



**UNIVERSITY  
OF TURKU**

# **Considerations for introducing a cloud service in health informatics: user experience monitoring of information systems**

Health Technology  
Master's Degree Programme in Digital Health and Life Sciences  
Department of Computing, Faculty of Technology  
Master of Science Thesis

Author:  
Melissa Welander

Supervisors:  
Asst. Prof. Antti Airola (University of Turku)  
CEO Janne Pitkänen (Adusso Ltd.)

November 2021

The originality of this thesis has been checked in accordance with the University of Turku quality assurance system using the Turnitin Originality Check service.

**Master of Science Thesis**  
**Department of Computing, Faculty of Technology**  
**University of Turku**

**Subject:** Health Technology

**Programme:** Master's Degree Programme in Digital Health and Life Sciences

**Author:** Melissa Welander

**Title:** Considerations for introducing a novel SaaS product in the field of Health IT: UX monitoring for EHRs

**Number of pages:** 51 pages

**Date:** November 2021

**Abstract**

This thesis will show concrete examples about how user experience monitoring will improve security of health information systems, patient safety, efficiency, and ease of use. This thesis will prove how the current EMR systems that are stand alone in nature lack the ability of advanced error monitoring capabilities. As part of this research, I will demonstrate with detailed interviews and data collection surveys how automated user monitoring systems improve data record accuracy consistently. Key terminology to Electronic Medical Records (EMR's) and the usability of cloud computing software solutions will be defined. EMR's are the primary software used in hospitals for charting patient information and this research focuses on the summarization of key information to the history of healthcare technologies and their functionalities. Usability testing, cloud computing, and how security and trust are affecting the adoption of cloud-based services will also be discussed in more detail. Along with the importance of market research, how to create buyer personas, and what drives their need to buy. The study was conducted in collaboration with Adusso Ltd. in Helsinki, Finland to gain better understanding about what motivates hospital IT departments to buy and the main issues with EMR systems. In collaboration with Adusso we investigated a use case example of their existing customer Apotti leveraging the user error reduction and cost saving benefits they experienced after deploying Adusso's UX2play system. We sought answers to these topics using semi-structured interviews and analyzing our customer profiles. We found that UI layout, interoperability, and the number of clicks that nurses spend in the EMR are major issues that most EMR systems have. This implies that companies using EMR's should implement user monitoring to pinpoint the issues they do have so that they can be fixed and the work of physicians and clinicians can be improved.

**Keywords:** EMR, EHR, Optimization, Usability Research, User Experience Monitoring, Market Research, Cloud Computing, SaaS

## Abbreviations and Acronyms

EMR	Electronic Medical Record
EHR	Electronic Health Record
UX	User Experience
UI	User Interface
HIMSS	Healthcare Information and Management Systems Society
SaaS	Software as a Service
GDPR	General Data Protection Regulation
HIPAA	Health Insurance Portability and Accountability Act
HITECH	Health Information Technology for Economic and Clinical Health Act

# Table of Contents

<b>1</b>	<b>INTRODUCTION .....</b>	<b>1</b>
1.1	BACKGROUND AND HISTORY .....	2
1.1.1	<i>Market Research</i> .....	2
1.1.2	<i>Buyer Personas</i> .....	3
1.1.3	<i>Cloud Computing</i> .....	4
1.1.4	<i>User Experience Monitoring</i> .....	4
1.2	OBJECTIVES .....	5
<b>2</b>	<b>METHODS.....</b>	<b>6</b>
2.1	RESEARCH APPROACH.....	8
<b>3</b>	<b>LITERATURE REVIEW .....</b>	<b>9</b>
3.1	HEALTHCARE INFORMATICS AND ELECTRONIC HEALTH RECORD SYSTEMS .....	9
3.2	IMPROVING USABILITY.....	13
3.3	SOFTWARE SERVICE AND DELIVERY MODELS.....	20
3.4	NEW PRODUCT DEVELOPMENT AND MARKET ADOPTION.....	21
3.4.1	<i>Marketing effort and strategy</i> .....	23
3.4.2	<i>Security</i> .....	24
3.4.3	<i>Trust</i> .....	26
3.4.4	<i>New product development</i> .....	27
<b>4</b>	<b>DATA COLLECTION.....</b>	<b>29</b>
4.1	INTERVIEWS .....	30
4.1.1	<i>Interview 1 Product A:</i> .....	31
4.1.2	<i>Interview 2 Product B:</i> .....	32
4.1.3	<i>Interview 3 Product C:</i> .....	35
4.1.4	<i>Interview 4 Product D:</i> .....	36
4.1.5	<i>Interview Confidentiality Form:</i> .....	38
4.2	SURVEY .....	39
<b>5</b>	<b>ANALYSIS AND FINDINGS .....</b>	<b>41</b>
<b>6</b>	<b>CONCLUSION .....</b>	<b>45</b>
	<b>REFERENCES.....</b>	<b>47</b>

## 1 Introduction

In this thesis research questions were formulated to answer how user experience monitoring helps to succeed in IT system deployments and maintenance. It also provides insight into the customer digital experience through the perspective of the end user in real time. For hospital IT departments being the target customer it is critical for them to solve user data entry problems quicker and achieve better end-user satisfaction with a constructive feedback channel. This research was formulated to validate Adusso's solution offering utilizing the buyer personas, technology trails and customer conversion, market research, and industry vertical expansion. Below, there will be three bullet points to organize each idea. The first was focused on gathering information on who signed up for the free trial and didn't use it, as well as those that turned into customers. The notion was to analyze this information on excel and to get an idea of customer groups. The second bullet point focused on survey creation and finding out from free trial users their motives for signing up. The final bullet point focused on market research and finding out who else in the industry and other industries does user monitoring and what makes them successful.

The research questions will provide pain points of user error when using electronic medical record systems without user experience monitoring. Research question 1 slowly developed into a more condensed version of bullet point 1 and 2. The focus became, defining the buyer personas within the customer target market (hospital IT personnel) for who sign up for technology trials for cloud based, Software as a Service (SaaS) user monitoring tools designed for healthcare EMR administration. The research surveyed four different healthcare companies in three different countries. Other considerations included the research question 2. Research question 2, "what makes companies doing user monitoring successful?" Which was too broad. Then following with the question, "How does the use of AI technology and machine learning impact the outcomes of the user experience monitoring?", but this was a little too specific. With these two questions being asked it led to a middle ground, focusing on the implementation of user experience monitoring for different companies and industries and the outcomes associated with them.

This thesis will be focusing on electronic medical record error reduction for healthcare system based on Adusso's expertise in this market. Healthcare in Finland is decentralized and has a public sector and private sector. Public sector care is delivered through municipalities, which there are 300 of. Private sector is for about one third of patients and for the most part for those that do not want to wait for appointments. Health information is exchanged mostly through joint registers and regional health information systems. Kanta, the national patient data repository launched in 2010 for citizens to use and have access to their own health record and prescriptions. "The Patient Data Repository is a national health information system that enables centralized archiving of electronic patient records and long-term storage of the data. The Repository transmits data between healthcare service providers [6]."

## **1.1 Background and history**

The main purpose of this study is to find some of the key contributing factors affecting the cloud service adoption and to find out if there are healthcare IT buyer personas that are trialing with user error reducing technology before buying. Additionally, there will be research conducted on the outcomes of user monitoring varying by company.

### **1.1.1 Market Research**

Market research is one of the many major forms of collecting market information that is verifiable, timely, and trustworthy. There is great value in data and information and when used properly, can improve the outcomes of any small business' success. Market research was first theorized by a man named Daniel Starch in the 1920's who claimed that advertising had to be seen, read, believed, remembered, and acted upon for it to be effective. We then entered the qualitative consumer era in the 1940's to 1960's which brought a distinct need for people to try and better understand what motivates consumer choices. Quantitative surveys were standard but techniques like the use of focus groups grew. In the 1940's a new form of consumer research called motivational research grew, and the pioneer was Ernest Dichter. He believed that using Freudian concepts to psychoanalyze consumers would give suppliers an upper hand. He believed everyone has hidden desires, taboos, repressions, and secrets and that

figuring out the personality of a product was key to marketing it. In the 1960's new technologies developed and brought about the use of the phone, computer, and internet [20].

In the past, (and still today) market research was done using tools like face-to-face and phone interviews, but the information age and the improvements in technology have allowed us to generate a number of new tools to collect this sort of information, like those of digital and online methods. In 2006, the use of a phone to conduct interviews had weakened in developing markets like the US and Europe, while face-to-face interviews and polls were being utilized more. Further, around 2011, the use of both phone and face-to-face decreased as the utilization of the world wide web to conduct this sort of research skyrocketed. It was seen as a feasible, efficient, and easily accessible tool [21]. In the present digital era that we currently live in, we use qualitative and quantitative approaches to understand consumers, and can mass scale our efforts for surveys, news, communication etc. [20].

### 1.1.2 Buyer Personas

Understanding buyers and what makes them want to buy is key for building marketing campaigns and improving business success outcomes. Some organizations generate semi-fictional buyer personas to classify consumers into groups so they know who to target with their products. A persona impacts the marketing strategy and includes characteristics like demographic for example. Some companies have different types of personas for different services. A persona can be developed by looking at existing customers and seeing prospecting customers. Then when segmented, surveys can be sent out or interviews can be conducted to find out what motivates them to buy. Looking at existing customer data in the Customer Resource Management (CRM) Software, Pipedrive is also useful for our company, Adusso. Characteristics like company size, geographic location, and job titles provide baseline data [22].

The customer journey is an important part of learning in-depth about what makes customers want to buy from you and the customer needs and pain points. Being able to understand how the customer interacts with the business allows companies to create a customer-centric mentality. Focusing on putting ourselves in the lens of the buyer will give us insights on what motivates them to buy or convert into customers. Tools like Maslow's hierarchy of needs have long been used to map out human needs in order of priority. Our most basic needs relate to physical survival and this is the first thing that motivates human behavior. This relates to the SaaS B2B environment as according to Dan McDade, there are three needs that motivate us to buy: fear of loss, perceived risk of deterioration, and opportunity to improve, all in relation to the person's current situation [23].

### 1.1.3 Cloud Computing

Cloud computing is the fundamental technology used in most companies including Adusso's technology offering when managing and transferring large amounts of secure health data records. The history of cloud computing dates back to 1963, when the Defense Advanced Research Projects Agency (DARPA) developed technology allowing a computer to be used by two or more people simultaneously, which was the precursor for what we now know as cloud computing, or "virtualization". Virtualization was the creation of a virtual machine and the offering of virtual private networks as a rentable service over the internet. In the 1990's virtual computers became popular and led to the development of cloud computing infrastructure. The cloud gained popularity and in 1999, Salesforce became a well-known example for using cloud computing successfully by delivering software programs to end users. This type of technology was accessible to anyone with internet access in a cost-effective, on-demand manner. Public cloud allowed customers to rent services without having to deal with maintenance, admin, troubleshoot, and backups, in a much faster manner [24].

### 1.1.4 User Experience Monitoring

The user experience (UX) profession has grown considerably since it was first introduced by Don Norman in 1993, who coined the term for his team at Apple. The revolutionary era of the



PC in the 1980's was what initially created a need for improving usability to begin with. End user experience monitoring (EUEM), is enabling teams to monitor a device's performance from the end user's perspective so that the quality of these products and services is standardized and companies can gain insights into the performance of the application. This process tracks the customer's interaction with the product so they can be optimized [30].

## 1.2 Objectives

In order to find solutions to my research questions, a well thought out plan must be made to follow certain objectives. For the purpose of this study it is important to gain understanding on market research and topics like customer demand (organization needs) and user preferences (individual needs). Customer demand is the ability of consumers to purchase goods and services. This relates directly to the second research question, "How are the outcomes of user monitoring impacted by different forms of implementation varying by company and industry?". User preferences are generally customized for a particular user to get an idea of their specific inclinations. This relates to my first research question, "Are there certain buyer personas that sign up for free trials of SaaS B2B products and how does this impact outcomes of use and customer conversion?". Studying user monitoring is proposed for the betterment of the healthcare system as a whole and to improve the work of doctors and nurses. The main outcome of this study is the identify and analyze the data entry experience that healthcare workers have had when using EMR systems. In order to improve the systems we need a proper understanding of what is going wrong in the first place. In this thesis we solved the main issues and compared them based on a four different experts from different companies. What we still have left to solve is sending out the survey we created based off of this work that studies the buyer personas and customer profiles of people that sign up for free trials of SaaS products. Once companies implement usability research they can start fixing issues with their systems.

*"Research Question 1: Are there certain buyer personas that sign up for free trials of SaaS B2B products and how does this impact outcomes of use and customer conversion?"*

*Research Question 2: How are the outcomes of user monitoring impacted by different forms of implementation varying by company and industry?"*

## 2 Methods

A research methodology is a strategy or approach to finding and solving a specific problem. The type of methodology considered in this thesis is the qualitative research methodology. That way there would be first hand participant observation. This is defined by Teharani et al. as “the systematic inquiry into social phenomena in natural settings [18].” Usually a qualitative research methodology is best when a researcher investigates a new field of study or hypothesizes prominent issues. It is common to use observation and interviewing as methods of understanding and interpretation [19]. This type of research has been done in the past mostly in Finland, to study usability so that the benefits can be optimized and the EMR systems can be improved. The study assessed physicians’ critical assessments of the usability of these systems for their improvement [5]. A quantitative approach would not have been suitable for this specific part of the study because it focuses on analyzing numerical data and finding patterns based on that. In this part of the study focusing on semi-structured interviewing, we are focusing on non-numerical evidence of concepts, opinions, and experiences.

In order to choose what type of qualitative research approach it was important to consider how some views of what was possible for the study would affect each approach. Some approaches for qualitative research include grounded theory, ethnography, and phenomenology. The phenomenology approach used for this research focuses on finding data through interviewing and explores results from the perspectives of those that have experienced it. In order to get started specific steps were followed from an article by Teharani et al. [18]. First, it’s important to examine the existing literature on the topic and find out what is already known about the topic. Second, to find a skilled collaborator and ask an expert, (in this case I asked Janne Pitkänen, the CEO of Adusso as an expert in the field doing his PhD in usability research and having done multiple research studies) [32]. And third the phenomenology approach.

The phenomenological approach has some strengths and weaknesses which I will outline in this paragraph. Some strengths include that it provides a unique perspective on how people perceive things, it allows us to gain a unique understanding, and it provides us with lots of rich data. Some weaknesses include its subjectivity for reliability and validity, the bias it induces, maintenance of pure bracketing from interpretation, presenting findings can be difficult, and the results are harder to claim as “typical” in any way [34]. Some of the other theories in comparison, like the grounded theory and ethnography differ slightly making them not as smart of options for this study. The grounded theory mainly focuses on social relationships and behaviors of groups. Ethnography on the other hand focuses on looking at people in their cultural setting and gathering observations to produce detailed accounts for different social phenomena [35]. The phenomenology theory is the most commonly used qualitative research method used in healthcare aside from the grounded theory [36]. Many other studies researching the topic of Electronic Medical Records (EMR’s) have used the phenomenological approach for qualitative research. One example is a study written in 2008 that looks into nurses’ experiences with EMR’s with the use of interviews [37]. The design of a phenomenological interview is generally an open dialogue between two people which explores the phenomenon itself by asking about the what rather than the why. The two most common are structured and semi-structured interviews, and in this case we used the semi-structured [38].

The interviewing method will be primarily used for this research. Specifically focusing on semi-structured interview formats, which are in-depth conversations where the interviewee answers questions that are preset and open-ended. Generally semi-structured interviews last for about 30min to an hour. First, a 30 minute time slot was created for the interviews. It was found that most of them lasted about an hour as the respondents were eager to discuss the topics. Usually these types have central questions and then sub-questions that stem off of and relate to the central question. The interviews were all conducted over Zoom and recorded with the UIcapture tool, which is a component of our product at Adusso. Recording the interviews allowed to go back and make notes on information that was missed during each interview.

Analyzing the results of the semi-structured interviews based on the phenomenological method, I used Giorgi's method of analysis. This includes four phases: 1. Reading transcriptions many times, 2. Creating units with meaning, 3. Grouping units together, and 4. Synthesis. Units were created with meaning attached to them and made into groups and I looked for similarities and differences in the data. Finally I created a chart that shows those grouped meanings and all four companies to properly synthesize the data.

Another tool was developed for quantitative research, where this is an ability to continue this study further with the use of surveying. Quantitative research is the process of collecting numerical data, from which patterns can be analyzed, relationships can be tested, and therefore hypotheses can be made. For the other section of the study, focusing on the survey portion based on the customers that have signed up for free trials, we can use a quantitative approach. The quantitative approach focuses on numerical data, which would be the results of our surveys. We could generate percentages based on each question and response to the survey through MailChimp application allowing us to analyze some statistics.

## **2.1 Research approach**

As mentioned above the methods I will be using are semi-structured interviews and surveys. I set up zoom meetings with the interviewees and collected data based on their responses. The survey I created on Mailchimp so that it would be an efficient place to import contacts that have signed up for our free trial and where I could easily generate a survey for those users. The survey will be attached to an email campaign that I can send out to whoever fits the demographic. Mailchimp is also a great place for generating statistics on the data collected for analysis purposes. The rest of the thesis is organized as follows: The literature review will explain considerations of health informatics and some history of the healthcare space. Some information on EMR's and how they came about as well as aims for improving them and issues faced with their usability will be discussed. I also demonstrate some data on the main issues with usability. Next I went into detail about the software service and delivery models for cloud computing platforms as well as the new product development, market adoption, marketing efforts, security, and trust. I demonstrate the data gathered through interviews and the survey that was built for future study, as well as analysis on these findings.

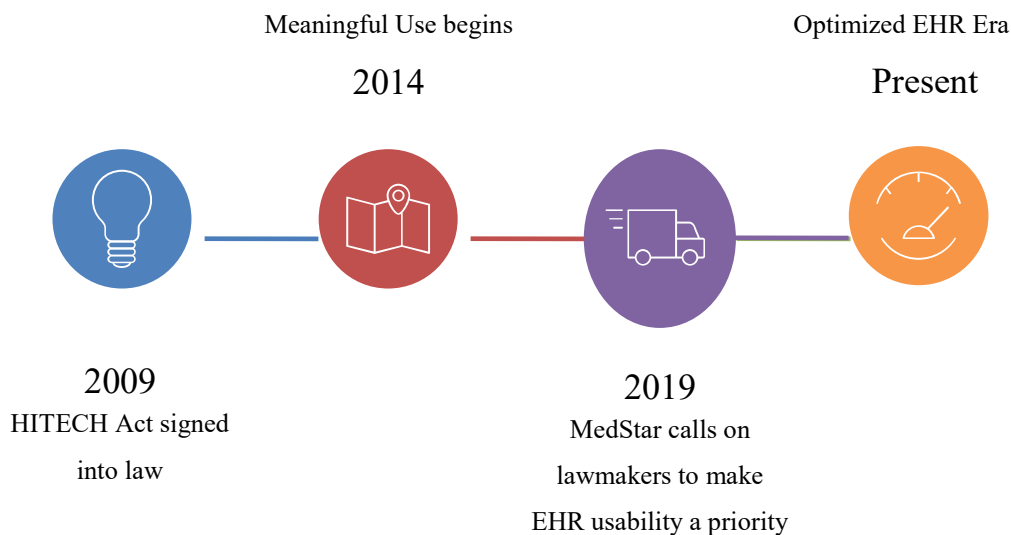
### **3 Literature Review**

#### **3.1 Healthcare Informatics and Electronic Health Record Systems**

The Healthcare Information and Management Systems Society (HIMSS), defines EMR systems as “a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports. The EHR automates and streamlines the clinician’s workflow. The EHR has the ability to generate a complete record of a clinical patient encounter—as well as support other care-related activities directly or indirectly via interface—including evidence-based decision support, quality management, and outcomes reporting.” EMR’s are often called EHR’s depending on which part of the world we referring to. EMR’s are used by healthcare professionals in many different care settings and even patients can use them by looking at their patient portals. Some key functionalities that EMR’s serve are: health information and data management, order entry management, results management, clinical decision support (CDS), electronic communication and coordination, patient support, reporting and population health management, and administrative processes. In general EMR’s help users to perform tasks by working as a memory aid, a computational aid, a decision support aid, and a collaboration aid.

Usability in terms of EMR’s is defined as how easy it is for users to perform their tasks accurately and efficiently while using a system. If systems are missing key functionalities, have poor reliability, or any type of insufficient match between interface features and user tasks will reduce usability and interfere with workflows. “The National Center for Cognitive Informatics and Decision Making in Healthcare (NCCD) funded by the Office of the National Coordinator for Health IT under the Strategic Health IT Advanced Research Projects (SHARP) Program, defines usability based on its TURF (Task, User, Representation, and Function) framework as “how useful, usable, and satisfying a system is for the intended users to accomplish goals in the work domain by performing certain sequences of tasks [25].””

Figure 1. Decade of accelerated EHR adoption in the US



*Figure 1. above shows the progression of a couple of healthcare laws and acts by year as we have progressed towards the EHR/EMR era that we are currently in today. This relates to the evolution and growth in the healthcare industry and moving away from legacy systems and paper records into a more secure technology driven industry.*

The history and background of EMR usability is widespread. The HITECH Act played a large role in the adoption of EMR systems and was used to promote the security and meaningful use of health information technology. When it comes to the users' ability to conduct their work in an efficient manner, missing important functionalities, poor reliability, and inadequate match between the interface features and user tasks can really hinder how well the application functions. Usable refers to whether the system is "easy to learn, easy to use, and error-tolerant." This is measured by "learnability, efficiency, and error-tolerance." There are some factors that can be grouped under the ones mentioned above, like simplicity and naturalness.

The HITECH Act was introduced in 2008 and only 10% of hospitals had adopted EMR's thus far. This increased the adoption rate of EMR systems to 86% in 2017, as it improved efficiency and care coordination, allowing for health information to be shared between covered entities. The HITECH Act introduced incentives that encouraged hospitals to switch from paper records to electronic ones, as well as HIPAA compliant safeguards for privacy. In order to make sure that hospitals complied with these standards for privacy and security, financial incentives for adopting and penalties for violations were put into place.

The meaningful use program was funded by the Department of Health & Human Services, who's main goal was to incentivize care providers to adopt EMR systems in exchange for a monetary value. The EMR's were required to be certified though, meaning that they should meet defined standards set by an authorized testing and certification body. These EMR's had to be used in a meaningful way, like for filling prescriptions and exchanging health information for the purpose of improving care quality and efficiency.

The primary aims of the program were:

- Improve coordination of care
- Improve efficiency
- Reduce costs
- Ensure privacy and security
- Improve population and public health
- Engage patients and their caregivers in their own healthcare [3].

As the adoption of EMR systems increased around 2015, there was also an increase in the number of reports regarding usability issues as well. It is clear that there is a connection between the usability of an EMR system and the quality of care when it comes to patient

safety. This can translate as things like user fatigue, errors in usage, and decreased satisfaction among users. Improving usability of these systems is of course associated with increased patient safety and user satisfaction, as we define this as the ability to use “technology efficiently, effectively, and satisfactorily [7].”

Since user experience as a concept is still relatively vague, it is important to take into consideration safety and prevention of errors when usability studies are designed. When systems are designed for usability, they should be enabling users to meet goals and needs. From the viewpoint of the physician, when supporting their daily tasks, ICT systems need to be compatible with physician’s tasks by providing them with “key functionalities (context-matching), be efficient (especially in terms of record-keeping and information retrieval), and have intuitive user interfaces [5].” EMR and ICT systems should be adaptable to many different environments for different user needs by supporting information exchange and interoperability.

When studying usability of healthcare systems it is important to note certain aspects for improvement and optimization. For example, efficiency of conducting routine tasks, physicians’ abilities to utilize key functionalities, learnability of the system in relation to the amount of training received, and the safety of the system in regard to system errors correlated to adverse patient events. A study done in Finland on the usability of EMR systems and physician satisfaction from 2010 to 2014 the physicians reported that the usability has not improved over the four year period [5].

Things like speed for system response time and layout have been reported as two of the most bothersome factors when it comes to usability issues resulting in physician dissatisfaction. Surveys done in Finland also showed dissatisfaction with EHR usability if systems were not efficient, they did not have proper support, and if the interface was not intuitive. Nurses have also been included in this conversation and have faced similar issues with their documentation tools and technologies. Specifically having issues with individualization, self-descriptiveness,



and error tolerance [7]. The inability to personalize workflow tools and interfaces leads to increased time spent entering in patient information.

In Finland to measure the usability of the EHR systems, the National Usability-focused HIS Scale (NuHISS) is used. The questionnaire was used to analyze physicians' experiences with EHR systems and appropriately utilized for nurses as well. The results showed a low level of satisfaction and problems with usability in relation to data entry, as well as insufficient support for workflow and visual display. Results differed from studies done in the past on this topic, showing that the satisfaction for both physicians' and nurses' varied by EHR vendor brand rather than discrepancies by group (physicians vs. nurses). Some information entered into the EHR seemed to disappear from the system as reported by physicians and seemed to vary by EHR brand and had to do with poor usability.

The above study conducted in Finland showed that nurses and physicians found different parts and aspects of the EHR to be challenging in regards to usability. Researchers state that, "EHRs should support fluent multidisciplinary information exchange and patient care. Recent research suggests that the success of the implementation process might strongly influence the usability and safety of an EHR system. Ratwani et al. found wide variability in task duration, clicks and accuracy when physicians were completing basic functions across EHR products based on given scenarios. Depending on the quality and success of the implementation process, even the implemented EHR products from the same vendor may differ in terms of usability and safety [7]."

### **3.2 Improving Usability**

EHR usability issues can often lead to patient safety concerns that are "swept under the rug". Things like a confusing display, data entry, workflow support, and too many alerts can all lead to physician burnouts and put the patient at risk. Tackling some of these issues can feel daunting for many nurses and doctors. When it comes to EMR's it is important to account for

not only safety of patients but efficiency as well when it comes to clinicians doing their day to day work. Efficiency can be hindered if IT support is poor for exchange of information, communication, and collaboration [5].

Clinicians know that EHR displays are cluttered with information like, textboxes, drop down menus, and patient data. This can be overwhelming especially when they have busy schedules and lots of patients daily. It can be easy to miss simple things like an incorrect patient height or weight entry. Sometimes when entering in a prescription, the EHR system automatically defaults to a specific dosage based on the height measure, which can result in an incorrect dosage for the patient if not caught. MedStar and AMA created a great website, [EHRSeeWhatWeMean.org](http://EHRSeeWhatWeMean.org), [31] that shows the issues that EHRs have when it comes to usability. The videos do a great job of displaying how easy it is for errors to arise, how unsupported their workflows are, and how confusing the displays can be.

So how do we improve EHR usability?

By continuous optimization and listening to the users. Objective evidence recording, continuously tracks and monitors what the users are doing as they are working and performing their daily tasks and duties. By monitoring what clinicians are doing from their perspective, we can gain a better understanding of what truly needs to be fixed. While recording we are simultaneously gathering the clinicians' input and comments on issue tracking to see what is causing them the most frustration throughout their workday so we can get to the bottom of it. Of course, a system like this needs to be HIPAA and GDPR compliant, allowing only those with proper credentials to access the recordings and using machine vision to display only what is necessary for system improvement and nothing that would be considered Personal Health Information (PHI) [33].

Objective evidence recording also has the ability to catch entry errors resulting in medication dosage errors. This allows back-end developers and IT support to tackle the issue and know the reason for why and where the system is “acting up”, so that we can stop this from happening again in the future. As more issues are fixed and the system improves, the number of clicks clinicians make within the EHR during their shift declines. This is important as less clicks means we are simplifying the course of action for individual tasks. An article from Becker’s Hospital, states that physicians in the emergency department spend 44% of their time entering information into the EHR system and average at about 4,000 clicks per shift. [29] By reducing the number of clicks, the less likely it is for clinicians to make errors, the more time they save, and the less likely we are to have burnouts, which are all too common in the healthcare industry. If we can improve the usability of EHR systems, we can improve the lives of the clinicians using the systems and most importantly improve patient safety. When physicians from public hospitals were surveyed in a Finnish study, 42% said that a non-intuitive and faulty system caused or almost caused a serious adverse event for a patient putting them in a risky and unsafe situation [5].

Here are five practical tips which I developed as part of my research on making EHR’s more user friendly:

Since technical issues like system errors and latency tend to be dominating problems immediately following deployment, it is important to have procedures in place to address them as quickly as possible. This can be done by monitoring and tracking to achieve comprehensive resolution, allowing for improved usability. Fix technical issues first to free up time for usability.

When transitioning to a new system, user training is crucial for successful deployment, but investing in training beyond the initial 2-3 days may not be worth your time or money. Instead, receiving on-site help when needed and targeted video clips for training that don’t take clinicians away from patients can be more helpful for improving usability.

Having to click through multiple interfaces, with multiple checkboxes, multiple drop-down menus, and fill in (oftentimes) repetitive information, can lead to errors and burnouts. Simplifying the interface and tailoring workflows by monitoring the user in action is important so we can identify how to streamline clinician daily practices.

An EHR needs to be maintained for it to stay up to date. This can be done by summative testing and gathering satisfaction scores from users with the use of the system usability scale (SUS).

Making a mistake in the patient data entered in the EHR can happen to the best of us, like entering the weight in kilograms when the system is configured to pounds, could cause an incorrect amount of medication to be prescribed. Personalizing the EHR and adding simple configurations like an alert or highlight to make a high-risk area stand out can actually save a patient's life.

If the EMR system includes functionalities to help the prevention of errors, if the user is clearly informed about what they are doing, and if the user can easily get help when needed, the physician is less likely to run into errors when using the system. EMR's should be able to serve a single physician but also for many environments because of the vast number of departments and the need for much communication and cooperation. A study showed that there are four areas that could be improved: availability of medication information from other organizations, more support for cross-organizational collaboration between physicians, monitoring the orders that are given to nurses, and support when it comes to collaboration between physicians and patients [5].

The General Data Protection Regulation (GDPR) took effect on May 25th 2018, applying to all European Union (EU) states. The aim of this regulation is to "protect the data and privacy of the European population by giving control back to citizens and to make the regulatory environment simpler for international business [8]." Finland is currently a leader in the digitization of healthcare and the collection and use of patient data, as they are the first

country to meet the stringent requirements of GDPR, all while utilizing citizen data to benefit the healthcare sector as a whole (including patients) [9].

Figure 2. Usability of EMR Systems

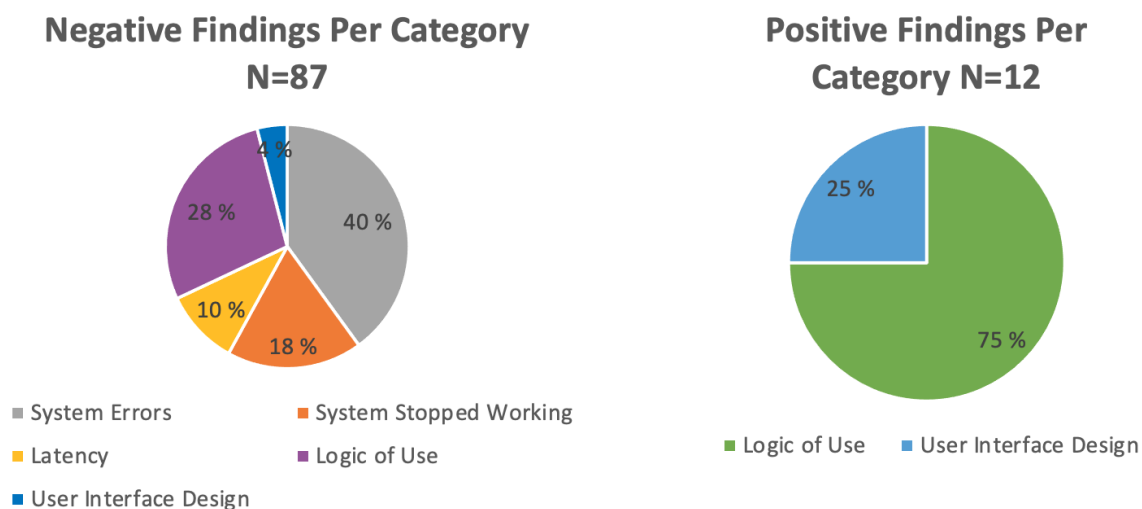
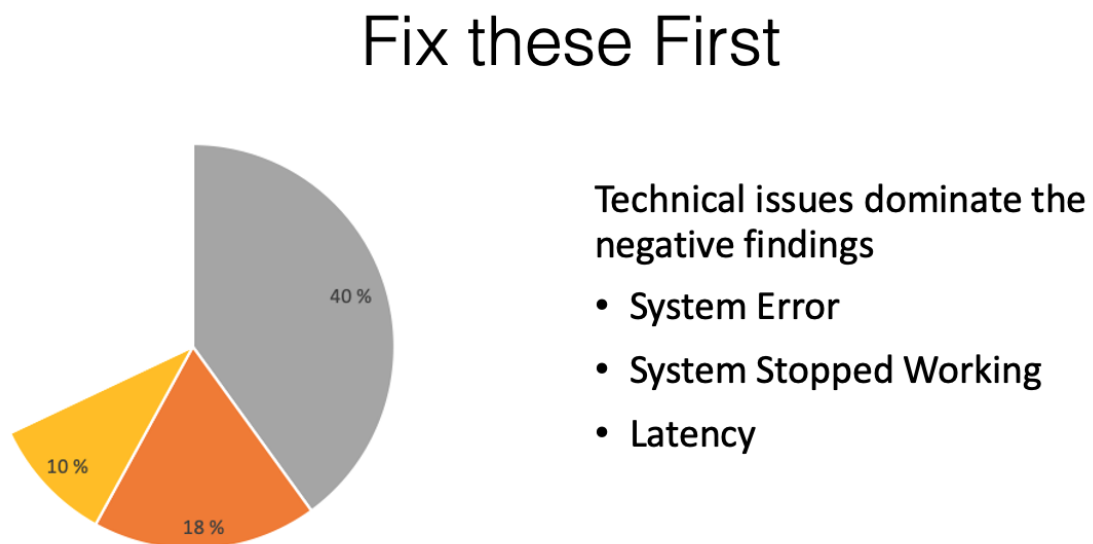


Figure 2. shows a study done on EMR software for an anonymous company immediately following deployment. The report categorizes the system characteristics into negative and positive groups in relation to usability of the system. The negative section includes system errors, latency, user interface design, logic of use, and system stopped working. The positive group showed logic of use and user interface design. These are shown in percentages to give the reader an idea of its relation to the whole. As end users were studied while regularly utilizing the system in their daily tasks the way they normally would, they were told to mark down whenever they faced an issue with the system and what the issue was or whenever they were happy with the system and the reasoning for it. We created a report for a total of 99 user observations when using the EMR system.

Figure 3. Usability of EMR Systems



*Figure 3. above shows a pie chart from a report conducted with Susanna Martikainen of the usability data collected on the Adusso UX2play system and its technical issues.*

Figure 4. Usability of EMR Systems

## Start Optimizing User Experience

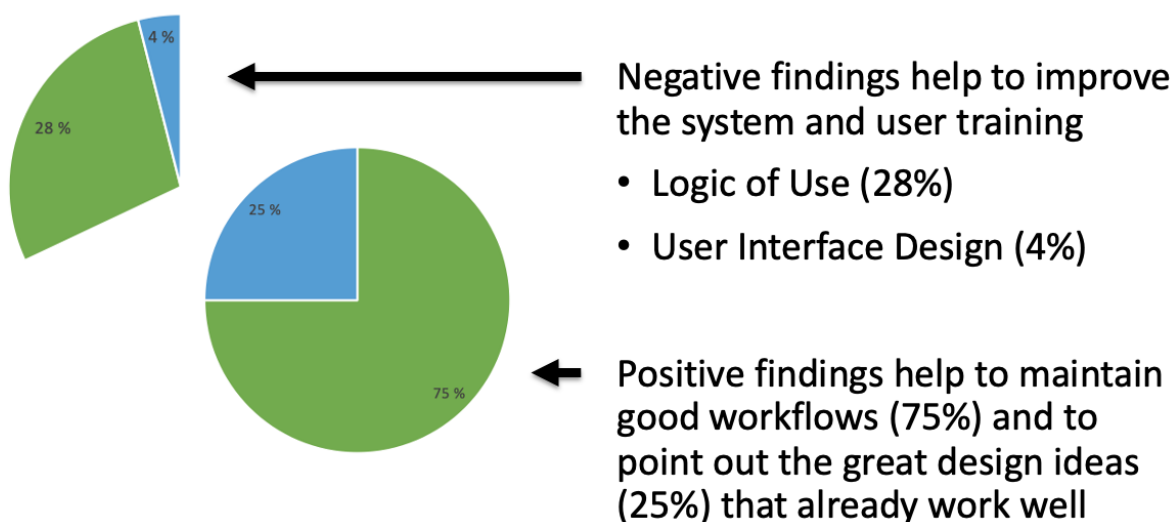
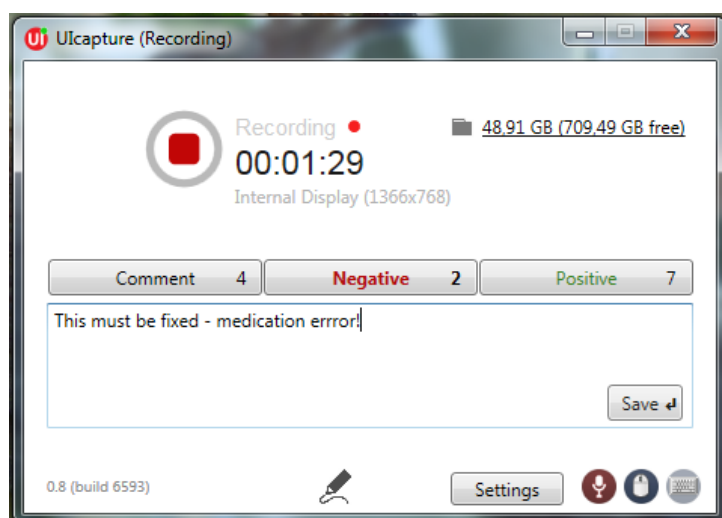


Figure 4. above shows a pie chart from a report conducted with Susanna Martikainen of the usability data collected on the Adusso UX2play system and its negative findings paired with positive findings on system design. Reference: Martikainen, S. (2018). Adusso's Report on Case Study.

Figure 5. UIcapture Recording



☹️	integration	Prescription gives an error - something related to Kanta services?	View	Copy Link
😊		(no description)	View	ServiceNow Copy Link

Figure 5. shows how to make a comment in the Adusso UIcapture screen recording system. Recording the EMR systems in the background while the user performs their daily tasks allows us to get an idea of what specifically causes the most issues as well as what works the best based on the comments that are left. The top image is the recording system which allows physicians to start the recording or end it whenever. The empty box below is the space where a comment can be left whenever an issue or a positive characteristic in the system is encountered. The image below shows what the IT and tech support sees after comments are made and an anonymized video of the screen can be viewed by select personnel for the purposes of improving, fixing, and optimizing the EMR.

### 3.3 Software Service and Delivery Models

Cloud computing has become more popular as companies try to expand and improve their IT services and performance. This allows companies to offer all of their services via the internet on demand, at lower cost, with less complexity, greater scalability, and a much broader reach. Cloud computing consists of the SPI model which provides three types of services: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). SaaS, “is a delivery model for software in which the application is held by the vendor, who undertakes to deliver functionality, on demand, to customers. SaaS thus differs from traditional software distribution in which customers receive their own copy of the software. This notably frees companies from developing and managing software themselves [2].” “SaaS enables service subscribers to access a software application from a soft- ware vendor through the web [4].” PaaS has the capability to allow customers to deploy their own applications on the cloud, using it as a platform. Finally, IaaS has the capability of allowing customers to have compute resources to run things like operating systems and applications in the cloud [12].

Cloud services allow organizations to pay for services as they go so that they only pay for what they use and can easily scale services up or down based on their needs. This allows companies to be agile and adapt quickly to changes. In order to further the adoption of SaaS,



providers should focus on designing effective marketing strategies based on the enterprise users' needs and concerns. Small and medium sized enterprises are not adopting the SaaS model as quickly as some would have hoped or assumed regardless of its immense growth potential. One of the most frequently reported concerns being data security. This includes data leakage and loss of privacy which is especially important in the healthcare industry and when dealing with patient information. This creates a need for larger efforts in marketing and sales, making "SaaS seem attractive, cost-effective, easy to obtain and purchase, and well known enough to be trustworthy [4]."

Cloud computing combines different concepts like service oriented architecture (SOA), Web 2.0, virtualization, and other internet technologies, where data is stored and hosted on servers for easy access on demand [12].

### **3.4 New Product Development and Market Adoption**

When developing new SaaS products for the market, many factors should be considered. Factors like technical issues, development and maintenance, interoperability, business models, pricing/negotiating, customer/supplier relationships, or granularity of services. It is also rare to find studies regarding the drivers of SaaS adoption, which is important. Some of the benefits that are generally seen with SaaS are factors like the attractive cost model for customers, the flexibility of different types of technologies, and the shortage of IT skills that many companies have. Some of the risks include, the applications reliable for access, how secure is the data and is its privacy ensured, and if we can depend on the process/quality of service [1].

When it comes to adoption of SaaS technology, certain factors can either help or hinder the process. Some studies have found that things like application specificity can negatively impact the adoption of SaaS products. This includes business driven and technology driven uncertainty. Business driven referring to pricing, process, and service levels. Applications

with lower levels of specificity, strategic significance, and adoption uncertainty seemed to have higher adoption rates for SaaS. This means that SaaS companies should emphasize software that is easy to standardize. Meaning that a company's core data would not be included in the cloud-based model as many are still skeptical about storing company data on the provider side in case of network downtime.

Many IT companies also tend to base their decision-making on the SaaS model and its adoption on expert opinions and peer pressure. What this means for SaaS based companies, is that they should target and engage with opinion leaders and third parties like associations and lobbies who generally have a say in new technology. Offering their solution to these groups for free in exchange for marketing and publicity would help tremendously. It's also important for SaaS-based companies to address their products through showing and mitigating technical and economic risks. By integrating features that mitigate risk, peoples' trust of SaaS products would increase as well as decrease opportunistic behavior. Companies can place themselves in a partnership type position with CRM and ERP companies, ensuring their clients that they will fulfill customer needs [1].

When it comes to actually following through with cloud adoption on a mass scale, it's important to address some key topics. Deciding on sourcing is important, so partnering with public cloud providers. Companies should also create an operating model for the public cloud, where coders understand the ins and outs of compute, storage, and security protocols. Some existing legacy applications should also be configured to align with the new security and capacity protocols of the cloud. Finally, it's crucial that employees are trained with the right skills to develop applications on the cloud quickly and securely. This required the hiring and training of cloud experts and introducing them to development teams, as well as retaining existing workforce. Leadership at companies looking to adopt the cloud must truly commit in terms of time and money to successfully implement these solutions [10].

### 3.4.1 Marketing effort and strategy

When it comes to cloud adoption there are many benefits associated with its standardization and automation that tie into strategy. With the cloud, companies can reduce overhead costs, help scale IT processes whenever needed (up and down) to optimize usage of assets, improve flexibility as a whole when it comes to meeting business needs, and increase quality of service through standard solutions. Some key strategies that SaaS companies should keep in mind if considering the switch to adoption are to evaluate their current IT portfolio, choosing which approach to use (aggressive or opportunistic transformation), creating clear business goals, ensuring investment from finance leaders, addressing change management, and adopting new KPI's. An agile operating model requires massive shifts in mindset and company behavior. This way companies can successfully achieve agility, flexibility, efficiency, and cost savings [10].

Marketing is specifically defined as an organizational process that creates, communicates and delivers value to customers by maintaining customer relationships through profitable means for both the company and the target groups. When marketing a SaaS product many factors are important to account for. For example, provider size, implementation model, and market communication channel can all affect how the product will be marketed. The size of the enterprise for example, will play a major role in defining the target market and customer group it will sell to. The implementation model can include things like deployment, integration, training, and consulting. The market communication channel delivers information about the product to the customer through advertising, promotion and building relationships. Tools like web pages, targeted email campaigns, newsletters, search marketing, viral campaigns, and banners are often used. An important metric when considering KPI's for tracking customer conversion is the customer acquisition cost, which represents the cost of winning the customer to purchase your product or service [11].

### 3.4.2 Security

Security is a major barrier for many companies when looking to adopt cloud computing. Security concerns are usually associated with areas like external data storage, being dependent on the public internet, inability to have control over certain aspects, multi-tenancy and integration with internal security. Moving data beyond the company networks can be a big concern especially in healthcare. It's important for SaaS providers to demonstrate security through the use of service level agreements and compliance when audited. A service level agreement (SLA) is a contract between a cloud user and a cloud service provider that agrees on a set of deliverables from one party to the other [12].

Since there are several forms and delivery models of cloud computing, the security solutions also differ based on the form. The forms are referred to the SPI model, or Software, Platform and Infrastructure (as a service). When it comes to the security of SaaS, the burden lies on the provider, as it provides less customer control and more integrated functionality. PaaS (Platform as a Service) on the other hand allows for greater customer control, since it has greater extensibility. While IaaS (Infrastructure as a Service) offers the most customer control and security out of the three since it has a lower level of abstraction than both models. It's also important to note that both PaaS and SaaS are layered and hosted on top of IaaS meaning any breach in security to IaaS will affect the top layers. Although it is possible for this same effect to work the other way around as well from top to bottom [12].

Some common security issues that are involved with SaaS are similar to those of any web application. Hackers can try to get ahold of sensitive data through flaws and vulnerabilities in the software. Multi-tenancy can also pose some security risks as it serves multiple customers within one instance. This means that all data would be stored in the same database, risking a privacy and security threat to all clients. This would require security policies to safeguard data. Another security threat involves data backups. Within the SaaS model, since the provider is responsible for the security of the data, a data backup is critical in case things go wrong. Things like data privacy, segregation, and security are all important aspects for the provider to keep in mind. Another threat to cloud computing is the accessibility of data, being

that it is hosted over the internet. Mobile malware that steals information, insecure Wi-Fi, device OS vulnerabilities, insecure marketplaces, and proximity-based hacking are all very real threats [12].

Since the deployment models can also vary, so does the security based on those models. The deployment models consist of the public cloud, the private cloud, the community cloud, and the hybrid cloud [14]. The public cloud is a type of computing where resources are available to the public, while the private cloud is more of a corporate cloud, where data is on-site in the company's data center. A hybrid cloud is a mix between the two, where the private cloud extends to a secure public cloud [13]. The community cloud refers to several organizations supporting a community with shared goals and objectives for the cloud. With so many different types of models, a set of risks and benefits comes with different combinations of circumstances.

Stronger cybersecurity laws addressing privacy and data protection are being passed all over the world and should be accounted for when considering cloud computing software. GDPR in relation to data privacy, personal data breaches, and data transfers are important aspects to consider when accounting for security protocols. Companies should incorporate technical mechanisms to protect personal data in the design of systems and processes; that is, privacy and protection aspects should be ensured by default. Personal data breaches are also relevant in this conversation as the organizations must maintain a Personal Data Breach Register and, based on severity, the regulator and data subject should be informed within 72 hrs of identifying the breach. Data transfers are important as well because the controller of personal data has the obligation to ensure the protection and privacy of personal data when that data is being transferred outside the company, to a third party and/or other entity within the same company.

The California Consumer Privacy Act (CCPA) is also an important law to consider when accounting for security protocols. CCPA gives consumers more control over how companies

are using data that they collect about them and covers a broader range of personal information than most U.S. privacy laws. Consumers have the right to know about the personal information that the business collects from them, right to delete personal information collected, right to opt-out of the sale of their information, and the right to non-discrimination [15]. Among other things, it reaches any information that is capable of being associated with a consumer or household (incl. IP Addresses, online identifiers etc).

Stop Hacks and Improve Electronic Data Security Act (NY SHIELD) is another important security law that must be considered when discussing businesses using cloud computing and web hosted applications. NY SHIELD is a data security law passed by the New York Senate in 2019 and went into effect on Mar 21, 2020. “The Shield Act significantly strengthens New York’s data security laws by expanding the types of private information that companies must provide consumer notice in the event of a breach, and requiring that companies develop, implement, and maintain reasonable safeguards to protect the security, confidentiality and integrity of the private information [16].” It requires companies to set up a "Data Security Program" in order to continuously monitor and improve their cybersecurity. They also need to implement "reasonable safeguards" to make sure that any private information handled or accessed is safely stored and/or discarded. NY SHIELD mandates two main obligations, keep private information safe, and provide notice of data breaches.

### 3.4.3 Trust

Trust is crucial in cloud computing and can usually be assessed based on reputation and self-evaluation. The word trust can be loosely defined as it can elude to security and privacy in the tech world. “Trust is a mental state comprising: (1) expectancy - the trustor expects a specific behavior from the trustee (such as providing valid information or effectively performing cooperative actions); (2) belief - the trustor believes that the expected behavior occurs, based on the evidence of the trustee’s competence, integrity, and goodwill; (3) willingness to take risk - the trustor is willing to take risk for that belief [17].” Although trust and reputation are different, the reputation of a cloud service provider often goes hand in hand with trusting

them and whether customers choose to pick them as a provider. The overall view of a community towards a specific provider reflects on their reputation and therefore whether they will be chosen as a service. In order to verify that the company truly is trustworthy and reevaluate that trust to their customers, a Service Level Agreement (SLA) must be made, along with some Quality of Service (QoS) monitoring. A QoS is the measurement of the performance of a service overall based on the users' perspective. Oftentimes a third party entity will be needed and used to provide SLA verification and QoS monitoring. For example, in a private cloud there may be a cloud broker or trust authority, or in a public cloud a commercial professional cloud entity may be used [17].

In order to fully gain trust in the cloud, transparency and accountability are key. The Cloud Security Alliance (CSA) launched the Security, Trust, & Assurance Registry (STAR) program where cloud providers can publish self-assessments of their security controls in the Consensus Assessments Initiative Questionnaire (CAIQ) or the Cloud Controls Matrix (CCM) regarding best practices [17]. The CloudTrust Protocol (CTP) was also adopted by the CSA to ensure transparency and make sure that everything that was being stated as happening in the cloud was truly happening and vice versa. The RSA cryptosystem announced the Cloud Trust Authority (CTA) as its own cloud service, receiving the name, Trust as a Service (TaaS). TaaS was used to configure the security of multiple cloud services in a single point. The RSA's philosophy is "trust = visibility + control", which was the basis for the use of CTA as a tool. Some services included in the CTA were identity service and compliance profiling. These allowed for multiple cloud providers to have single sign-on and the ability to view many cloud providers and compare them to industry standards [17].

#### 3.4.4 New product development

When it comes to building new cloud services, it is best done as a collection of cloud services or APIs, or otherwise known as service-based/service-oriented architecture. When building cloud applications, it's important to focus on underlying functions and using those as services

that can be independently leveraged [26]. When developing a new cloud product some key aspects to keep in mind:

- Developers must be familiar with the newest cloud technologies which means corporations should invest in training.
- Performance issues can hinder new development. Wide area network resources for example should be available. Accounting for server load and bandwidth issues need to be accounted for so they meet service-level agreement (SLA) objectives.
- Focus beyond own applications is important as there are many connected components and security processes can easily become exposed to third parties.
- Integration complexity increases with the cloud so connecting various solutions to make sure they operate correctly is important.
- Cloud service fees can add up with usage based metering because the bill rises as resources run so this is important to keep in mind [27].



## 4 Data Collection

This interview will conduct EHR systems, implementing and monitoring solutions, challenges faced, and biggest competitors. These questions will help formulate and conduct each research question mentioned in this thesis. For example the buyer personas sign up for free trials of SaaS B2B products and the impact each outcome has on the use of customer conversion. Along with the outcomes of user monitoring and the impact by different forms of implementation varying by each company and industry.

Research Question 2: How are the outcomes of user monitoring impacted by different forms of implementation varying by company and industry?

## 4.1 Interviews

Semi-structured Interviews:

Below is the general structure of the interviews and the questions asked with each respondent.

### **Market Research - Interview Questions:**

1. Are you currently doing any form of user analytics/monitoring/feedback collection?  
If so, what? How are you implementing this monitoring solution?
2. Is this how you currently make improvements and optimize your EHR system?
3. How has it helped your team and/or clinicians? (pinpointing providers who need assistance) How has it helped your clients?
4. Benefits?
5. What are the key features in the implementation process that makes you successful?
6. What kinds of system bottlenecks and deviations do you track?
7. What are some of the outcomes of the platform? Are there any stats or metrics that you track?
8. What about KPI's?
9. When and how did you realize you needed something like this in place?
10. What are some of the challenges that you've faced with your current system? What kind of improvements would you make to it?
11. What are some of the challenges your customers have faced and has your product filled that gap and how?
12. Who are your biggest competitors?
13. Where do you see the future of this type of user monitoring and analytics going?  
What about the future of the optimization of EHR systems as a whole?

#### 4.1.1 Interview 1 Product A:

Product A is a symbiosis of two old legacy systems. Old legacy systems generally tend to have more issues, as does this one. There is a billing section which is not generally in EMR systems, this makes it a complete and comprehensive system (the only one in Finland).

They completed some usability tests on the system at a couple different clinics. A preventative care tool is missing and being developed for the platform. The care table component was added later which combines medications, lab results etc. allowing the users to customize so they can see the bigger picture of the patient and create graphs based on the data.

The new system has advantages: it's simpler to use and therefore faster/more efficient. Interviewee A believes that the ways that the tools are being developed should be changed by engaging the customer/end user at the early stages and not just building on the old systems. Nationwide consensus for healthcare needs so that the design can be conceived on that basis with the use of modern tools. Prioritizing usability and safety of the data. Usability can save professionals time and be able to spend that time with the patient and use the system as a tool the way it should be used. The old legacy systems typically require manuals and instructions on the use of the system which is a large problem.

Customer feedback complaints: Too many clicks and too many pop-up windows are usual complaints from users. The visual presentation of the UI, i.e. text is too small etc., is also a large complaint from users when it comes to these systems. Scalability is also something that they struggled with as they would go to patients' houses and use mobile phones and tablets and this required scalable programs (some things get left out or showed too small). Some users also needed Citrix to reach the program so this made it hard to scale as well.

Many doctors and nurses work in different environments using the same system but it looks different in different environments so they can't see and access everything they normally would. Some items can be personalized and pinned like a desktop adding flexibility but this is still not enough. The main superusers should also have really good tools as the support teams will need to be able to fix and work on the product when necessary.

Technicalities behind solutions and the old ways of doing things was generally an issue at company A. Lack of proper design due to the inability to think outside of the box but adding new features and layers onto existing systems seemed to be what causes the most issues. Due to legacy technology the amount of work that is needed to implement the smarter changes is too expensive and they would settle for the easier less expensive less smart solutions. Starting over would have been time consuming and expensive so they usually just added onto old systems. A great improvement would be to make user experience testing more routine and consistent to observe the customer satisfaction and gain some insights. A workshop was held here and there but oftentimes they would gain some insight but with little to no change. Testing was only done about 2-3 times a year.

#### 4.1.2 Interview 2 Product B:

Interviewee has done work with the company that has a legacy EMR system that was continuously updated in effort to improve the system and make it more current. A current EMR system was the result but it was based on a legacy system. The team that he/she worked with at the time was doing some user monitoring and analytics solutions at a test lab where they filmed the tests being done and created some guidelines for this usability. Some benefits of this type of user monitoring research testing for them was that they generated color schemes that were helpful in highlighting important things like the number of bits of info on the screen and what buttons would permanently show at all times versus what would be an optional button depending on the screen view etc.

Some other key aspects that made this company successful with their implementation was that they interviewed their customers first to figure out what their base needs were. They also visited customers of all sizes and shadowed their work to figure out what tasks were and were not carried out, as well as, what was repetitive. This helped the entire ecosystem linked to UX as they were better able to pinpoint for optimization.

Some of the biggest challenges they faced when trying to optimize and improve these systems was that with these legacy systems when you try to fix one thing in the system, something breaks elsewhere. This made it nearly impossible to try to fix as the system had layers and layers of co-dependencies that only caused problems to the whole. After paper records were digitized, there was no plan so system development was minor. Systems are layers upon layers of new functionality, no resources or time set aside to improve the old. Development was about money because you make more money when you make more functionalities. In order to improve systems they would have to be totally rebuilt since there are so many dependencies between systems.

Some of the outcomes of the platform that the team measured were things like user satisfaction for the customers and end users. Mandatory changes to the system were also tracked. These are changes that the customer was forced to buy and could eat up to 50% of the year's capabilities. This was something that there was no incentive for those working on the system to make work efficiently and the end user wasn't taken into account or given a voice. Finally in 2010 it became more widely understood that more contact was needed with the end user so physicians that were also part time IT development were hired, as well as nurses. They worked on medical device legislation and had to do checks on the system while it was being developed.

Issues that customers usually faced was that the system was too complex, and buttons/information was hard to find. Users did not know how to carry out certain tasks and would get frustrated. The systems were also usually created for the Finnish market only. The

systems were generally small, and one size does not fit all since trying to optimize to group would result in other groups suffering. There were little resources and one size that ultimately fit no one. Many decisions were made by developers and this wasn't helpful for actual users: clinicians. For systems with structured data entry like most of the systems in the US, the issue was that everything was more confined resulting in more safeguards. In regard to unstructured data entry (free text), like most systems in Finland, the issue is that information is hard to find after it is saved and if something gets misspelled it is usually not caught. The benefit to this though that the information and data entered has some context as anything can be written.

The reason why many of the users were against helping with system improvements and optimizations was that they couldn't see the end result of the improvements, they just saw that they had to do extra work which they were not fond of.

In summary, the reasons for the current state of usability with product B:

- Started with digitizing paper record, there was no "next steps" plan on what to do when that goal was reached
- Large systems with lots of internal dependencies make development slow
- Customers are IT departments, not end users. Needs are different.
- Mandatory changes (legislation, HILMO, Kanta) and customers who want them done cheaply
- "We are the experts" thinking of old timers
- It brings in more money to develop new features, than improving existing ones
- Most systems are more clerical than clinical. They exist to make sure clinical workers record everything required.

### 4.1.3 Interview 3 Product C:

To do all of the work that is expected of a physician it would take 21.7 hours a day of work, including chronic and preventative care for about 2,500 patients. This is the basis that company C originally wanted to start doing targeted analytics on EMR software. The company wanted to measure the amount of active time clinicians spent in the EMR as this was a logical way to break it down and be able to directly compare clinician performance in relation to the EMR software.

The original use was to focus on system performance and CPU to see time spent in EMR between function calls. This led to comparing active vs. passive time spent in the EMR based on created activity ratios for clicks, keystrokes, and mouse miles. Time in the EMR was eventually measured per patient by taking the active time in EMR and dividing it by the number of patients seen as determined by the number of notes written. Normalizing by the number of patients seen allows us to get a direct comparison. To create meaningful comparisons between users an adjusted time in EMR or projection is needed. This is done by looking at how much work the physician is doing themselves in the EMR and their efficiency. Adoption is how much of the work they are doing in the EMR. Are they writing their own notes and orders? Divide by specialty and facility to look for users that need help.

Chart review, documentation, and orders are what take up the most of the physicians' time. Clicking through too many different places in order to complete a function. This usually has to do with training in regard to being able to find what the clinician needs. Some solutions include customizing your views based on what the clinician uses the most so it's easy to get to quickly. Unless every clinician was having an issue with a certain view then this would be considered a technical or design issue. Workflow end pages (modernization of tools) that clients aren't using a lot of the time which would save bouncing around the chart and looking for things. and someone in IT made them view (candid tools) and didn't spend enough time in discovery mode. Customization can also lead to waste and variance if it's not used correctly. Finding groups of specialties, users, or facilities that are struggling. The more time that the provider is spending in the EMR the less time they are spending with the patient.

Figure 6. How we measure active time in EMR

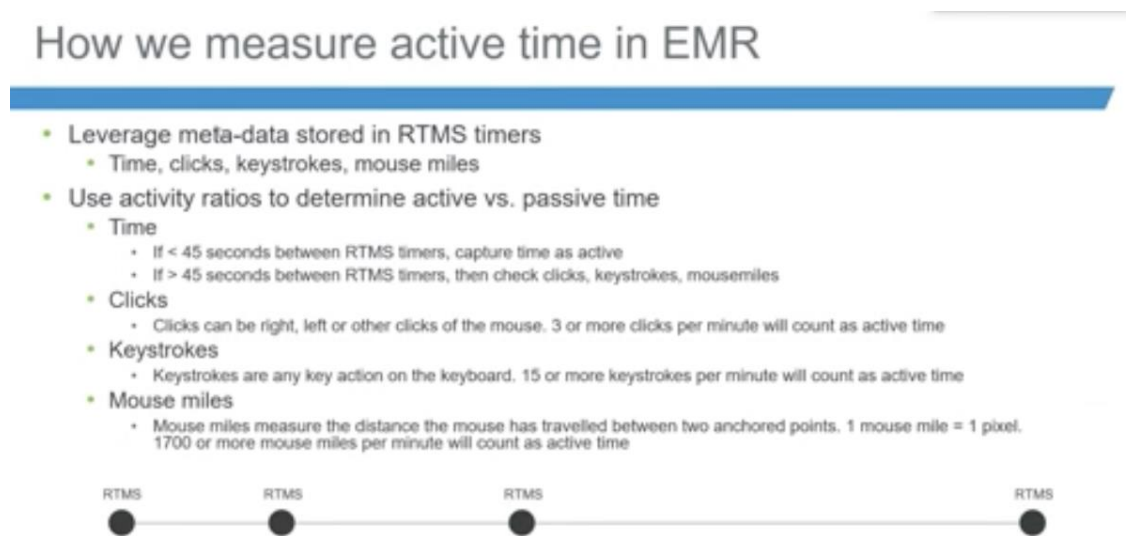


Figure 6. Company C user activity metrics without user monitoring technology.

#### 4.1.4 Interview 4 Product D:

Interviewee D works as a chief standardization officer who works on employing and deploying new standards. Company D works with about 20 EMR systems. One of the largest systems in use is from the early 90's and the technology is from that time as well. Many modules are still not updated from that time. Aiming to go from silos to a more common platform that is more easily accessible and interoperable.

The EMR systems at company D seem to be old fashioned and a bit behind. Some of the major reported issues that have come from using the EMR systems include number of clicks needed to get from point A to B, system is not "smart enough", ability to find information, having to transcribe information (not being able to copy and paste), the system not saving inputted data, hard coded language barriers and incorrect translations (causes repetitive questions directed towards patients), UI layout, and interoperability issues. One of the largest most pressing problems seems to be that the information is in silos and they are unable to see



everything as a whole, which makes it hard for the systems to work together and share information.

Some parts of the systems are hard coded with language barriers that have source code that can't be changed. The functionalities are dependent on the deepest back end of the system and have layers applied on top of each other (try to have as few between UI and database as possible). The system seems to also have no consistency, for example, as something will mean "yes" when highlighted in yellow on one page but on a different page grey highlighting will mean "yes". Many employees are only trained on their small portion of the system which means everyone in the company is doing things in their own way. Cultural differences seemed to be a big issue as Swedish software varies from software in the US.

An image and functionality registry is something that has helped company D to create a common universal system to look into everything and the modules from different vendors. All data is stored in the common platform that was created out of international standards. What could also be potentially helpful is being able to customize their own personalized toolbox and getting the right information at the right time. Interviewee D also suggested a functionality of pre-population for different fields, which would reduce repetition of information being asked of the patient. As the patient travels from unit to unit the system does not save key information and users are forced to ask for the same information over and over again. Since the modules were developed by different teams initially, they haven't developed a way for them to run as a common process.

When it comes to implementation processes, a lot of pre-procurement work should have been done but was delayed until starting which wasn't very efficient. They use a process model from Contsys standard which is a framework for defining inner processes. Terminology should be common, and a lot of manual interpretation is done as patients go from one care unit to another. Having training based on the information and structure of the system is

helpful so that there is one common understanding for everyone. After training, having employees start working with the system almost immediately to gain practical understanding.

Some usability studies have been done where cameras read eye movements and where the eye focuses when reading cases. Although this is more focused on the medical part. Had no time and effort to put into usability but was interested in an efficient way of improving usability and catching unnecessary errors.

#### 4.1.5 Interview Confidentiality Form:

The form below was given to and signed by all interviewees to ensure confidentiality and protection of privacy.

##### **Interview Confidentiality Form**

Study Title: Graduate Thesis – Market Research

It is our goal and responsibility to use the information that you have shared responsibly. Now that you have completed the interview, we would like to give you the opportunity to provide us with additional feedback on how you prefer to have your data handled. Please check one of the following statements:

You may share the information just as I provided it. No details need to be changed and you may use my real name when using my data in publications or presentations.

You may share the information just as I provided it; however, please do not use my real name. I realize that others might identify me based on the data, even though my name will not be used.

You may share the information I provided; however, please do not use my real name and please change details that might make me identifiable to others. In particular, it is my wish that the following specific pieces of my data not be shared without first altering the data so as to make me unidentifiable (describe this data in the space below): \_\_\_\_\_

You may contact me if you have any questions about sharing my data with others. The best way to reach me is (provide phone number or email):

\_\_\_\_\_

Respondent's signature \_\_\_\_\_ Date \_\_\_\_\_  
Investigator's signature \_\_\_\_\_ Date \_\_\_\_\_

## 4.2 Survey

This thesis researches topics like buyer personas and customer conversion, with that being said, a survey was conducted which was sent out to all users that have signed up for a free trial of this product. Giving the company a better understanding on what motivates the consumers to sign up for a trial in the first place, what their company does, and if our product was useful to them (or if it's not useful). This allows analysis of data and results to better profile and target customers in the future for sales and marketing teams performing lead generation and developing marketing campaigns. Today data and knowledge is power when it comes to increasing revenues and improving customer retention.

Figure 7. Survey

Hello, this is a survey created by Melissa Welander, Business Development Representative at Adusso Ltd. The purpose of this survey is to conduct market research for a final Master's Thesis. Thanks!

Did you use the free trial? If yes, how many times? \*

Yes, 1 time.

Yes, 2-5 times.

Yes, <6 times.

No

If no, why not?

Why did you sign up for a free trial of our UX2play product? What were you hoping to get out of the trial?

\*

How useful was the trial?

0

1

2

3

4

5

6

7

8

9

10

No use

Extremely useful

What made the trial useful?

Did you or someone else within your organization end up purchasing the product?

\*

Yes

No

What is your role/position at your organization? \*

Submit

Figure 7. A survey was constructed to get an idea of the types of personas that are signing up for free trials of Adusso's product, UX2play and whether they found the trial useful. We wanted to know why they signed up and what about the product was useful to their specific business processes.

## 5 Analysis and Findings

When looking into the findings and results of the four semi-structured interviews, we can draw some valuable conclusions. All four interviewees were from companies that are EMR vendors. Interview A and B both pertained to legacy EMR systems, while C and D were not. Interview D was the only interview that broadly spoke about around 20 different systems in general as well as about some legacy systems. The way that EMR's function is broadly largely based on the vendor that is producing the system and therefore we can see some variance. All four interviews were conducted over Zoom and were therefore virtual meetings. All four interviewees have also had years of experience in the healthcare field, making them all reliable sources.

We can learn a lot from analyzing the responses from these interviews as they all have some similarities and some differences. Interviewee A and B were both Finnish and located in Finland, while interviewee C was American and located in the US, and D was Swedish and located in Sweden. Company A, B, and D have all done some form of usability (A and B more than D), while C has not, showing that they all had individualized approaches to improving these systems. The EMR systems that interviewees A and B responded about were both built on legacy systems which caused layering new modules and solutions on top of old software. This was done due to the fact that it was cheaper to build on top of the old than start over fresh. This resulted in fragile systems that were difficult to fix later on as there were a multitude of co-dependencies which would easily break if one part elsewhere was fixed or changed. Interviewee D also noted that the functionalities of some of the older systems that they worked with were dependent on the deepest parts of the back end of the system and that there were many layers between the UI and the database. Although not directly mentioned, we can conclude that they most likely share some of the same issues as A and B do.

A difference that I noticed between companies A and D was in relation to the customizability and ability to see the big picture as a whole. Company A had customizable features allowing for more visibility of the EMR UI, while company D seemed to have the issue of too many

data silos and the inability to see the big picture of the patient data and chart as a whole. I also noticed that the interviewees from companies B and D both complained about cultural differences specifically with their country (Finland and Sweden) and the United States. It seems that some parts of the systems were hard coded initially for use in the US, but when the users tried to use the systems in European countries they did not function as they would have liked them to. For company B, the data was meant for structured entry, resulting in more safeguards and confinement making it difficult to enter exactly what was necessary. In regard to company D, the issue mainly had to do with incorrect translations and hard coded language barriers in the source code that could not be changed.

Company C had the most different approach of all four companies interviewed as they focused mainly on time spent in the EMR and improving usability from the front end rather than the back end. When focusing on front end, the general focus is on how the clinicians are spending time in the EMR and how that can be improved, as well as reducing the amount of “pajama coding”, or coding after work hours. This is great for reducing physician burnouts, helping physicians allocate time correctly, improving workflows, and spending less time on unnecessary views in the system. Company C was able to capture the concept of practice design, which is defined as the way that healthcare team members are assigned, how patient care is delivered, and how care pace is used. The data that is extracted from the EMR can show the amount of time spent on specific activities by the physicians and directly assess practice design. [28] Companies A, B, and D all focused more on the back end of things which gets more into usability of systems and the developer side.

One complaint that all four interviewees had in common was that the number of clicks and therefore time spent clicking through the EMR was too high. Companies A, B, and D all shared in common the fact that they had issues with the UI layout. The UI was either too complex or the writing was too small. Some other issues that were presented, mainly from companies B and D, were that decisions were too often made by developers who did not see the viewpoint of the end users or the clinicians, and the interoperability of the data.

Interviewee from company B was the only one who mentioned successful implementation

utilizing customer interviews to figure out base needs as well as shadowing their work to figure out what tasks were repetitive etc. to improve optimization. Interviewee D also mentioned wanting to be able to copy and paste information as transcribing it is repetitive and a pain. Tutty et al. mentions though that “note bloat” has become an issue in the past years due to utilizing the copy and paste function [28]. This is causing increased errors as it makes it more difficult to find key information in clinical documents.

As a whole, all four vendors could benefit from proper training of its employees especially when it comes to go-live and implementation. We know that the, “Factors that can negatively impact implementation include lack of engagement across stakeholders, overly cautious or misinformed compliance departments, inadequate allocation of IT resources pre- and post implementation, poor system design and functionality decisions, intensity and delivery of training, inadequate staffing levels, and inattention to workflow redesign necessary to effectively integrate new technology.” [28] Systems should not be updated and built on top of old layers of solutions. Improving things like complexity of the UI and customization/personalization of different views would be beneficial. This would allow physicians and clinicians to find what they need quickly so that they can work efficiently.

Asking physicians and clinicians directly for their feedback and input of the systems would be helpful as they are the end user and the ones ultimately working with the product on a daily basis rather than developers. As Tutty et al. states, “Additionally, it is not uncommon for there to be no clinician or physician participation in the usability testing of vendor products. Many EHR products were designed with billing, payer requirements, and meaningful use criteria in mind, rather than clinician use, resulting in a user experience laden with data entry that causes decreased productivity and efficiency, and a diminished patient-physician relationship.” [28] Regular usability testing would be helpful and creating systems that are scalable.

Interoperability of all systems is helpful in regard to the patient care process and moving patients between different care units. As Tutty et al. also states, physicians do not always have access to patient records from other clinics or even from within their own organization, creating frustration, delays in patient care, and even patient safety risks. Often times the fear

of violating HIPAA leads to physicians taking a more conservative approach to what information they share leading to an unnecessary lack of patient data. Ranging across vendors, there is a lack of different types of interoperability: technical (data formats) and semantic (shared meaning). As a whole all vendors and users could benefit from fixing some of these issues and making health IT systems more user-centric.

Figure 8. Company Comparison Analysis

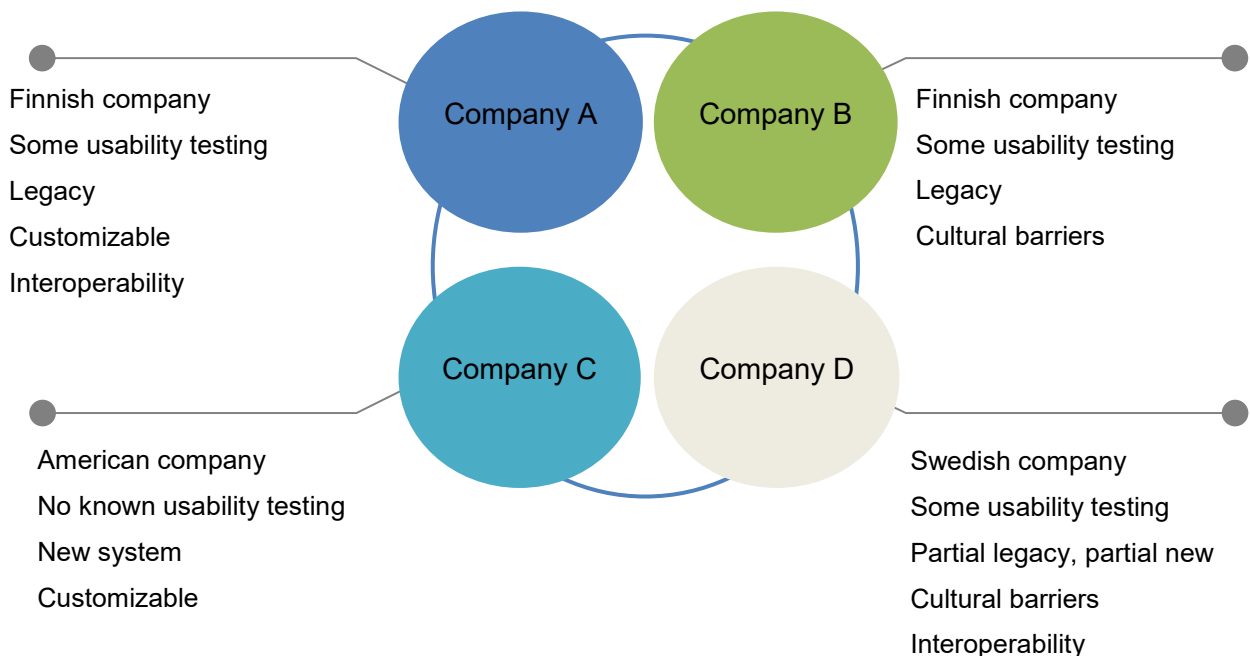


Figure 8. above shows the comparisons between all four companies and some of the relationships between them. The differences between the companies are shown as well as some of the similarities.



## 6 Conclusion

To conclude my master's thesis I would like to reflect on the most important topics that were discussed throughout this thesis. Based on my research there is clear evidence that the number of clicks and time spent going through the EMR was high (consistently 15% or more than the average Adusso's customer that deployed the UX2play user error monitoring solution) in all four companies. The healthcare system as a whole is complex and some of the IT systems are generally behind in relation to the technology in many other sectors of our economy. This is why user experience monitoring and usability research are such important concepts for the development of electronic medical records. The history of the healthcare system and many of the laws and policies involved have come to shape the way we view healthcare today and the way that many of the physicians and nurses do their daily work. Without HIPAA, meaningful use, and GDPR policies, the privacy of patient records would not hold the same type of value as they currently do. This affects the way healthcare workers share information and the interoperability between systems.

When it comes to user experience monitoring of these EMR systems though, a lot of improvements can be made with how we currently do things as a culture and society as a whole. As we saw in some of our interviews, some of the companies have and are conducting consistent usability testing, but even this is not enough. The type of testing that some of these companies are doing is few and far between and involves getting direct feedback from the end user on what is working and what is not so that the systems can be optimized and improved further. We see that these companies are gaining lots of valuable data and this is allowing them to make improvements on their systems but the usability studies should be conducted much more often and effortlessly. By generating consistent data on these systems we can continuously improve the systems as a whole. The current improvements we are seeing generally have to do with UI layout and design, clicks and time spent in the EMR, complexity of the design, and interoperability of data. When nurses and doctors can spend less time dealing with errors in the system, they can spend more time with the patient, resulting in better outcomes for the patient and improved patient safety and outcomes.

When it comes to the cloud and some of its compute models for implementation, we have seen a general rise in the number of SaaS solutions for many companies. As the amount of SaaS solutions has risen, the need for increased security and trust solutions are also important factors to keep in mind. Having a server running all of a company's data in the cloud leaves them much more vulnerable for attacks. When combining a newer technology solution like SaaS with a sector that is generally behind like healthcare, many precautions must be taken into account for this merger. Gaining customers and clientele in the SaaS industry though can generally be done through offering a free trial period of a product and targeting certain buyer personas and profiles. Looking into who signs up for the free trials allows us to easily segment which types of people are in the target market audience and the statistics we can track to gain more insight on them.

In order to continue this work further I created a survey to specifically gain insight on this market and ask customers and potential customers why they signed up for the trial and if it was helpful or not. This is something that I would like to study further as we generate a larger number of clients and more business as a company. I believe this work can always be studied further though as the usability of these systems is never fully complete and the systems can always be optimized further. The hope for EMR systems is that the more we optimize the system the better the working life of physicians and nurses will be as we decrease burnouts, reduce time spent in the EMR, improve patient safety, and make their workflows as efficient as possible.

## References

- [1] Benlian, A., Hess, T., & Buxmann, P. (2009). Drivers of SaaS-adoption—an empirical study of different application types. *Business & Information Systems Engineering*, 1(5), 357.
- [2] Butterfield, A., & Ngondi, G. E. (2016). *A dictionary of computer science*. Oxford, United Kingdom: Oxford University Press.
- [3] What is the HITECH Act. (2020, August 18). Retrieved February 26, 2021, from <https://www.hipaajournal.com/what-is-the-hitech-act/>
- [4] Wu, W. (2011). Developing an explorative model for saas adoption. *Expert Systems with Applications*, 38(12), 15057-15064.
- [5] Kaipio, J., Lääveri, T., Hyppönen, H., Vainiomäki, S., Reponen, J., Kushniruk, A., Vänskä, J. (2016). Usability problems do not heal by themselves: National survey On physicians' experiences with EHRs in Finland.
- [6] K. (2019, January 31). Significant increase in the use of kanta services - press releases. Retrieved March 30, 2021, from <https://www.kela.fi/web/en/-/significant-increase-in-the-use-of-kanta-services#:~:text=A%20total%20of%202%2C796%2C618%20individuals,over%2065%2Dyear%2Dolds.>
- [7] Kaipio, J., Kuusisto, A., Hyppönen, H., Heponiemi, T., & Lääveri, T. (2020). Physicians' and NURSES' experiences On Ehr Usability: Comparison between the professional groups by employment sector and system brand. *International Journal of Medical Informatics*, 134, 104018.

- [8] Kapitein, D. (2018, June 27). Share our DATA: GDPR and the PATIENT VIEW. Retrieved April 29, 2021, from <https://healthmanagement.org/c/hospital/post/share-our-data-gdpr-and-the-patient-view>
- [9] HealthManagement.org, S. (2019, June 18). GDPR-friendly patient data: Finland leads the way. Retrieved April 29, 2021, from <https://healthmanagement.org/c/it/news/gdpr-friendly-patient-data-finland-leads-the-way>
- [10] Bommadevara, N. (2018, April 12). Cloud adoption to accelerate IT modernization. Retrieved May 11, 2021, from <https://www.mckinsey.com/~media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/cloud%20adoption%20to%20accelerate%20it%20modernization/cloud-adoption-to-accelerate-it-modernization.pdf?shouldIndex=false>
- [11] Tyrväinen, P., & Selin, J. (2011). How to sell saas: A model for main factors of marketing and selling software-as-a-service. Lecture Notes in Business Information Processing, 2-16.
- [12] Hashizume, K., Rosado, D. G., Fernández-Medina, E., & Fernandez, E. B. (2013). An analysis of security issues for cloud computing. Journal of Internet Services and Applications, 4(1), 5.
- [13] C. (n.d.). What is public cloud - definition - citrix. Retrieved May 12, 2021, from <https://www.citrix.com/glossary/what-is-public-cloud.html>
- [14] Hurtaud, S. (2011, October). How to ensure control and security when moving to SaaS/cloud applications. Retrieved May 12, 2021, from [https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/risk/ensure-control-security-saas-cloud-applications\\_SHU.pdf](https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/risk/ensure-control-security-saas-cloud-applications_SHU.pdf)
- [15] Bonta, R. (2021, March 03). California consumer Privacy Act (CCPA). Retrieved May 13, 2021, from <https://oag.ca.gov/privacy/ccpa>

- [16] James, L. (n.d.). Stop hacks and Improve electronic data Security ACT ("shield act"). Retrieved May 13, 2021, from <https://ag.ny.gov/internet/data-breach#:~:text=The%20Shield%20Act%20significantly%20strengthens,protect%20the%20security%2C%20confidentiality%20and>
- [17] Huang, J., & Nicol, D. M. (2013). Trust mechanisms for cloud computing. *Journal of Cloud Computing: Advances, Systems and Applications*, 2(1), 9.
- [18] Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a Qualitative Research Approach. *Journal of graduate medical education*, 7(4), 669–670.
- [19] Jamshed S. (2014). Qualitative research method-interviewing and observation. *Journal of basic and clinical pharmacy*, 5(4), 87–88.
- [20] Director, K., Kierlanczyk, K., Director, & Working across both Cultural Insights and Qualitative Research. (2019, June 02). A brief history of market research. Retrieved May 19, 2021, from <https://www.keltonglobal.com/perspectives/a-brief-history-of-market-research/#:~:text=The%20first%20true%20instances%20of,order%20to%20be%20considered%20effective.>
- [21] Nyukorong, R. (2017). Conducting market research: An aid to organisational decision making. *European Scientific Journal, ESJ*, 13(10), 1.
- [22] Simpson, J. (2017, August 24). Council post: Finding your audience: The importance of developing a buyer persona. Retrieved May 19, 2021, from <https://www.forbes.com/sites/forbesagencycouncil/2017/05/16/finding-your-audience-the-importance-of-developing-a-buyer-persona/?sh=290443647341>
- [23] McDade, D. (n.d.). Why buyers buy. Retrieved May 19, 2021, from <https://www.pointclear.com/blog/why-buyers-buy>

- [24] Foote, K. (2017, June 22). A brief history of cloud computing. Retrieved May 20, 2021, from <https://www.dataversity.net/brief-history-cloud-computing/#>
- [25] Johnson CM, Johnston D, Crowley PK, et al. EHR Usability Toolkit: A Background Report on Usability and Electronic Health Records (Prepared by Westat under Contract No. HHSA 290- 2009-00023I). AHRQ Publication No. 11-0084-EF. Rockville, MD: Agency for Healthcare Research and Quality. August 2011.
- [26] Linthicum, D. (2020, May 07). 5 ways to build a Cloud-ready application architecture. Retrieved May 21, 2021, from <https://techbeacon.com/enterprise-it/5-steps-building-cloud-ready-application-architecture>
- [27] Korzeniowski, P. (2019, January 22). Five tips for easing your way into cloud application development. Retrieved May 21, 2021, from <https://techbeacon.com/enterprise-it/5-tips-ease-cloud-application-development>
- [28] Tutty, M. A., Carlsare, L. E., Lloyd, S., & Sinsky, C. A. (2019). The complex case of EHRs: Examining the factors impacting the EHR user experience. *Journal of the American Medical Informatics Association*, 26(7), 673-677.
- [29] 4,000 clicks Per SHIFT: ED Physicians' EMR Burden. (2013, October 11). Retrieved January 23, 2021, from <https://www.beckershospitalreview.com/healthcare-information-technology/4-000-clicks-per-shift-ed-physicians-emr-burden.html>
- [30] Stevens, E. (2019, July 12). The fascinating history of UX Design: A definitive timeline. Retrieved May 24, 2021, from <https://careerfoundry.com/en/blog/ux-design/the-fascinating-history-of-ux-design-a-definitive-timeline/>
- [31] Videos: Electronic Health Record (EHR) Usability Challenges. (2019, February 04). Retrieved May 24, 2021, from <https://ehrseewhatwemean.org/videos/>

- [32] Pitkänen, J., & Pitkäranta, M. (2016). Improving meaningful use and user experience of healthcare information systems towards better clinical outcomes. *Finnish Journal of EHealth and EWelfare*, 8(2-3), 98–106.
- [33] Ratwani, R. (n.d.). Raj Ratwani, PhD. Retrieved June 04, 2021, from <https://www.medstarhealth.org/mhri/about-us/mhri-leadership/senior-leadership/raj-ratwani-phd/>
- [34] Chief, E. in. (2019, December 5). 8 Advantages and Disadvantages of Phenomenological Research. ConnectUS. <https://connectusfund.org/8-advantages-and-disadvantages-of-phenomenological-research>.
- [35] Noble, H., & Mitchell, G. (2016, April 1). What is grounded theory? Evidence-Based Nursing. <https://ebn.bmj.com/content/19/2/34>.
- [36] Reeson, Michael. (2020). Phenomenological research in health professions education: Methods, data collection and analysis. *Ann Dent Oral Health*. 2020; 3(1): 1013.
- [37] Liong, Anne. (2008). Descriptions of Nurses' Experiences with Electronic Health Records (EHR): A Phenomenological Study. *Research gate*. 2008; 5(2): 9901.
- [38] Guerrero-Castañeda RF, Menezes TMO, Ojeda-Vargas MG. Characteristics of the phenomenological interview in nursing research. *Rev Gaúcha Enferm*. 2017;38(2):e67458.