approximately 77% of the total number of Concepts used in the definitions pointing to their importance for researchers and authors.

## 5.2. Metrics for Usability Measurements

The term usability is very broad and it consists of many subcategories/ dimensions/ utilities according to different authors. The idea of usability dimensions appeared due to the difficulty of describing usability and measuring it. Usability is divided in subgroups/ categories or dimensions for better usability evaluation.

### 5.2.1. Using Dimensions to Separate Subjective and Objective Usability Data

Usability measurement provides subjective user insight based on users' satisfaction of the product or not. It is very difficult to measure the subjective satisfaction of a user and make an objective conclusion about the usability of a product

Usability measurement as a general term provides very narrow, limited results. It can cover user satisfaction or ease of use which sometimes usability is called. The computer applications are becoming more and more complicated and the evaluation process of usability and functionality of a system is becoming more sophisticated and complicated as well. It is not enough just to evaluate the ease of use of a system; the usability evaluation consists of many items reflecting different parts of design and functions of the application.

In the Questionnaire for User Interaction Satisfaction (QUIS) developed by (K. L. Norman, Shneiderman, Harper, & Slaughter, 1989) there are 21 out of 27 items directly related to the interface features. Another questionnaire SUMI (Software Usability Measurement Inventory) measures user satisfaction.(Kirakowski & Corbett, 1993)

SUMI provides three types of measures: an overall assessment, a usability profile, and item consensus analysis.  In the usability profile there are 5 dimensions included: effect, efficiency, helpfulness, control, and learnability. User satisfaction is related to other usability measures such as efficiency and learnability.

The study of Human-computer interaction identified 8 criteria of usability: compatibility, consistency, flexibility, learnability, minimal action, minimal memory load, perceptual limitation, and user guidance. (Lin, Choong, & Salvendy, 1997) These criteria are essential for the usability evaluation.

So, based on the different studies of Human-Computer interaction, which had begun more than 30 years ago, usability was evaluated with the help of different subcategories or dimensions depending on the preferences and goals of researches.

The usability studies started in the commercial application as it is very important for business to attract more customers to their product and have user friendly interface and easy to use application. Businesses became aware of the usability importance almost from the beginning of Hi-tech era. Professional business applications are following commercial product and are investing more and more time in the developing user focused, easy to use products.

6. Research Question 3: Why Measure Usability for Non-Clinical Users?
    6.1.  Clinical and Non-Clinical Users Use the EHR Differently

The EHR usability studies are mostly done among clinical users of EHR systems and there is almost no data of usability studies among non – clinical EHR users.

Clinical users have different workflow compare to non- clinical users.

- Clinical users such as physicians and bed-side nurses work at the bed side and have to make the decision there. They do not have much time for input the data.

- Clinical users approach to the workflow is more stressful, time limited and hectic.

- Clinical users do not do reports and analysis of retrospective data.

- Clinical users input medical data into the EHR systems

- Non- clinical users mostly work with the output data.

- Non – clinical users create reports, data analysis, figure out trends and patterns, Non- Non-clinical users can make business, clinical, finance analysis and create predictive models of hospital operation.

- Non-clinical users provide administrative, financial, billing and coding support.

- Non – clinical users very often work with retrospective data.

Most of publications on EHR usability issues focus on clinical users and their problems. The focus of problems and the needs are different due to the nature of different workflow of these two types of users. It is important for clinicians to have the system which support high level of customization, interoperability, support multitasking with clear design and navigation.  For non-clinical users the same features of the EHR systems are very important as well Non-clinical users need more sophisticated reporting tools, intuitive design in all modules of the system. Non-clinical users need the integration of 3d party software into the EHR systems.

On of rare publication about the usability problems among non –clinical users is "Exploring the Perceptions and Use of Electronic Medical Record Systems by Non-Clinicians."(Murphy, Reddy, & McNeese, 2014)   The study is done in one hospital among non – clinical users of the emergency department. Non- clinical users said that using the EHR system is critical in their work and at the same time nobody wants to hear their voices about serious usability issues in their work. They mentioned problems in the communication and collaboration with other clinical and non-clinical users due to the usability issues in the EHR system. Non-clinical users identified the problem of inconsistency of the EHR systems and it has negative impact on their work. For example, when the patient is transferred form the ER, the interface of EHR for inpatient is different compare to the ER EHR interface and it cause a lot of problems for non-

clinical users. Also, there is technical limitation for non-clinical users vs. clinical. The system is set up for clinical users and that is why non-clinical users have to spend more time to find the workarounds and they become less efficient in their work. The suggested solution in the study is the involvement of non-clinical users in the design stage along with clinical users. In order to understand their needs and configure the system considering non-clinical users' needs.

The study figure out the communication and collaboration problems between clinical and not –clinical users. However, the study did not mention the connection of this problem to the efficiency of work. Future research should be performed on the usability issues having the impact of the efficiency of work of healthcare professionals.

The lack of studies in usability issues among non –clinical users prove the importance of my study of the effect of the usability issues of the efficiency of work among EHR non-clinical users.

Many authors stress the importance of t high quality training during the implementation, maintenance stages. Well trained users will have higher efficiency, fewer errors and having more satisfaction from their work.

6.2.    Usability Issues Faced By Clinical Users

Usability issues prevent EHR successful implementation and cause the frustration of clinicians which decrease the efficiency and productivity of work.(Johnson et al., 2011) mentioned that the National Center for Cognitive Informatics and Decision Making in Healthcare (NCCD) gives the definition of the EHR usability based on its TURF (Task, User, Representation, and Function) framework as:

- *Useful* refers to "how well the system supports the work domain where the users accomplish the goals for their work, independent of how the system is implemented."

- Alert and reminder fatigue causing users to switch off or ignore functions in the EHR.

Authors of this work suggest fixing the Lack if standardization by implementation of semantic interoperable EHRs: archetype based EHRs. To make EHRs more accessible authors suggest introducing EHR version for moveable devices via internet with simple graphical user interface.

It is challenging to develop EMR systems with excellent usability (Belden, Grayson, & Barnes, 2009).

EMR serves many purposes, holds different type of information and accomplish different tasks for many types of clinical users. Also, EMR is required in every day work of different administrative, pharmacists, laboratories, financial, business and Health Informatics users.

Clinicians' workflow is very stressful and interrupted constantly. Clinicians are focused on a patient and at the same time they have to think, prescribe procedures and medications and write their progress notes and summaries in the patients' records. So, they seldom give their full attention to the software.

Belden et al.(2009) define usability principles which effect efficiency of use and error level. They are Simplicity of design, Naturalness (how ease and natural the user feel working with the EHR system), Consistency. Minimizing Cognitive Load, Efficient Interaction of a user with the system, Forgiveness and Feedback, Effective Use of Language, and Effective Information Presentation.  Also, authors suggest the methods of evaluating usability principles. The EMR usability principles focused on the clinical use are very similar to others; however, flexibility, customization, learnability, memorability and helpfulness do not exist in the list.

I think the missing characteristics of usability are very important and essential in the usability evaluation. Skipping these dimensions can cause more problems in achieving efficiency of work and minimizing errors.  Dimensions mentioned by and

Belden J. et al. and dimensions which are missed in the list are equally important for the efficient work of clinical and non- clinical users.

Johnson(2006) explores the reasons of barely usable software in healthcare systems. He states that usability problems are not just inconvenient for the end user but they can have direct effect on patient's safety and decrease quality of care. The issues with medical information display can cause errors and damage a patient, for example wrong dosage of medications, wrong side of a body for prescribed procedure. Johnson C. review usability issues among clinical and non- clinical users of EHR systems and other medical applications and points out the breakdown between manufacturer and user which cause more usability problems. National regulators and patient safety agencies are beginning to monitor usability problems and recommend responding to the serious ones. Also, they encourage having more attention to the interface design during the development stage. Usability problems have direct effect on the reporting process on patient safety and quality of care.

Johnson thinks that the lack of involvement of the end user in the development EHR process causes later serious usability problems. He explains that clinicians are very good in developing ad hoc solution for the problems and "workarounds" the problem. At the same time clinicians spend more time to finish the task and not disclosing the usability problem. Also, it can influence patients' safety.

Johnson focuses on usability issues in general and the effect on quality of care, reporting tools and clinicians satisfaction. He states that patients' safety agencies are aware of usability issues of the health care system and the process on reporting and fixing problems has been started.

The study describes the creation of DSM-Design Structure Matrix as a tool for engineering modeling to enable end-users analyze the product. (Kuqi, Eveleigh, Holzer, & Sarkani, 2012) This model is used for the EHR usability issues. Kugi et al.

The analysis of the low level of EHR adoption and claim that usability problems can delay the adoption process. DSM was introduced in 1981 by Steward and it allows

users to decompose a system into many sub-systems.  Authors cite the EHR Usability Paint Point Survey done by HIMSS in 2012 The results show that that about 80% of 1237 usability problems found were rated as 'high' or 'medium' in terms of pain point severity. HIMSS states that usability is the most important factor for EMR systems adoption. Usability has a direct impact on the clinical productivity and errors associated with user fatigue and overwork. The study is focused on EMR UI design and finding inefficiencies in the UI systems which could impact usability. Authors focused on the efficient user interaction with the system and they used it for measuring usability, Even though the study did not focus on ease of use and effectiveness of the EHR systems it was possible to make the conclusion about the importance of the usability issues In the process of better EHR adoption.

Many studies of usability measure the efficiency of work (Silow-Carroll, Edwards, & Rodin, 2012) (David Schlossman, 2014) and it is measured by the time or how many steps required achieving the goal. These types of studies required expert to measure the efficiency of work. On the other hand, perceived efficiency can be measured remotely and do not require experts on site. In the case of studying perceived efficiency the investigator and the user/respondent do not need to be together at the same location or time zone.

Usually, busy health care professionals do not have enough time for the careful training of constantly developing and becoming more cumbersome health care systems. Clinicians and non p clinicians experience constant usability issues with the EHR and other applications. There are four factors that can contribute to this problem. Poor Usability of a system, Lack of professional training, Poor manuals and Help files, and unwillingness of a user to make a small effort and look at the Help file.

 Many healthcare systems do not have very complicated functionality and clinicians experience cognitive overload. (C. W. Johnson, 2006)

Clinical and non –clinical EHR users do not have enough time to learn the system and find features they need. One point of view that clinicians should read

manuals and help files, the other point of view is that the interface design problems cause trouble finding  the core functionality of a system. Both point of view have their reasons and can be true.

Clinicians should spend more time learning the system and the developing companies should provide easy to understand and learn training materials and Help file.

Some companies perform user testing on the early stages of software development. Even though, later they still have serious issues with usability when the product developed.

One of the reasons of poor usability is the lack of communication between developers of the EHR systems and clinicians and that is why clinicians do not know how to configure the system and set up functions they need.

Johnson C stresses the importance of providing sophisticated documentation and focus on more careful intensive training in the beginning of the implementation stage. Also, the author thinks that it's very important to have dialogue between all parties during the development and implementation stages in order to consider end-users feedback for creating a usable product.

A study of perceived efficiency of the EHR implemented in the community health centers (CHC) stressed the importance of qualified training of the complicated systems to achieve satisfying results for all users.(McAlearney et al., 2010) There was a lack of funding in the EHR implementation project in the CHCs and that is why they could not provide the proper EHR training to the users Managers realized that despite resource constraints, CHCs need to have budget for ongoing training and EHR support that users can perform efficient, quality work and to have fully functional EHR in place with the high perceived efficiency estimate from the users.

Proper, professional training and constant IT support of the EHR end users are essential factors for achieving efficiency and quality healthcare delivery.

Sauro J. (2014) also points attention to the importance of the training for B2B software users B2B product developers made the conclusion based on the usability test results that the problems uncovered were because the users weren't properly trained. Without proper training it is hard to distinguish between real issues and false-positives due to an artificial testing setup.

So, Sauro also stresses the importance of the training to avoid false-positive usability issues.

On the other hand there are some studies which report successful effect from the EHR implementation on the efficiency and quality of care. One of this is the study conducted by the AHA's Health Forum in 2007 and 2009 among 9 leading hospitals. (Silow-Carroll et al., 2012)

Interviewees included chief information officers at the hospital, vice presidents of quality, and other staff involved in EHR implementation. The hospitals provided data and reports.

Quality improvement staff found that EHRs made performance reporting faster and more efficient due to the opportunity to retrieve and review charts remotely and to easily find information on standardized charts.

One hospital reported the amount of time nurses spend on direct patient care, as opposed to administrative tasks, increased from 42 percent before implementation to 51.4 percent after. However, the summary results showed that EHR improved efficiency of work.

HIMSS has done several EHR Usability Pain Point Surveys to evaluate the process of EHR adoption.

The results of 2014 survey report both positive and negative effect of the EHR usage by physicians. Respondents were 65% hospital-based physicians.

Some respondents reported the benefits of the EHR systems:

- Better access, especially accessing patient information remotely. No lost charts.
- Better legibility and sometimes better organization
- Multiple users can access the same record simultaneously
- Improved compliance with evidence based guidelines

Most still believe IT will be indispensable for improving care quality, improving population health, and controlling the unsustainable growth in costs

However, the list of negatives is much longer.

- 80% reported problems in the Reviewing Clinical Data category
- 75% in Clinical Decision Support
- 66% Physician Documentation
- 90% in CPOE
- 88% Provider to Provider Communication
- 71% Provider to Patient Communication
- 69% Technology –Related Challenges

Overall Satisfaction with EHR in the HIMSS survey: 41% Satisfied and 59% Not Satisfied.

Although, the sample size of the survey is not very big, only 342 valid respondents the results reflects serious problems with EHR usability among Clinical users. These problems are dangerous to patients' safety and very costly for providers and patients' as well.

There are no similar EHR usability research done among non-clinical users and even though some problems can be overlapping I think my research is very important for the industry and can help usability issues for non-clinical users along with clinical.

6.3.    Summary

Literature review on the usability issues and its influence on the efficiency of work showed that the usability is a serious problem preventing perform work efficiently. The specific usability issues are well known among clinical users of the EHR systems. Usability issues of the EHR systems are slowing down the EHR implementation process and decrease the efficiency and quality of work of clinical EHR users.

There is almost no information about how usability problems affect non-clinical users, with the few exceptions. I am going to create knowledge for the influence of the usability issues on the perceived efficiency of work of non-clinical EHR users in the hospital servings. The voice of non-clinical users should be heard and their opinion should be considered in the new releases of the EHR systems. In the future, there should be more involvement of the EHR end users (both clinical and non-clinical) in determining system requirements. More user-testing, focus groups, surveys should be performing in order to improve the situation and make EHR systems easy to use.

6.4.    Selecting the research method

Based on my review of research methods and my research goals and capabilities, I decided to collect the data using an online questionnaire.

Taking all these information into consideration about different methods I came to the conclusion that Web based survey method is the best in covering large or small samples of population, not biased, cheap, doesn't require several evaluators and expertise; also, it can evaluate several dimensions at the same time and has low cost.

The web based survey method might be the most appropriate for the EHR users clinical or non –clinical. In terms of interruption users can always come back and finish the survey, they have no pressure to complete the survey in a certain time.

Non-clinical users, as my target group, spend more time at the computer and they have constant access to their email vs clinical users, who are busy with patient

care most of the time. For the purpose of my research, the web based survey can be the ideal method for non-clinical users who can evaluate their efficiency is case of usability problems.

After the comparison of different methods of usability measurement the next question is how to measure usability and what metrics are used for it.

The design is experimental and cross-sectional. The questionnaire method consists of closed end questions; the answers are presented in the Likert format.

I also considered the possibility of doing an interview-type survey at my hospital. I rejected this idea because I believe the results would be biased by my personal relationship with the respondents. In addition, the sample size would be very small. Also, it would be based only on one EHR system, and there would not be the opportunity to compare results among different users of different EHR systems and different type and size hospitals. I also rejected the possibility of a traditional "snail mail" survey because of the cost and low response rates. Mail surveys usually have very low response rate, estimated at about 10% (Garson, 2013)

An online questionnaire offered the following advantages:

- Ease of collecting data
- Ability to reach a larger sample
- Minimal cost
- Automated data input and handling
- Convenience for respondents
- Flexibility of Design

There are also some possible disadvantages to online questionnaires:

- Limited capability to ask open-ended questions; cannot explore the answers given by respondents
- Excludes respondents with no Internet access

- Responses may not be completely reliable because of lack of control of survey variables

I determined that none of these disadvantages would be significant in my situation.

7. Designing the Survey Instrument

The questionnaire consisted of four parts:

- Screening questions
- Main Survey
- Demographic questions
- Comments

(See Appendix B.)

7.1. Screening questions

The screening questions consisted of the following yes/no questions:

1. Do you work at a hospital?
2. Are you a practicing physician or a bedside nurse?

These questions were designed to limit the sample to non-clinical hospital-based EHR users. Although the screening questions did not explicitly ask if the respondents used an EHR, the nature of the survey questions made it likely that users who did not regularly use an EHR would quickly abandon the survey. Only surveys where the respondent viewed at least half of the questions were counted as valid responses.

7.2. Main Survey

The main survey consisted of 20 questions, each focused on a different dimension or subdimension of usability.

Each question consisted of three parts:

1.    A statement regarding a usability issue (e.g., "Similar features in different modules of the EHR behave inconsistently.")

2.    One or two brief examples to illustrate the statement (e.g., "A search for a patient in the admission module is different from a patient search in the EMR and PCS modules. Such inconsistencies of basic functionality make it difficult to learn new modules quickly.")

3.    A question (phrased as a statement), asking the respondent to evaluate the impact of the described usability issue on his or her productivity. This question, and the five answer options, were the same for all questions in the main survey:

The impact of this usability issue on my work efficiency is:

- o  Very Low
- o  Low
- o  Moderate
- o  High
- o  Very High

This type of multiple choice question, allowing respondents to choose one option from a list of choices, is commonly used in the social sciences and is referred to as a "Likert type" question.

Likert type questions are useful for measuring attitudes toward issues. The answers in the Likert scale are presented in an ordered range from one extreme to another. The number of choices can vary. Five is a common number of choices for Likert-type questions.

### 7.3. Demographic questions

After the main survey, five demographic questions were displayed to the respondent. These questions were intended to gather information that would be useful in recognizing patterns in the data.

### 7.4. Comments section

Finally, a freeform text box was displayed, with the following request:

Thank you so much for helping me with my research!
If you have any general comments or suggestions, please enter them below.
*Also, if you have any "'pet peeves" regarding the usability of your EHR that I didn't mention in my survey, please let me know about them here!*

Comments can be useful regarding finding more influence of some dimensions on the efficiency of work which is not possible to express by the questionnaire. Also, there might be some issues, such as training, which influence users' perception of EHR usability. These issues can sometimes be identified through the use of a comments section, and can help provide EHR developers with actionable insights.

### 8. Research Design

The survey provides the reflection of users' expectations from the EHR system and the real system usage in everyday life.

These Nielsen's and ISO scales are very broad to measure the usability issues. I looked at several lists of usability dimensions (Nielsen J. (1995), Quesenbery W. (2011), Zhang et al. (2011), etc.) and was not satisfied with any of them as survey instruments for my purposes.

I therefore developed my own list of measurable usability dimensions. If there are problems in the areas covered by dimensions it might cause decrease of work efficiency

and productivity. All dimensions from my list have an influence on the efficiency. I developed a questionnaire where each question addresses a single issue from my dimension list.  Non-clinical users were asked to answer each question about some usability issue with evaluating the particular issue's effect on the perceived efficiency.

The survey was completely anonymous and no personal or identifying information was collected.

### 8.1.   My dimensions

My survey measures 14 usability dimensions, five of which have separately measured subdimensions:

1) Consistency
    a)      Consistency of Design
    b)      Consistency of Function
2) Findability
    a)      Text Search
    b)      Filter
3) Ease of Navigation
4) Simple Design
5) Minimal Memory Load
6) Match Outside World
7) Feedback
    a)      System Status
    b)      Error Response
8) Flexibility
    a)      Output
    b)      Input
    c)      Distribution of Files
9) Customizability
    a)      Appearance

     b)     Navigation

10) User in Control

11) Helpfulness

12) Learnability

13) Memorability

14) Minimal Action

### 8.2.  The TURF list

I used the dimensions  described in the TURF article on EHR usability as a model (Zhang & Walji, 2011):

1)  [Consistency] Consistency and standards in design.

2)  [Visibility] Visibility of system state.

3)  [Match] Match between system and world.

4)  [Minimalist] Minimalist design.

5)  [Memory] Minimize memory load.

6)  [Feedback] Informative feedback.

7)  [Flexibility] Flexibility and customizability.

8)  [Message] Good error messages.

9)  [Error] Prevent use errors.

10) [Closure] Clear closure.

11) [Undo] Reversible actions.

12) [Language] Use users' language.

13) [Control] Users are in control.

14) [Document] Help and documentation.

I replaced [Language] with "Match Outside World." [Closure] and [Undo], as well as [Control], are included in my "User in Control" dimension. I also separated [Flexibility] and Customizability into separate dimensions. I made [Message] and [Visibility] subdimensions of Feedback.

I also added the following dimensions to the TURF list:

- Memorability

- Learnability
- Minimal Action
- Findability
- Ease of Navigation

8.3. Define Overlapping dimensions and create dimensions with the minimum cross-references to others.

There were some overlapping dimensions when I began to develop my list of dimensions. It is impossible to completely eliminate overlap and redundancy because of the relationships between usability issues, but I tried to isolate the issues as much as possible and create a set of dimensions that would allow me to focus on one usability issue at a time.

8.4. Create the questionnaire based on the dimension list.

After the dimension list was developed I created questions which focus on the negative situation, that the user cannot do the task because of lack of some opportunity and assigned each questions to each dimensions. I decided to ask questions in the negative form, asking if the user could not do some specific task efficiently. The reason for that is my goal to evaluate the usability issues' effect on the efficiency of work.  The possible answers in the Likert scale are from very low to very high, representing the degree of impact on the respondent's efficiency.

Participants should show their attitude to the issue described in the question and answer in a scale way whether or not this issue affected the efficiency of their work.

Often in a Likert-type question there is a "neutral" or "not applicable" option. I intentionally avoided these options.  I believe that in a survey where the questions are not about subjects where the respondents already hold opinions, many respondents will click on the neutral response automatically rather than make the effort to assess the possible effect of the usability issue on their efficiency.

9. Collecting the data

An introductory letter, survey link, and IRB-approved Informed Consent Statement were distributed between 6/8/2015 and 7/17/2015. (See Appendix C). Data was collected using a UTHSC Qualtrics account. The survey was closed on 7/24/2015.

The survey target population is hospital non-clinical EHR users.

The introductory letter, explaining the purpose of survey is created and it is sent to the participants together with the link to the survey.  In the letter it stressed that this is the opportunity for non-clinical users' problems to be heard and that the survey can bring actionable insight for the EHR developing companies. Hopefully, the usability issues of non-clinical users will be considered in the future releases of the EHR systems.

More than 600 likely respondents were identified through the LinkedIn professional networking website I sent the survey to those potential respondents individually, as well as distributing the survey link in LinkedIn groups and other websites targeted at EHR users.

The initial responses were mostly from the professional groups. After making the introductory letter shorter and sending the invitation survey to the individuals the response rate from the individuals became higher. I kept posting the survey invitation in new groups, reposted links several times in groups which it had been posted and sent the follow up letters.

Because of the manner in which the survey was distributed, it is impossible to meaningfully estimate the response rate.

The questionnaire placed in the Qualtrics program is self-explanatory with 5 possible answers. Each question has an example, which facilitates the understanding of the question. At the beginning of the survey, there is an explanatory note:

*NOTE: THE EXAMPLES GIVEN ARE FOR ILLUSTRATIVE PURPOSES ONLY.*

*WHETHER OR NOT A SPECIFIC EXAMPLE APPLIES TO YOU, PLEASE ANSWER EACH QUESTION BASED ON YOUR PERSONAL USER EXPERIENCE*

Valid responses are defined by the first 2 screening questions and answers on at least 10 questions out of 20. I decided to have 10 answers as the passing score assuming that respondents might not experience all issues covered in the survey. Fewer than 10 answers can be the factor of not familiarity with the issue at all, so it won't be legitimate responses. 10 answers is the minimum of responses in order to be used in the analysis.

10. Analyzing the data

The quantitative analysis will be performed in the SPSS program. The comments qualitative analysis will be also performed by the SPSS application for text files, if I get substantial amount of comments.

The respondents' answers will be processed by quantitative analysis with the help of SPSS application.

Parametric analysis is not suitable for the ordinal data. Using parametric analysis for ordinal data will always violate assumptions about the data, such as normality (Clason & Dormody, 1994).

Some authors discuss the possibility of parametric analysis for the ordinal type of data and the controversy of this subject.  (Sullivan & Artino Jr, 2013). They claim that ordinal data can be treated as interval data under certain conditions.  Parametric analysis is appropriate for interval data, which is normally distributed. Mean and other parametric measures do not describe correctly the central tendency in the case of non - normal distribution of responses.

Many experts suggest that the median should be used instead of the mean in analyzing ordinal data. For example, it is unclear what the average of "Very Low" and "Low" represents.

Analysis will be done using SPSS software, and will focus on generating actionable insights.

11. Results

Frequency Distribution



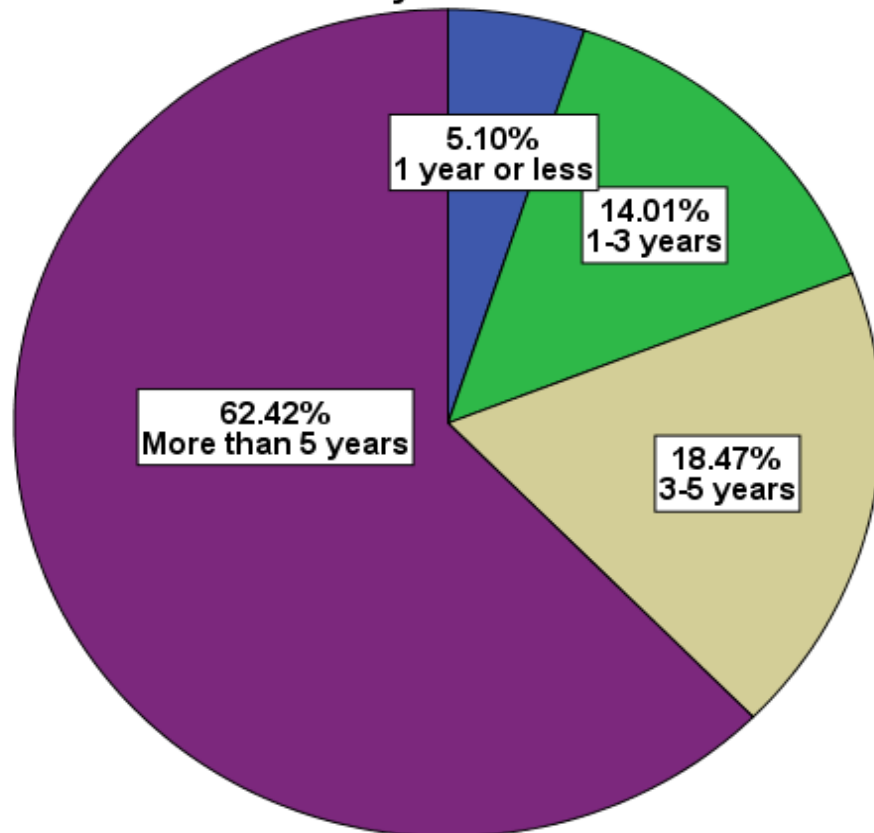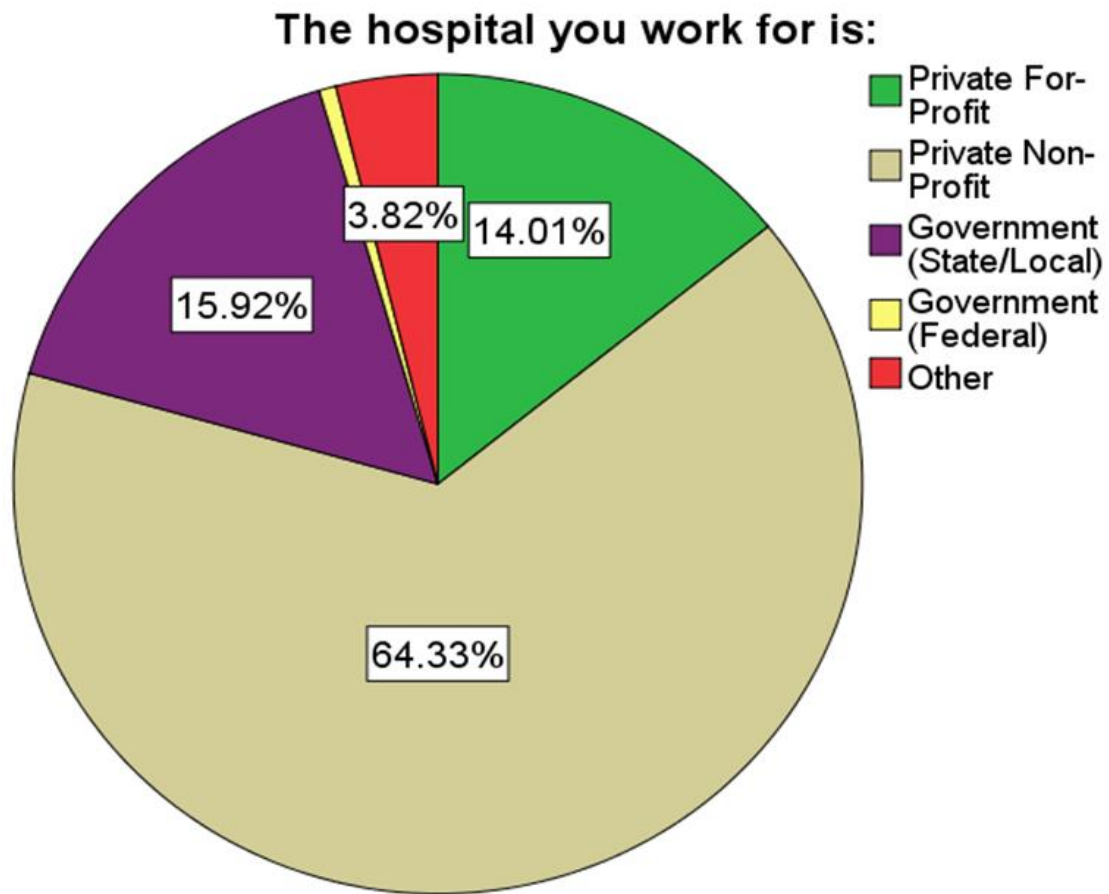How many years of experience do you have working with an EHR system?

5.10% 1 year or less

14.01% 1-3 years

62.42% More than 5 years

18.47% 3-5 years

Figure 1. Years of Experience

## The hospital you work for is:



Legend:
- Private For-Profit (green)
- Private Non-Profit (tan)
- Government (State/Local) (purple)
- Government (Federal) (yellow)
- Other (red)

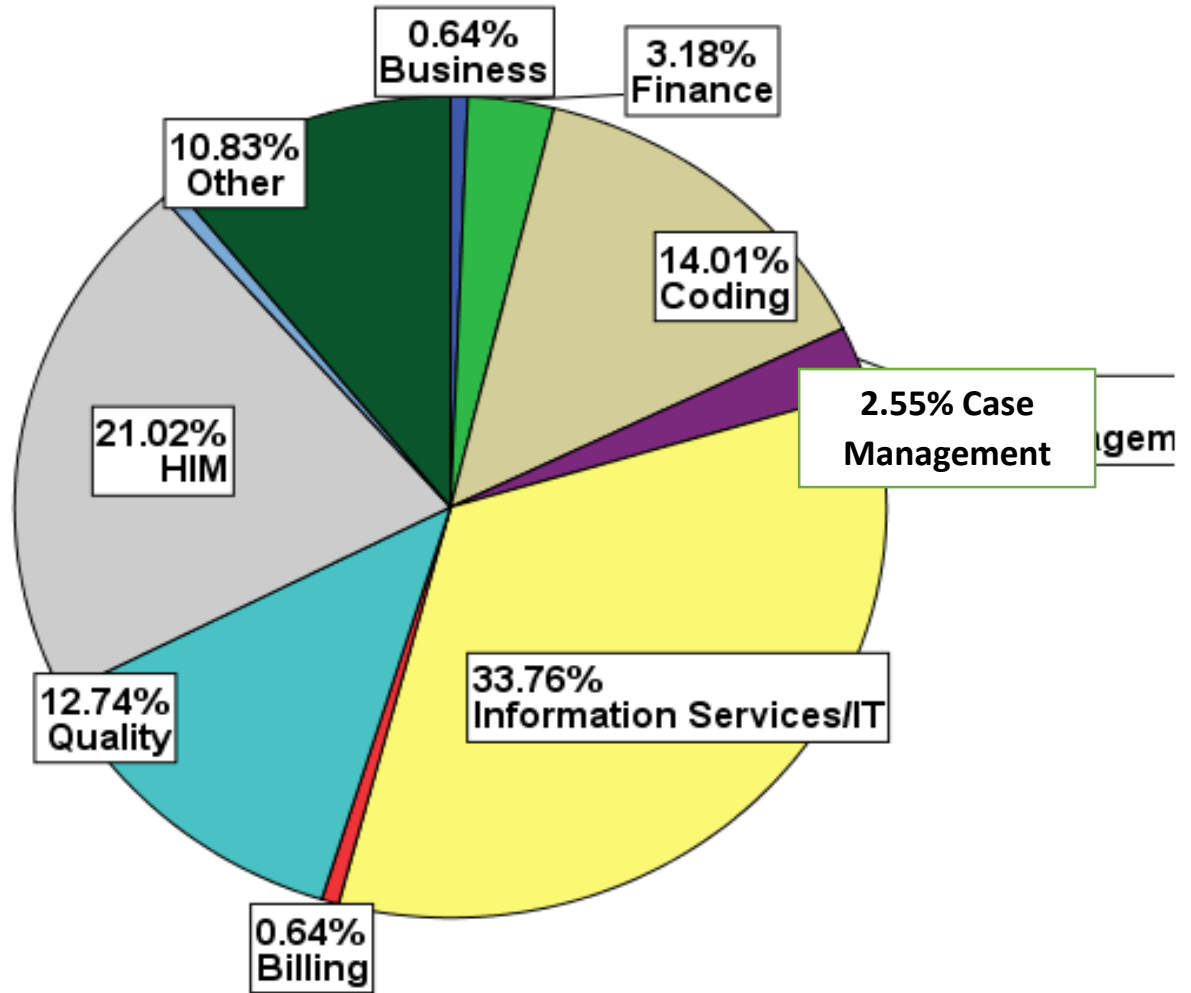14.01%
3.82%
15.92%
64.33%

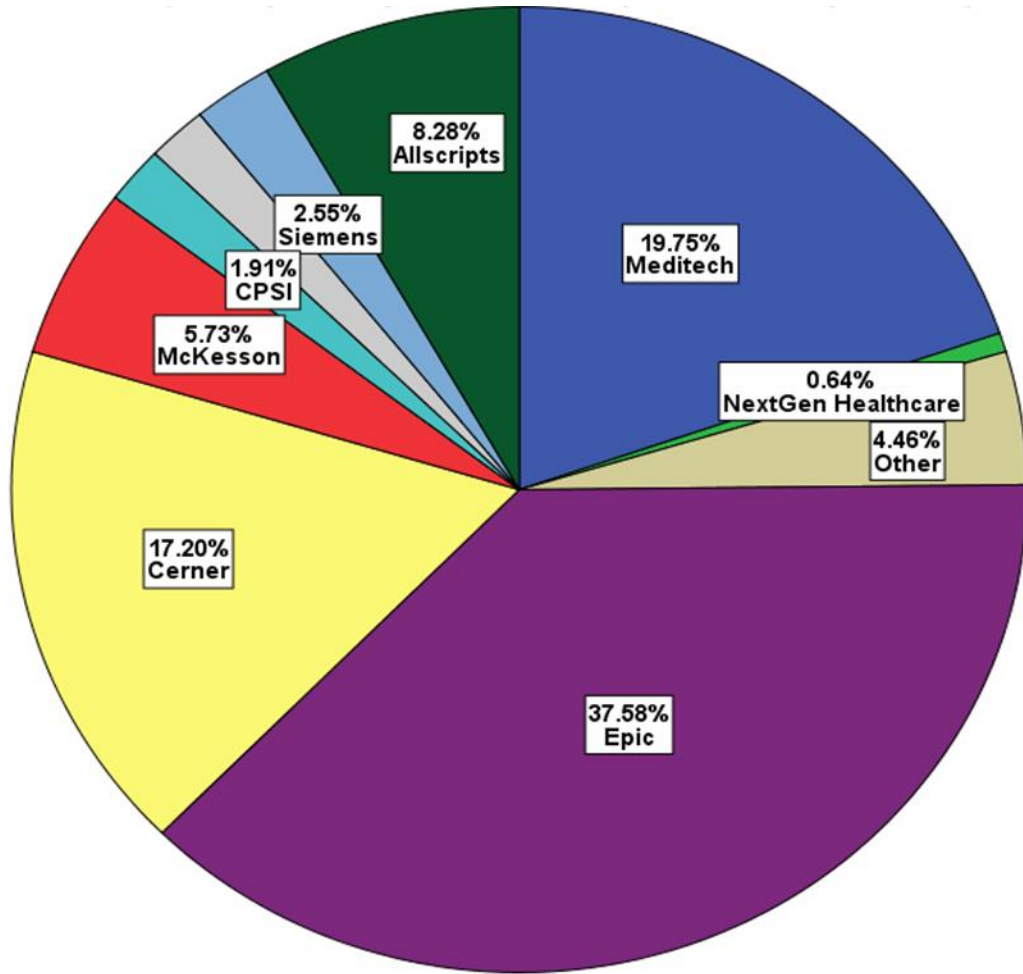Figure 2. Hospital Type

Figure 3. Hospital department

Figure 4. EHR System

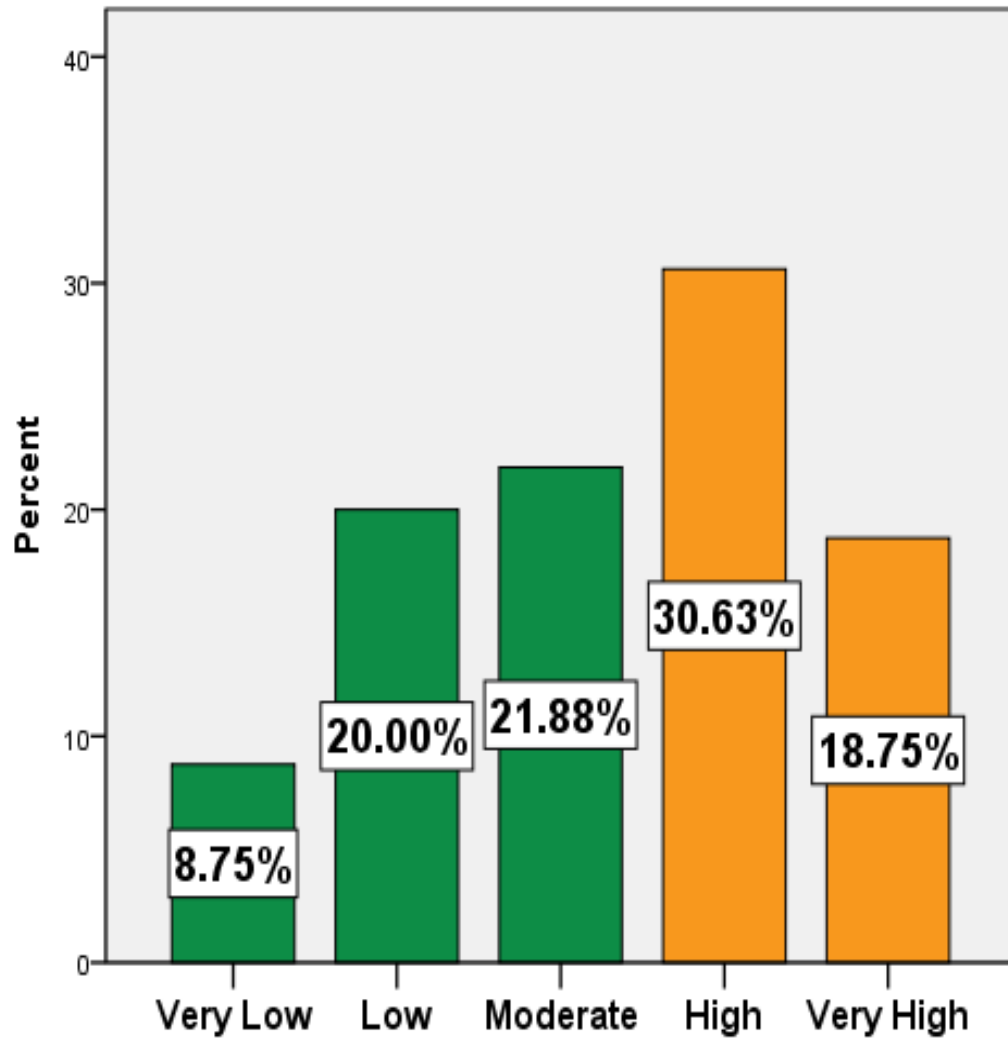I am unable to search for a word or phrase in a patient's records.



Figure 5. Findability Text Search (All EHR)

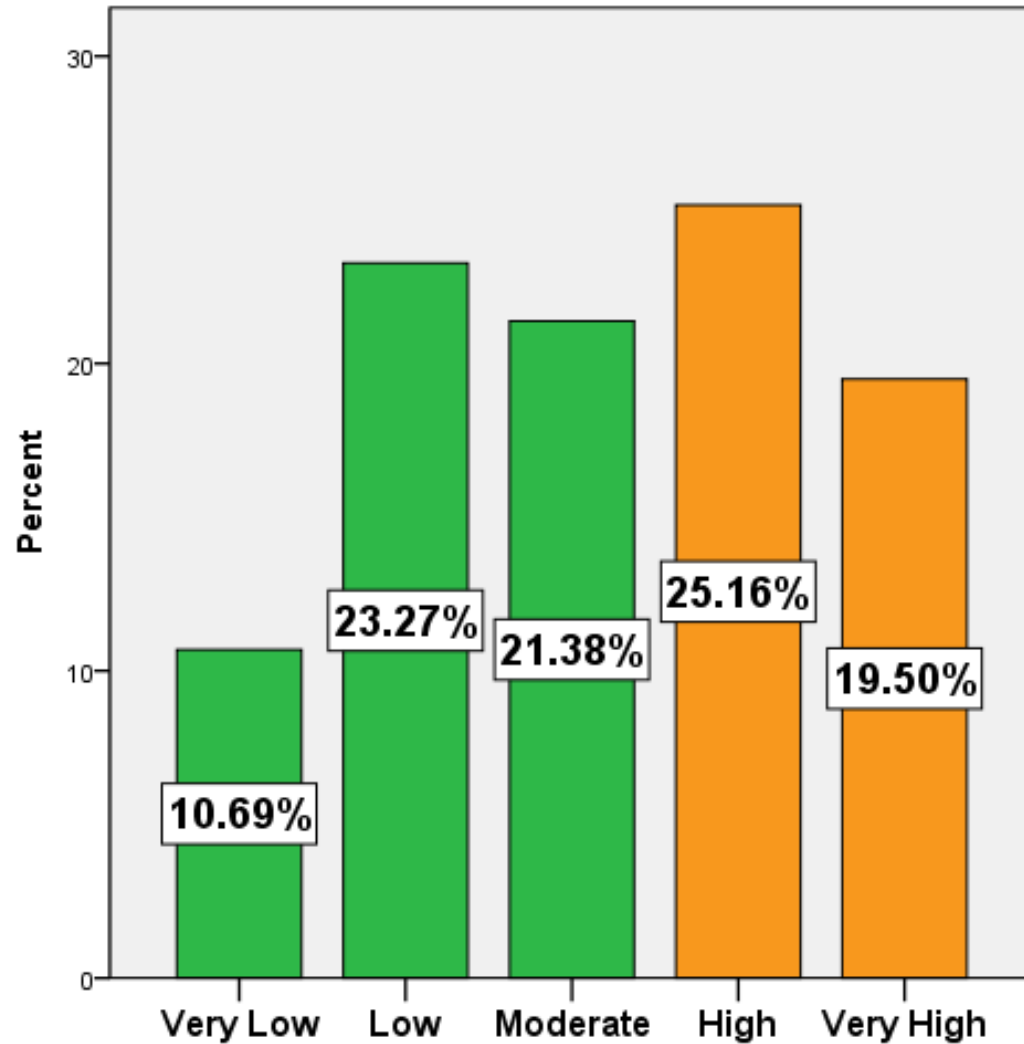I am unable to search for a word or phrase in a patient's records.



Figure 6. Flexibility ( All EHR)

I cannot save reports in the format(s) I need, but have to convert them manually to the required format.
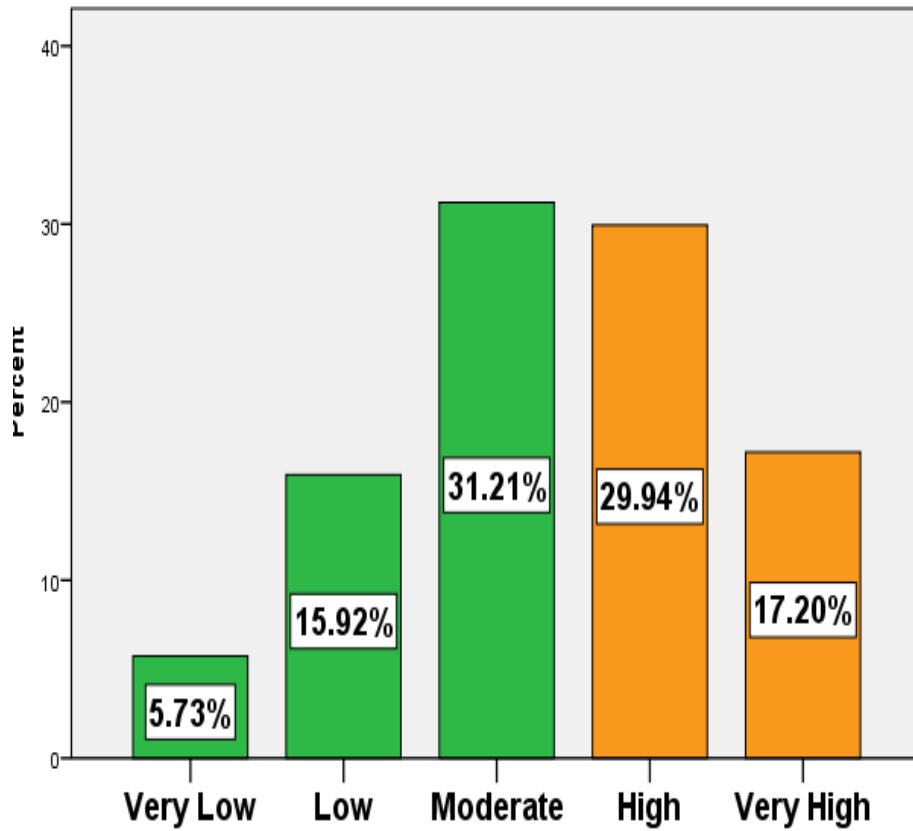
Figure 7. Helpfulness (All EHR)

When I have questions about using the EHR, it is  difficult and time consuming to find the information I need in the Help file.
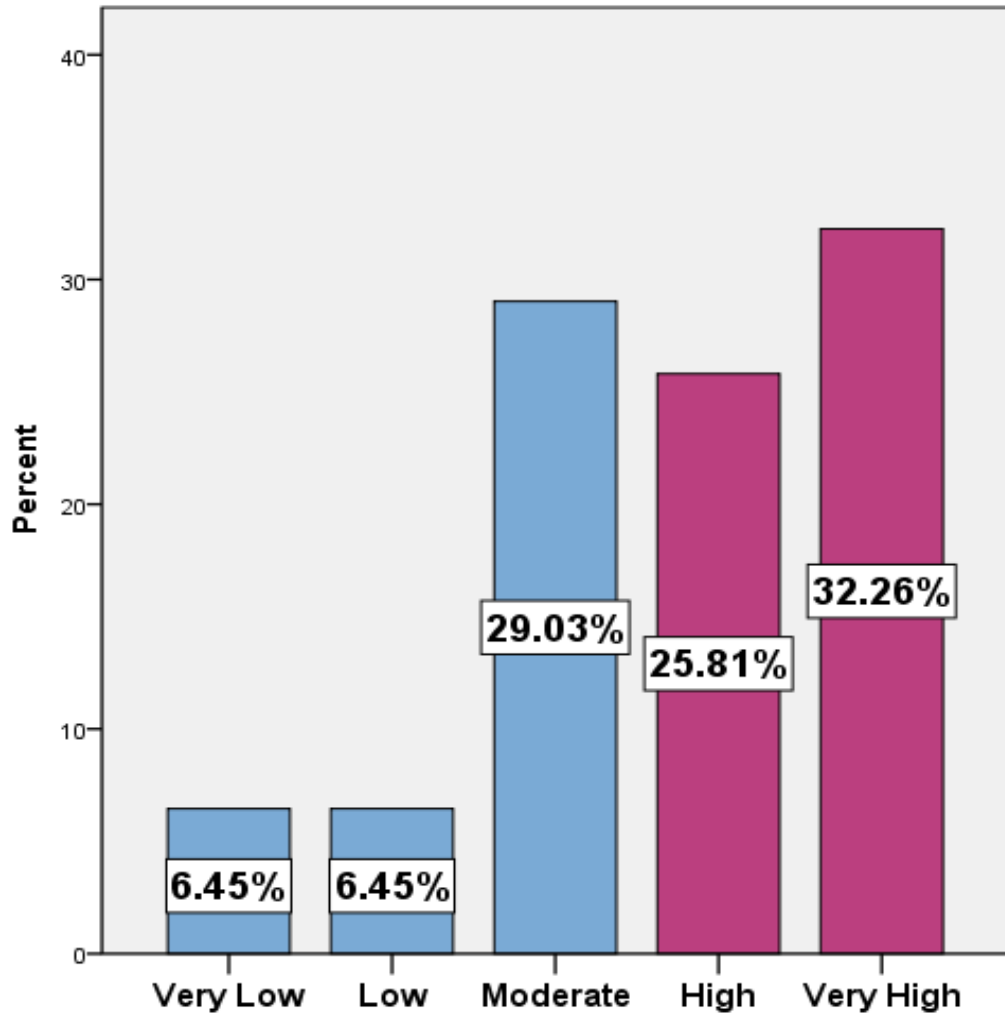
Figure 8. Flexibility Output Format (Meditech)

I cannot save reports in the format(s) I need, but I have to convert them manually to the required format.
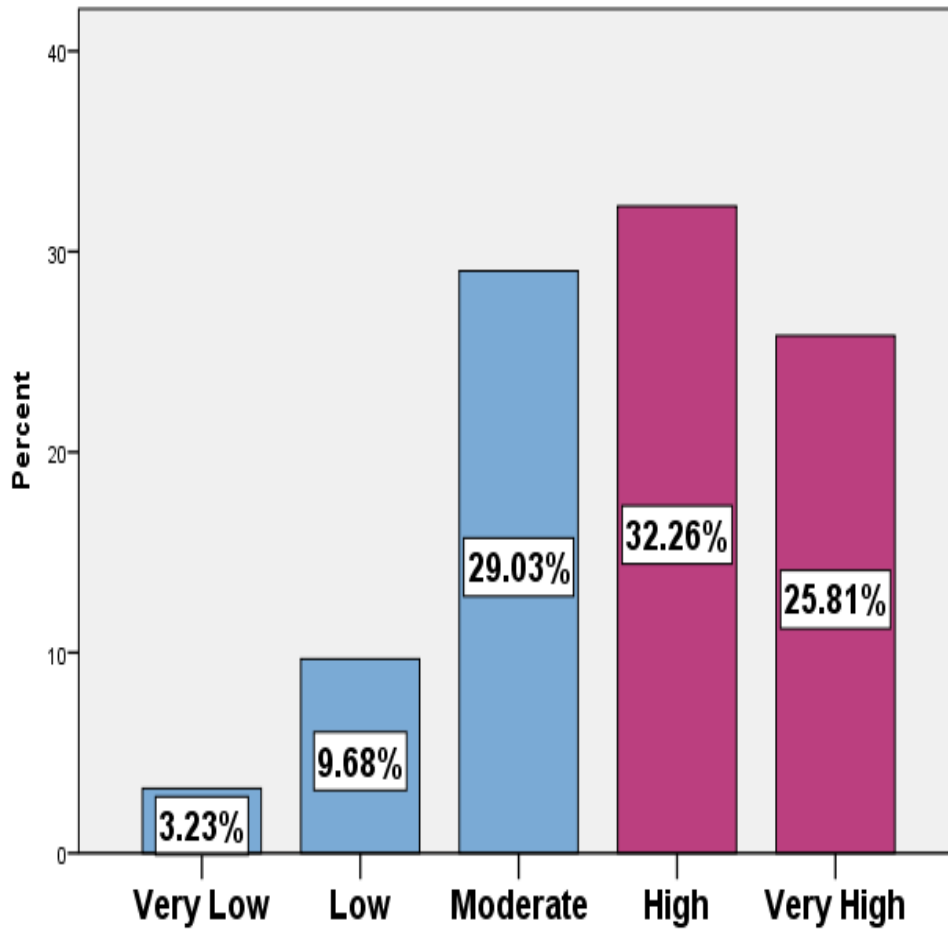
Figure 9. Findability Text Search (Meditech)

I am unable to search for a word or phrase in a patient's records

Figure 10.  Helpfulness (Meditech)

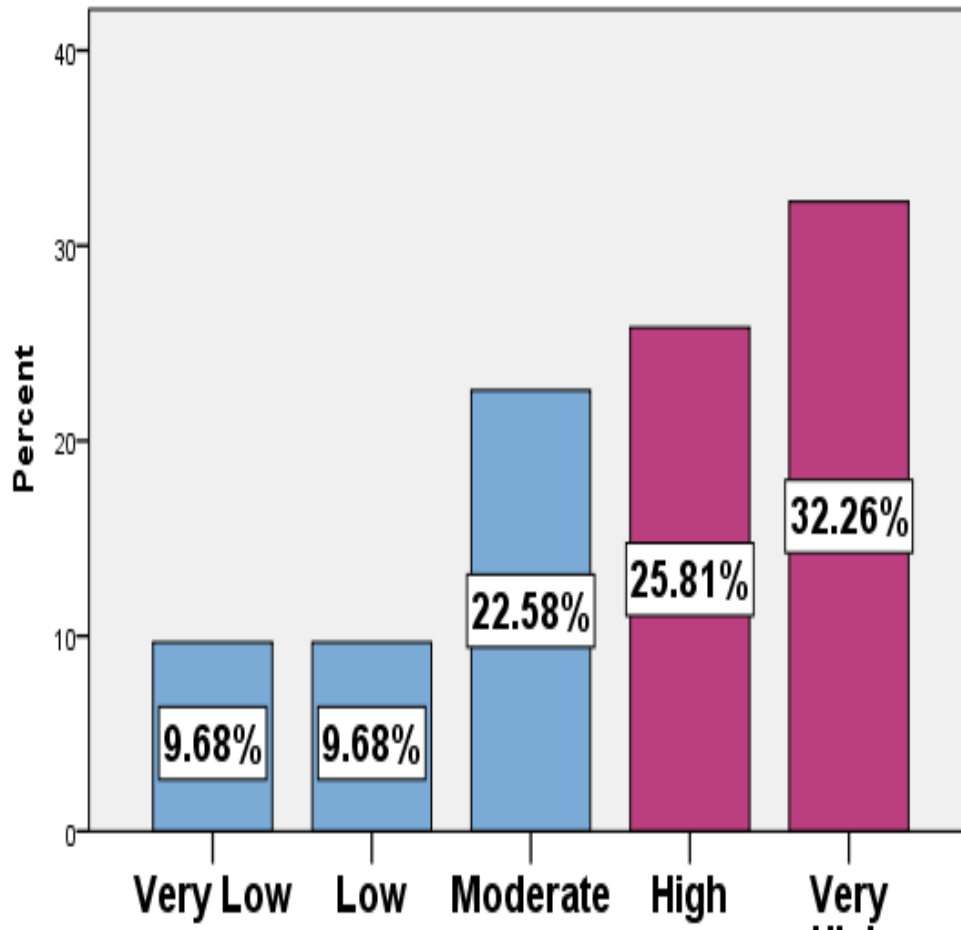When I have questions about using the EHR, it is  difficult and time consuming to find the information I need.

Figure 11. Helpfulness (Epic)

When I have questions about using the EHR, it is difficult and time consuming to find the information I need.
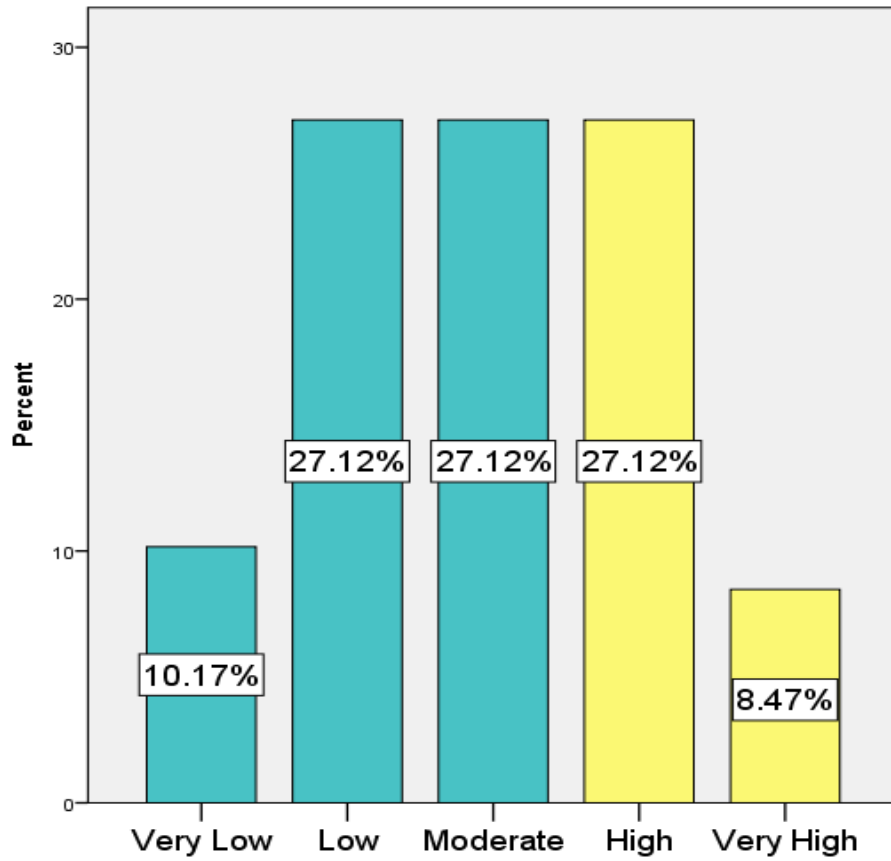
Figure 12. Learnability (Epic)

Learning new features and modules of the EHR system  is a time-consuming and difficult process.
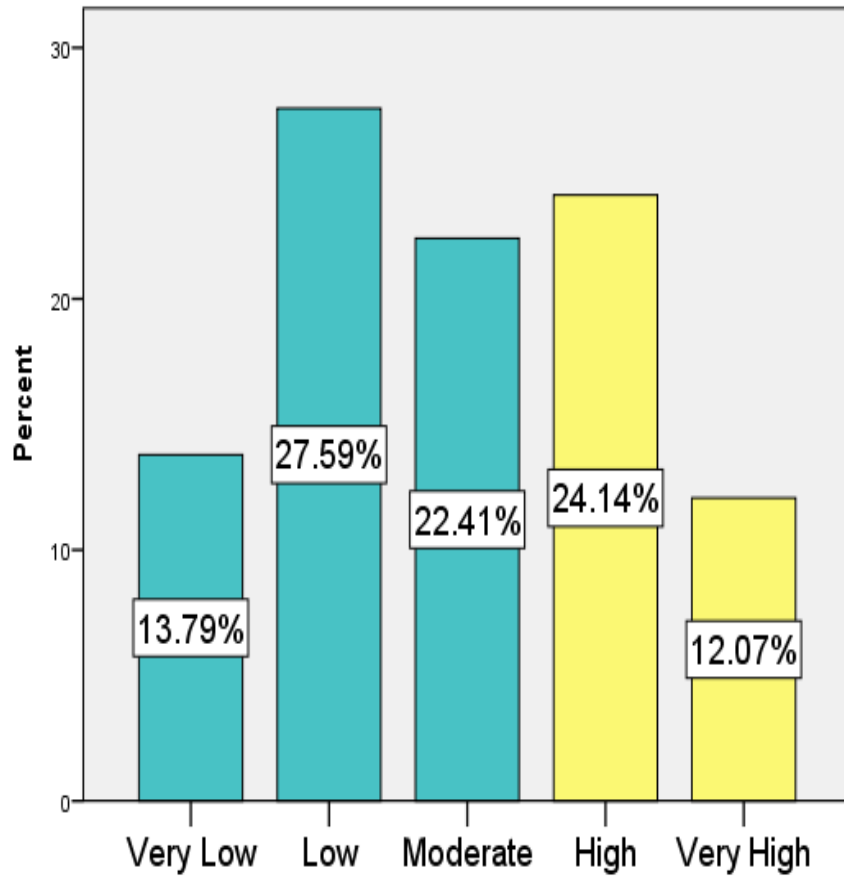
Figure 13. Feedback Error Response (Epic)

When I make a mistake, the error message does not provide me with useful information to understand and correct the problem

..
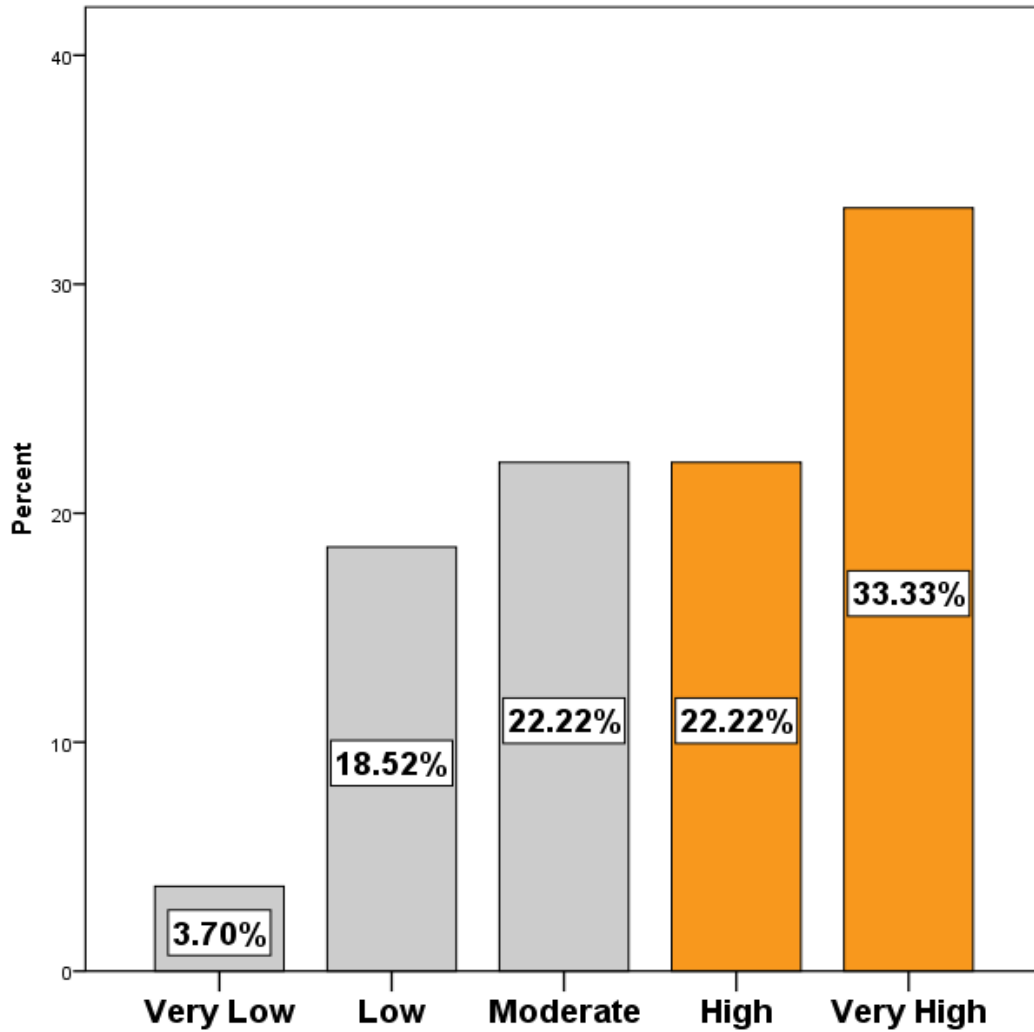


Figure 14. Memory Load (Cerner)

The EHR doesn't automatically store many of the settings and form field data I am likely to use again, so I have to enter them each time I return to a screen.
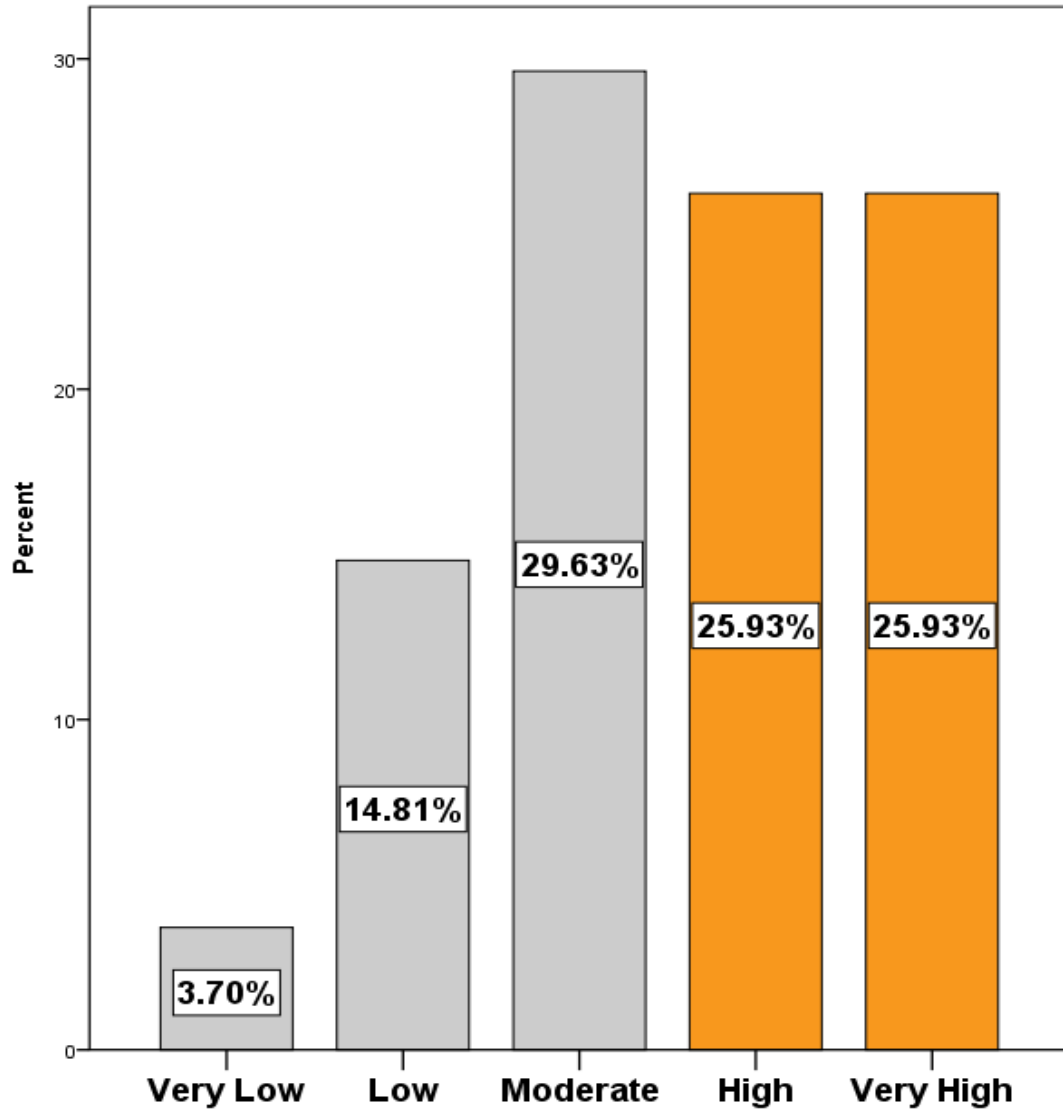
Figure 15. Customization Design (Cerner)

I cannot customize the appearance of the EHR to my needs and preferences
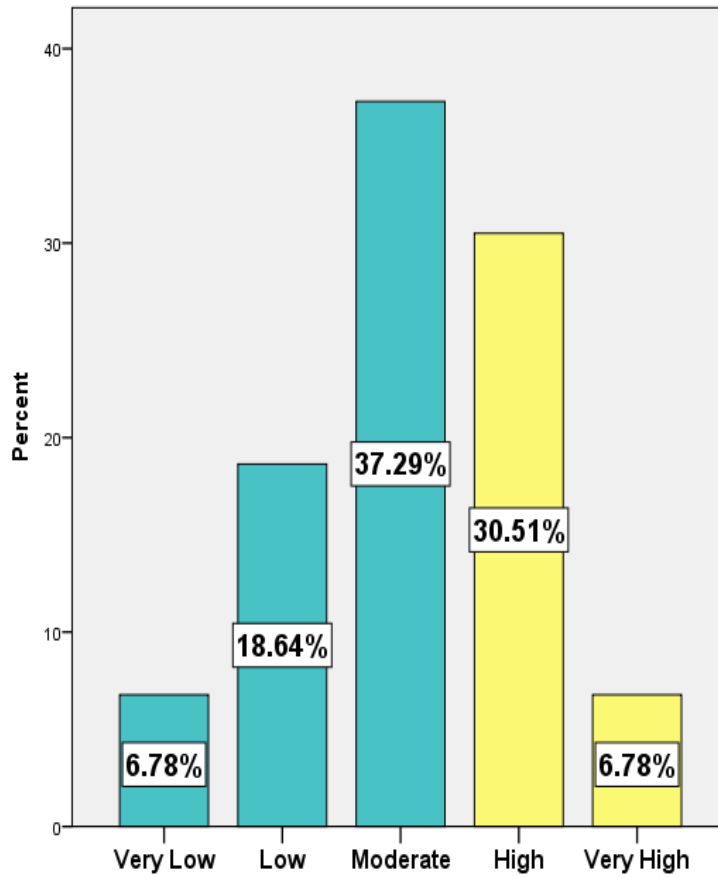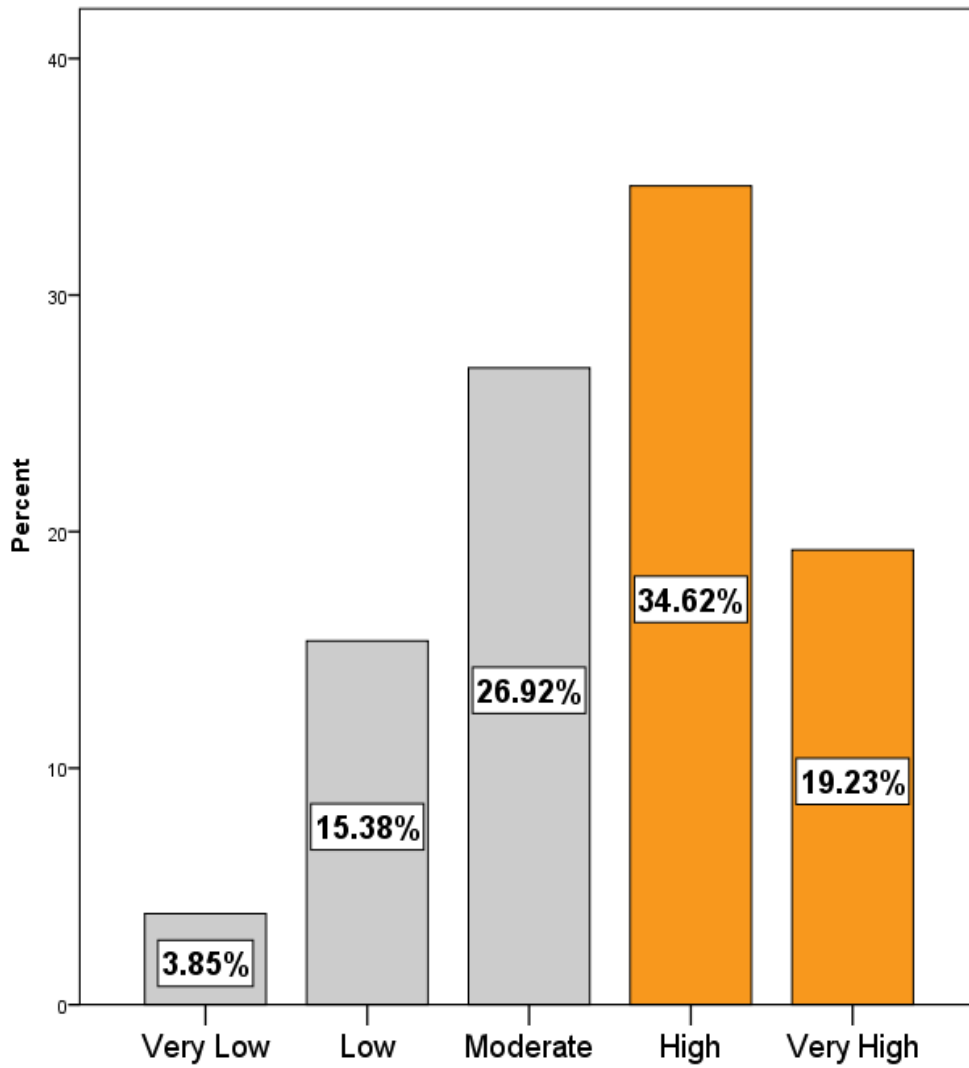
Figure 16. Helpfulness (Cerner)

When I have questions about using the EHR, it is difficult and time consuming to find the information I need.
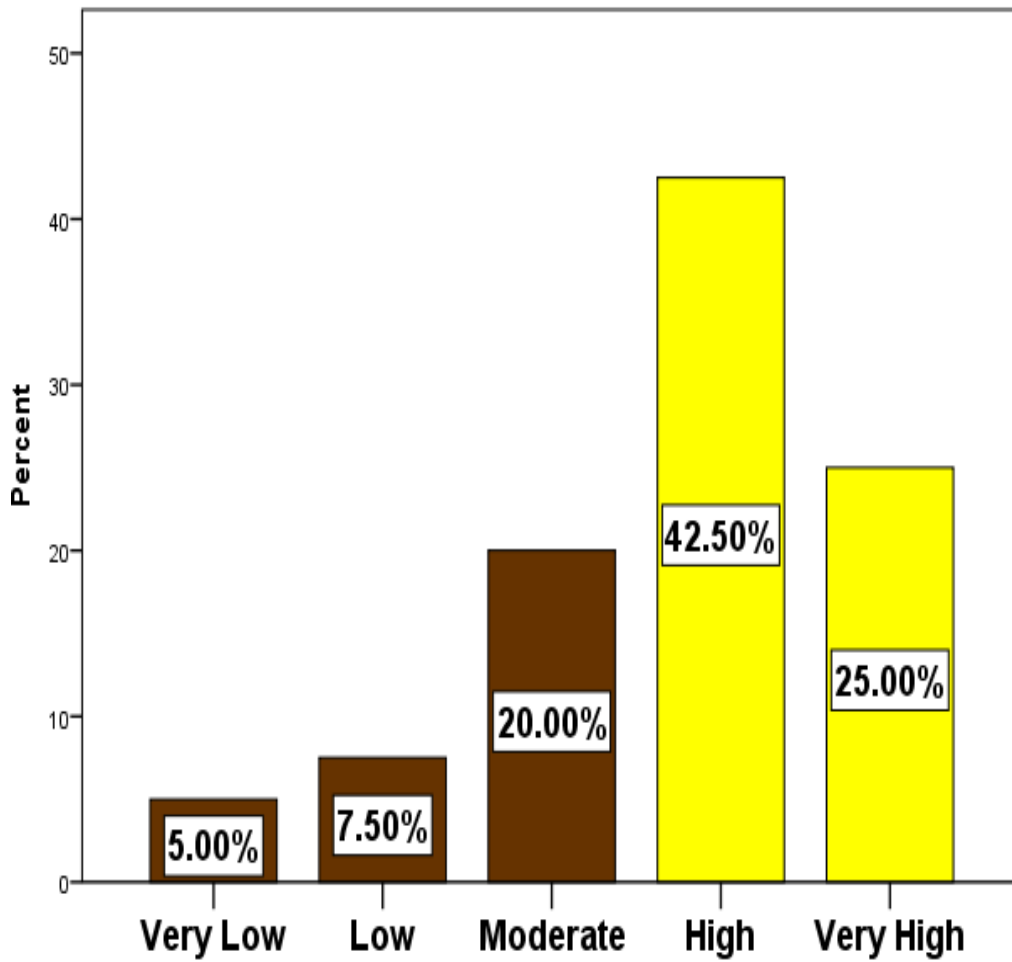
Figure 17. Findability Text Search (Others)

I am unable to search for a word or phrase in a patient's records
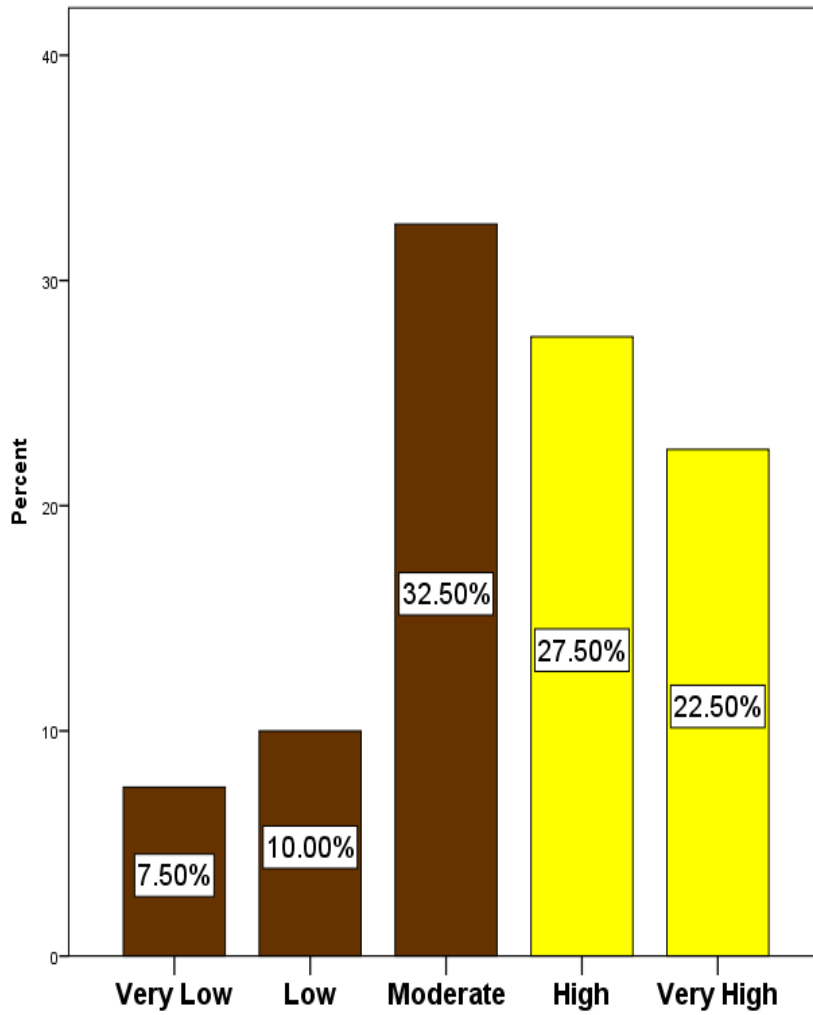
Figure 18. Ease Of Navigation (Others)

I cannot easily navigate from one screen or module to another
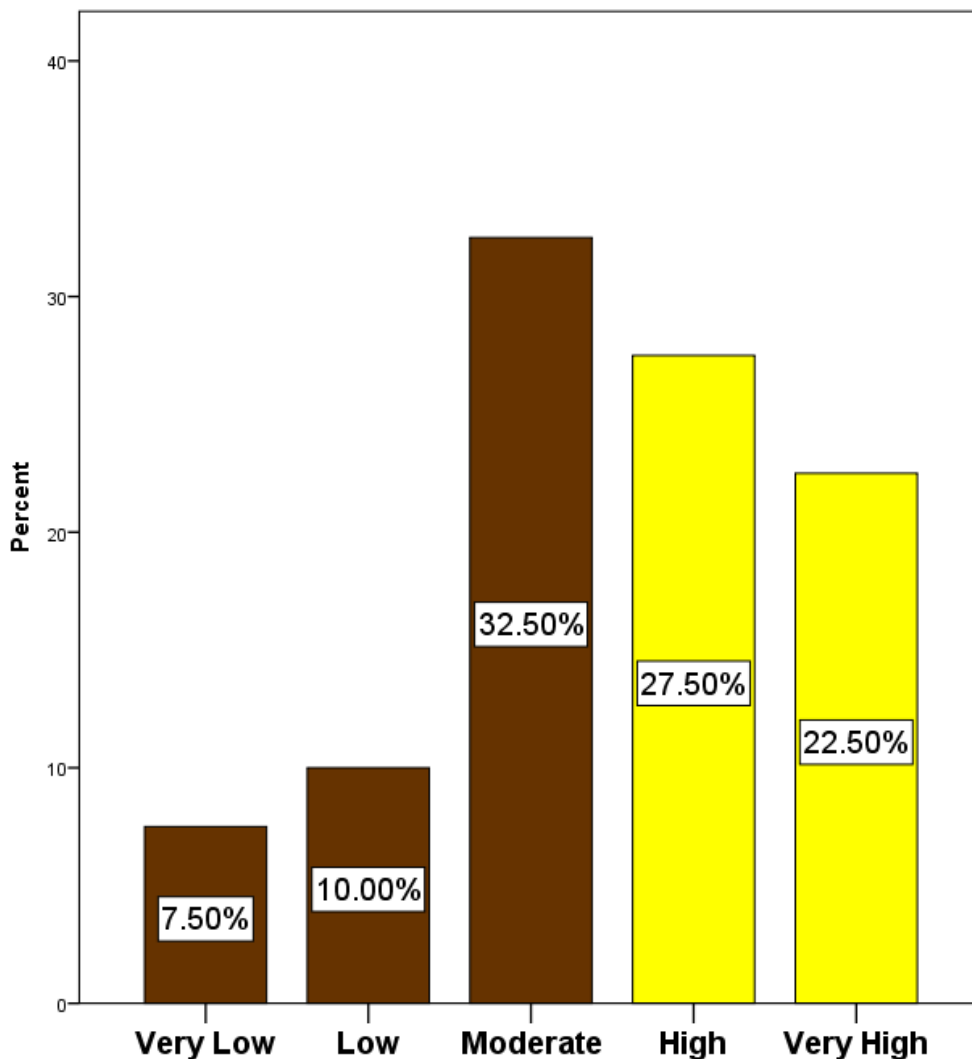
Figure 19. Helpfulness (Others)

When I have questions about using the EHR, it is difficult and time consuming to find the information I need.

12. Findings

I compared my results to the results of the HIMSS EHR Usability Pain Point Survey, which was directed at clinical users.

Finding of the HIMSS EHR Usability Pain Point Survey (2014) are:

EHR usability issues reported by physicians:

- Reviewing Clinical Data – 80%
- Clinical Decision Support – 75%
- Physician Documentation – 66%
- Computerized Physician Order Entry – 90%
- Provider-to-Provider Communication – 88%
- Provider-to-Patient Communication – 71%
- Technology-Related Challenges – 69%

Because the HIMSS survey was completely different, in both form and content, it is not possible to compare them directly. However, all the categories of issues in the HIMSS survey, except for technology-related challenges, are focused on clinical usage of EHR systems. All reported problems indicate problems of the system specific for the clinical users workflow.

The workflow  of non – clinical users is different and the problems reported in the usability survey for non-clinical EHR users are also different.

The communication problem and technology related challenges can be the common problem for clinical and non-clinical EHR users. However, such issues can be more functional and not represent real usability problems. The communication and collaboration problems were reported in the survey done among non-clinical users of ER department((Murphy, Reddy, & McNeese, 2014).

My survey indicated that key problems for non-clinical hospital-based EHR users were:

- Helpfulness
- Findability (Text Search)
- Flexibility (Output Format)
- Learnability
- Customization (Interface)

Helpfulness and Learnability ( based on the mean results)are issues for all EHR users

Other issues were more EHR-specific

The process of the analysis had several stages.

Define the most frequently reported issue, using the average,

Find the question and corresponding dimensions with the highest mean.

The most common EHRs system among non-clinical responders are Epic 37.58%, Meditech 19.75% and Cerner  17.20% (FIG 4)

The responses were analyzed in five groups of the EHR non-clinical users: Epic, Meditech, Cerner, All EHRs and Others.

 In each group the three worst dimensions were identified with the mean score.

Frequency distribution test was performed in SPSS for every 3 worst dimensions for all five EHR groups.

The data collecting with the help of Likert scale is categorical, ordinal data and the mean is just the indication that this dimension has more issues than others. It can be high mean because of hi level of responses in Low and moderate categories and not in the high and very high.  Low, Moderate categories do not have significant effect on the perceived efficiency of work of non-clinical users. The true values which have a strong effect on the perceived efficiency are in the High and Very High categories. So, the goal was to find out usability dimensions with the real effect on the perceived efficiency in High and Very High categories in all five groups of non-clinical users.

| Dimensions | All | MT | EPIC | CERNER | O |
|---|---|---|---|---|---|
| Findability/ Text Search | 49.38 | 58.07 | | | |
| Flexibility Output Format | 44.66 | 58.07 | | | |
| Helpfulness | 47.14 | 58.07 | 37.29 | 53.85 | |
| Learnability | | | 35.59 | | |
| Feedback Error Response | | | 36.21 | | |
| Memory Load | | | | 55.55 | |
| Customization Design | | | | 51.86 | |
| Ease of Navigation | | | | | |

- 
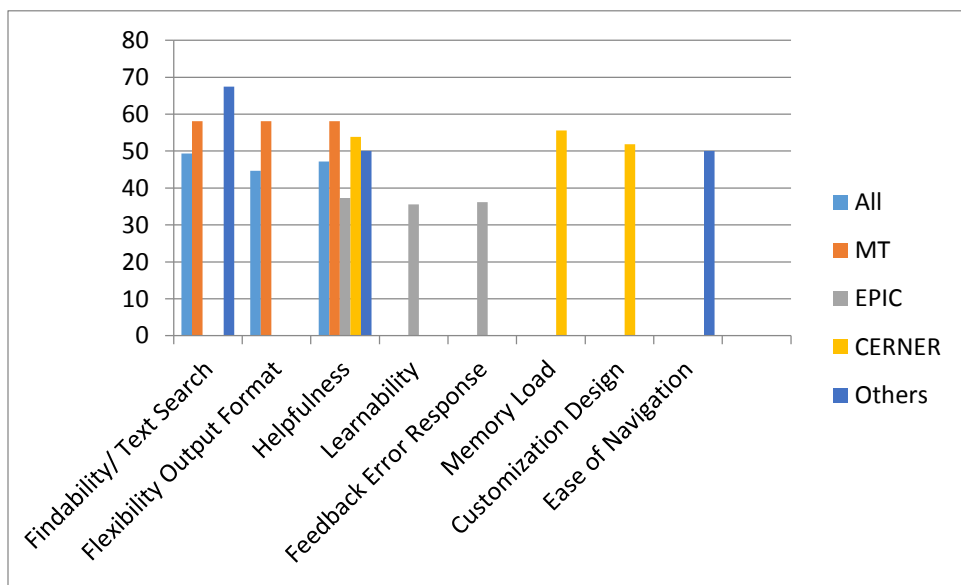


Findability for the High and very High categories is common to Meditech, Others and All EHR groups with higher than 50% of all responses.

Helpfulness is common to all groups with the highest score for Meditech, Cerner and Other groups.

Customization Design and Memory Load are specific for Cerner and the score is higher than 50%.

All responders mention the issue with the Help file of the systems which can be the main reason of other usability problems such as Customization, Flexibility and learnability.

Based on the analysis there is the negative effect on the perceived efficiency of work of non-clinical users of the EHR systems. Issues in the reported dimensions with the high score slow down the work of users.

Users left Comments after the survey was done.  Seven of them stressed the problems with training during the implementation and maintenance .

- The training for complex EHR systems like Epic is seriously lacking. Nurses and Doctors come to class for 8-16 hours to become 'Proficient.' 16 hours is not nearly enough time to fully understand even the basics."
- "So many untrained or undertrained end users that don't understand, or don't care, that it is a shared system. It's only going to be useful if all users try to enter data accurately and clearly, in a way that other users would understand."

13. Recommendations

EHR vendors should consider the issues raised by this study and engage in further usability studies/requirements analysis focused on non-clinical users.

Hospital management should consider available usability data before purchasing an EHR system and involve both clinical and nonclinical users in the EHR selection process.

Appendix A

Different Approaches to Dimensional Analysis

The ISO definition divides usability into efficiency, effectiveness and user satisfaction.

Nielsen defines 5 dimensions in his definition (2003):
- Learnability
- Efficiency
- Memorability
- Errors
- Satisfaction.

Nielsen and Molich developed 10 most general principles for usability dimensions (1990). Nielsen subsequently refined the original version (1995)

Nielsen's 10 usability heuristics for user interface design are:

- Visibility of System Status – The system should always keep users informed about what is going on, through appropriate feedback within reasonable time
- Match between the 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 term, Follow real world convention, making information appear in the natural, logical order.
- User control and freedom – User often choose system functions by mistake and will need the clearly marked "emergency exit" to leave unwanted state without having to go through an extended dialogue. Support undo and redo.
- Consistency and Standard- User should not have to wonder whether different words situations or actions mean the same thing. Follow platform conventions.
- Error prevention – Even better than good error messages is a careful design which prevents a problem from occurring in the first place; either eliminate the error- prone conditions or check for them and present to users with a confirmation option before they commit to the action.
- Recognition rather than recall – Minimize the user's memory load by making objects, actions and options visible. The user should not have to remember information from one part of the dialogue or another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
- Flexibility and efficiency of use – Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can oater to both inexperienced and experienced users. Allow users to tailor frequent actions.

- Aesthetic and minimalist design – Dialogue 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.
- Help users recognize diagnose and recover from errors – Error messages should be expressed in plain language (no codes), precisely indicate the problem and constructively suggest the solution.
- 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.(Nielsen & Molich, 1990)

There is the list of 5Es of usability requirements, created by Quesenbery(2006)

- Effective, Easy to Learn, Efficient, Error Tolerant and Engaging.
- Easy to Learn is parallel to the Nielsen's Learnability.
- Error Tolerant – is how well the product prevents errors and help to recover. Error Tolerant is similar to Error and Help users recognize diagnose and recover from errors of the Nielsen's dimensions.
- Engaging - How well the interface draws the user into the interaction and how pleasant and satisfying it is to use. Engaging has the similar features of visibility system status and User satisfaction from the Nielsen's

Keinonen (1997) defines seven dimensions of usability:
- Consistency is an essential design principle within applications. Consistency makes learning easier Visual consistency increases perceived stability of applications.
- Task Match: The information should be presented according to the user request no more no less, and in the preferable order for the user.
- Appropriate visual presentation User should be provided with all necessary information.
- User control:  Users should have direct influence on the objects instead of just giving the system instructions to act.
- Memory-load reduction: User interaction should rely more on user recognition than on recall of elements of a system. Recall is prone to errors.
- Error handling: All usability principles address the issue of error handling or error recovery. Error recovery relieves anxiety, enabling users to discover new alternatives, facilitating learning by doing.
- Guidance and support: Easy to use and relevant guidance and support should be provided in both the application and the user manual.

In the TURF (Toward a unified framework) of EHR usability is suggested that the working list of usability dimensions specifically focused on the EHR usability issues. (Zhang & Walji, 2011) I used this work as a basis for developing my EHR usability dimensions list for the usability issues evaluation.

EHR Usability dimensions presented in TURF are:

- Consistency :Consistency and standard in design
- Visibility: Visibility of the system
- Match Match between system and the world
- Minimalist Minimalist design
- Memory Minimize memory Load
- Feedback Informative feedback
- Flexibility Flexibility and Customizability
- Message Good Error message
- Error  Prevent use error
- Closure Clear Closure
- Undo Reversible action
- Language Use User's Language
- Control Users are in control
- Document Help and Documentation

The first six principles (Consistency, Visibility, Match, Minimalist, Memory and Feedback are properties of user interfaces.

There are no Learnability, User Satisfaction dimensions in the TURF list compare to the Nielsen's list. At the same time Flexibility is united with Customization. I think Clear Closure, Undo can be subcategories of Control (Users are in control).

My usability list is based on the TURF and Nielsen Heuristic usability dimensions. I focus on dimensions which directly influence the efficiency of work on non-clinical users.

The measurement of issues of usability dimensions which focus on efficiency of work will give me a good data compare to the subjective usability satisfaction evaluation.

The data analysis of usability dimensions focus on the efficiency of work will create the actionable results for the EHR vendors.

Appendix B

EHR USABILITY SURVEY

Thank you for your willingness to
participate in this survey.
Just two quick questions to determine if you are within the "target population" of the
survey...

Hospital Presurvey

Do you work at a hospital?

Yes

No

Physician Presurvey

Are you a practicing physician or a bedside nurse   ?

Yes

No

Explanation

The following survey is intended to measure how the usability of the EHR system you use at work affects your efficiency.

There are 20 questions. Each question is followed by one or more examples.

Please note that the examples given are for *illustrative purposes only.*

Whether or not a specific example applies to you, *please answer each question based on your personal user experience with a hospital EHR.*

Consistency

1. Similar features in different modules of the EHR behave inconsistently.

The impact of this usability issue on my work efficiency is:

Very
Low            Low           Moderate        High
                  Very High

EXAMPLE:

A search for a patient in the admission module is different from a patient search in the EMR and PCS modules. Such inconsistencies of basic functionality make it difficult to learn new modules quickly.

Survey 2

2. The user interface (screens) of the EHR have an inconsistent design/layout.

The impact of this usability issue on my work efficiency is:

Very
Low            Low           Moderate        High
                  Very High

EXAMPLE:

The design of the CPOE module is completely different from PCS and EMR, making it difficult to immediately locate tabs and menus.

Survey 3

3. I am unable to limit a patient search to only the information I need to see.
The impact of this usability issue on my work efficiency is:

Very
Low                          Low                Moderate              High
                             Very High

EXAMPLE:
When I look for a particular visit in the Electronic Medical Record module, the system returns the patient's entire visit history. I have to go through all the history records to find the visit I need.

Survey 4

4. I am unable to search for a word or phrase in a patient's records.
The impact of this usability issue on my work efficiency is:

    Very Low          Low          Moderate          High          Very High

EXAMPLE:
When viewing the patient's medication list, there is no way to search for a specific medication.

Survey 5

5. I cannot easily navigate from one screen or module to another.
The impact of this usability issue on my work efficiency is:

    Very Low          Low          Moderate          High          Very High

EXAMPLE:
I cannot easily switch between two modules and quickly get to the screens I need.  I have to go back to the main menu each time.

Survey 6

6. I cannot easily understand the presentation of information on the screen.
The impact of this usability issue on my work efficiency is:

    Very Low          Low          Moderate          High          Very High

EXAMPLES:

a) When I view a report, there is no visual separation between records, making it difficult to read the information quickly and accurately.

b)The patient record screens are crowded, and many of the fields are too small to conveniently read and click on.

Survey 7

7. The EHR doesn't automatically store many of the settings and form field data I am likely to use again, so I have to enter them each time I return to a screen.

The impact of this usability issue on my work efficiency is:

Very Low          Low          Moderate          High          Very High

EXAMPLE:

The EHR doesn't keep my settings for the readmissions report I run daily, and I have to enter all fields every day again.

Survey 8

8. The terminology of the EHR doesn't match the language I use in my work.

The impact of this usability issue on my work efficiency is:

Very Low          Low          Moderate          High          Very High

EXAMPLES:

a) I need to use dictionaries to understand the physician's specialties and status. b) The terms and abbreviations in the CPOE module are difficult to understand without reference to the dictionary.

Survey 9

9. When running a report or query, the EHR does not provide me with information regarding the system status.
The impact of this usability issue on my work efficiency is:

| Very Low | Low | Moderate | High | Very High |

EXAMPLE:
When I run a report or query the EHR does not indicate how much longer the processing might take. I have to check the status of the report periodically and interrupt my other tasks.

Survey 10

10. When I make a mistake, the error message does not provide me with useful information to understand and correct the problem.
The impact of this usability issue on my work efficiency is:

| Very Low | Low | Moderate | High | Very High |

EXAMPLES:
a) If I miss some fields in setting up a report, the EHR does not tell me what I missed and let me fix the problem. I just have to start the report again.
b) If I enter a date or patient ID in the wrong format, the error message does not provide me with the correct format requirements.

Survey 11

11. I cannot save reports in the format(s) I need, but have to convert them manually to the required format(s).
The impact of this usability issue on my work efficiency is:

| Very Low | Low | Moderate | High | Very High |

EXAMPLES:
a) I cannot save reports in Excel or CSV format so that I can analyze the data.

b) I cannot save the Discharge Summary from a patient's visit record as a Word or PDF file so that I can send it directly to the payor.

Survey 12

12. I cannot customize the appearance of the EHR to my needs and preferences.
The impact of this usability issue on my work efficiency is:

    Very Low        Low        Moderate        High        Very High

EXAMPLES:
a) I cannot increase the screen zoom level in all modules.
b) I cannot customize the size of the data entry fields, which are very small and make it easy to click in the wrong field.

Survey 13

13. When I have questions about using the EHR, it is difficult and time consuming to find the information I need in the help file.
The impact of this usability issue on my work efficiency is:

    Very Low        Low        Moderate        High        Very High

EXAMPLE:
There is not enough information in the help file to learn how to use the CPOE module, so that additional training is required.

Survey 14

14. Learning new features and modules of the EHR system is a time-consuming and difficult process.
The impact of this usability issue on my work efficiency is:

    Very Low        Low        Moderate        High        Very High

EXAMPLE:
It is not easy to learn how to find the doctors' orders in CPOE and read the order edit history.

Survey 15

15. It is difficult to remember how to use certain features of the EHR if I
have not used them for some time.
The impact of this usability issue on my work efficiency is:

Very Low          Low          Moderate          High          Very High

EXAMPLE:
After I come back from vacation, I don't immediately recall the details of the process for running
the different reports.

Survey 16

16. When completing a form, I am required to fill in fields that are irrelevant to my task.
The impact of this usability issue on my work efficiency is:

Very Low          Low          Moderate          High          Very High

EXAMPLE:
I have to fill all fields in the Discharge Planning form and put NA in the irrelevant fields. I should only
have to fill in relevant fields for specific interventions.

Survey 17

17. Some of the steps required to complete my tasks seem unnecessary.
The impact of this usability issue on my work efficiency is:

Very Low          Low          Moderate          High          Very High

EXAMPLES:
a) When I click on Admission in the main menu, I am presented with a page that is empty except for a Next button, which I have to click to get to the main Admission screen.
b) When I switch between tabs in the Admission module, the EHR doesn't remember which patient I was viewing, and I have to search for the patient again.

Survey 18

18. There is no way to customize the navigation in order to make my most frequent tasks easily accessible.
The impact of this usability issue on my work efficiency is:

Very Low             Low             Moderate             High             Very High

EXAMPLE:
I cannot create a shortcut or hotkey to run the census report, so every time I want to run the census, I have to go back to the main menu.

Survey 19

19. If the system starts running a process, I cannot interrupt it.
The impact of this usability issue on my work efficiency is:

Very Low             Low             Moderate             High             Very High

EXAMPLE:
If I start running a report and realize I entered the wrong insurance or location, I cannot stop the report. I have to wait until it's done and run it again with the correction.

Survey 20

20. I cannot send files outside the hospital network directly from the
EHR.
The impact of this usability issue on my work efficiency is:

Very Low          Low          Moderate          High          Very High


EXAMPLE:
I cannot send medical records from the EHR to the payor or home health agency by e-fax or email. I
have to save records in the required format and then either fax or email them.


Postsurvey 1


You have reached the end of the EHR Usability Survey. Thank you again for participating in
this project.

If I could ask for just a couple more minutes of your time, I have 5 questions (all on this page, below)
that will help me to analyze patterns in the survey data.
You may answer as many of these questions as you like, or skip them entirely.

As with the rest of the survey, your responses to these questions are completely confidential and
anonymous.


1. The hospital you work for is:


Private For-Profit Private

Non-Profit Government

(State/Local)

Government (Federal)

Other (please specify)


2. How many beds are in your hospital?

0-99                                          300-399

100-199                                          400-499

200-299                                          Over 500

3. Which department of the hospital do you work for?

Business                                         Billing

Admissions                                       Quality

Finance                                          Medical Staffing

Coding                                           HIM

Case Management                                  Other [                    ]

Information Services/IT

4. How many years of experience do you have working with an EHR
system?

1 year or less

1-3 years

3-5 years

More than 5 years

5. What is the primary EHR system that is implemented in your hospital?

Meditech             CPSI                Iatric

Epic                 Medhost             NextGen Healthcare

Cerner               Siemens             Health Care Systems

McKesson             Allscripts          Other (please specify) [          ]

FinalBlock

Thank you so much for helping me with my research!
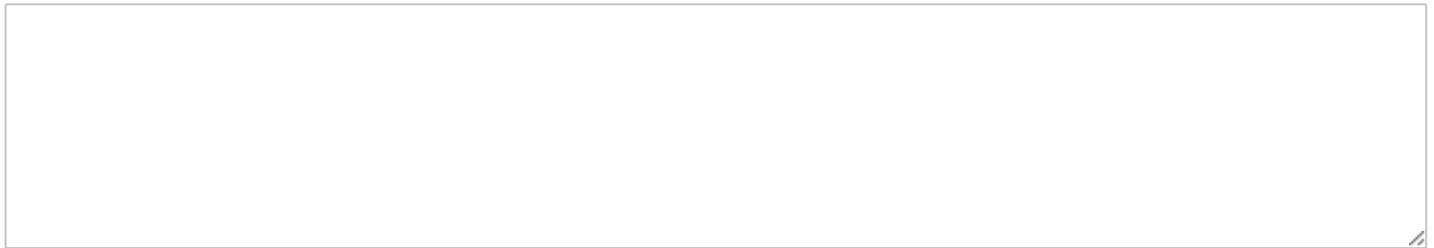If you have any general comments or suggestions, please enter them below.

*Also, if you have any "pet peeves" regarding the usability of your EHR that I didn't mention in my survey, please let me know about them here!*

*If you think your colleagues might find this survey interesting, please don't hesitate to send them the link to the survey with a quick note, something like this:*

*Hi,*

*I thought you might find this survey interesting! Here's the link: https://uthsc.co1.qualtrics.com/SE/?SID=SV_6MuIrXBcZKESR4V*

Appendix C

Informed Consent
Statement

You are being asked to participate in an online EHR Usability Survey as part of a research study I am doing for my Master's degree at the University of Tennessee Health Sciences Center. The purpose of the research is to determine the impact of usability issues on non-clinical users of electronic health records (EHR) systems.

The survey contains 20 multiple choice questions and should take no more than 15 minutes of your time. At the end of the usability survey, you will be asked a few questions regarding your use of EHR systems that will help me analyze the data.

There are no risks of any kind associated with this survey. You may decline to answer any question and you may withdraw from the survey at any time.

The potential benefit of this survey is an increased understanding of EHR usability issues, which may be used by EHR software developers to improve the user experience. There are no direct benefits to survey respondents, and no compensation will be provided to respondents.

Participation in this survey is completely voluntary. Failure to participate will not adversely affect your rights in any way.

There will be no collection of any personal data or identifying information. Survey responses are completely anonymized by Qualtrics, the online survey tool used to collect the data.

You may print a copy of this document for your records. Your participation in this survey indicates that you have read and agree to the above terms.

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RB NUMBER: 15-03918-XM
IRB APPROVAL DATE: 05/28/2015

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