

Aalto University
School of Science
Degree Programme in Information Networks

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Including usability in the procurement process of healthcare IT systems

Master's Thesis
Espoo, August 8, 2014

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Title of thesis Including usability in the procurement process of healthcare IT systems		
Degree programme Information Networks		
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Department Department of Computer Science and Engineering		
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Date 08.08.2014	Number of pages 75	Language English

Abstract

Poor usability of healthcare IT systems not only lowers their adoption rate, but can have even more severe consequences; it can affect the safety of patients and put their lives at risk. To increase the adoption rate and the safety of the systems, confidence on the systems usability should be acquired even before the system is implemented, during the procurement. However, thus far there has not yet been a body of extensive scientific literature addressing the topic.

The research goals of this thesis are to 1) map out how usability can be included in the procurement processes of healthcare IT systems and 2) compile best practices into practical framework for procuring usable healthcare IT systems. To meet these goals two approaches were applied literature review and interviews from recent procurements of healthcare IT systems. In the first phase of the study a scoping review was conducted and a preliminary framework was created based on the literature review to identify how the framework model was relating to the current procurement process, in the second phase of the study it was used as a bases for interviews of three cases of recent healthcare IT system procurement projects. The framework was then updated based on the results from the interviews of the three cases, and the refined framework is presented as a conclusion.

The framework consists of five phases of procurement and what usability activities should be carried out in each phase. The five phases of procurement are defining strategic goals, creating the requirements, system evaluation, system selection and implementation and training. Especially the need for of creating verifiable and comprehensive usability requirements in the requirement creation phase and testing the usability of the systems in the system evaluation phase with high-fidelity usability testing that includes actual users performing realistic tasks in a realistic context was highlighted.

Keywords Usability, healthcare IT systems, procurement, commercial off-the-self system, request for proposals, usability requirements, usability evaluation, electronic health record (EHR)

Tekijä Inkeri Saiku		
Työn nimi Käytettävyyden sisällyttäminen terveydenhuollon tietojärjestelmien hankintaprosessiin		
Koulutusohjelma Informaatiiverkostot		
Valvoja Marko Nieminen TkT	Professuurikoodi T-121	
Laitos Tietotekniikanlaitos		
Työn ohjaaja(t) Johanna Kaipio TkT		
Päivämäärä 08.08.2014	Sivumäärä 75	Kieli Englanti

Tiivistelmä

Terveydenhuollon tietojärjestelmien puutteellisella käytettävyydellä voi olla vakavia seuraamuksia: se vähentää järjestelmän käyttöönottoastetta, vie terveydenhuollon ammattilaisten huomion pois hoitotyöstä ja pahimmillaan jopa asettaa potilaiden turvallisuuden vaaraan. Käyttöönottoasteen ja järjestelmien turvallisuuden parantamiseksi tulisi järjestelmän käytettävyydestä varmistua jo ennen tuotteen käyttöönottoa, hankinnan aikana. Käytettävyyden sisällyttämistä terveydenhuollon tietojärjestelmien hankintaprosessiin ei ole kuitenkaan aiemmin laajalti tutkittu.

Tämän tutkimuksen tarkoituksena on 1) kartoittaa, miten käytettävyys voidaan ottaa osaksi terveydenhuollon tietojärjestelmien hankintaprosessia sekä 2) koota käytännön viitekehys käytettävien terveydenhuollonjärjestelmien hankintaan. Tutkimusmenetelminä käytettiin kirjallisuuskatsausta sekä haastatteluja viimeaikaisista terveydenhuollon tietojärjestelmien hankintaprosesseista. Kirjallisuuskatsauksen perusteella luotiin ensin alustava viitekehys. Alustavan viitekehysten pohjalta suoritettiin haastatteluja kolmesta viimeaikaisesta terveydenhuollon tietojärjestelmä-hankintaprosessista. Haastattelujen perusteella viitekehystä kehiteltiin edelleen ja paranneltu viitekehys esitetään tämän työn tuloksena.

Viitekehys koostuu viidestä hankinnan vaiheesta, sekä kuhunkin vaiheeseen liittyvistä käytettävyysohjeista. Nämä viisi vaihetta ovat: Strategisten tavoitteiden asettaminen, vaatimusmäärittely, järjestelmien arviointi, järjestelmän valinta sekä käyttöönotto ja koulutus. Erityisesti korostetaan todennettavien käytettävyysohjeiden asettamista vaatimusmäärittelyvaiheessa sekä järjestelmien arviointivaiheessa perusteellisen käytettävyydestäuksen suorittamista todellisten käyttäjien kanssa mahdollisimman todenmukaisia työtehtäviä ja mahdollisimman realistista kontekstia käyttäen.

Avainsanat Käytettävyys, terveydenhuollon tietojärjestelmät, hankinta, valmisjärjestelmät, tarjouspyyntö, käytettävyysohjeet, käytettävyyden arviointi, sähköinen potilastietojärjestelmä

Acknowledgements

Firstly I would like thank professor Andre Kushniruk for welcoming me in University of Victoria and for all the help and guidance with my thesis.

Coming to Victoria was a wonderful opportunity for me, and I truly appreciate all the time and attention I was given. I would also like to thank professor Elizabeth Borycki and Helen Monkman from University of Victoria, without you my stay in Victoria would not have as amazing as it was.

I would like to express my gratitude to my instructor, Johanna Kaipio D.Sc., for all the help and advise throughout the whole project, it made the process so much easier. I would also like to give thanks my supervisor professor Marko Nieminen for introducing me first of all to this topic, I could not have hoped for a more interesting subject for a thesis, and to the people who I could not have done this thesis without.

I would like to thank Annika Berg for all the encouragement, support and help a friend could ever wish for.

Finally for my husband, Daniel, thank you for all the love and support; you are my inspiration.

Espoo, June 10, 2014

Inkeri Saiku

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Glossary

Champion – Champion or sometimes Change Agent is a member of an organization that operates as a key actor in an organizational change. Changing an IT system can lead to a big organizational changes such as change of procedures and policies. In a procurement process the champions can also be seen as “power users”, as they have the expertise of users but are also getting training in user interfaces and choosing an IT system.

Clinical simulation – Clinical simulation means testing laboratory that aims to create premises for testing as close to the real clinical environment as possible. Clinical simulations have been used in training, but are increasingly used for testing of healthcare systems and equipment to find out detect usability and patient safety hazards that might otherwise go undetected.

Commercial Off-the-self system – Commercial off-the-self system is a ready made system purchased from a 3rd party. In governmental purchases this is alternative to the in-house development or funding a one-off system development. Usually off-the-self systems still require configurations done to the system so that it can be tailored to the specific context and use.

Healthcare IT system – Healthcare IT systems software systems used to collect and analyze health information about an individual patient or population. These include for example Electronic Health record (EHR) systems and other patient data systems.

Negotiation method – A method for public procurement where the final Request for Proposal (RFP) is created in dialogue with the vendors. The final RFP is only published at the end of the procurement process.

System Usability Scale – System Usability Scale (SUS) is a ten-item questionnaire that uses the Likert scale and is used for assessing users subjective assessment of systems usability.

Snowball Sampling – Snowball sampling is a method for gathering study subjects where existing study subjects recruit future study subjects.

Public Purchasing Process (PPP) – Public purchasing act is a procurement process of a public entity, and therefore is under stricter legislation. In addition to national regulations, countries part of the European Union must also comply to the EU wide rules. The principals of public purchasing are that the process has to be transparent and suppliers are to be treated uniformly and equally.

Usability Activities – In the context of this work usability activities refer to any kind of considerations for usability in the process of the procurement project. In addition to concrete usability evaluation, this includes also activities such as setting usability as a strategic goal.

1. Introduction

Healthcare information technology systems have the potential to not only save time and money for healthcare providers but also to save lives.

However, these benefits can only be realized if the systems are fully adopted and appropriately used in the healthcare organizations that purchase them.

Thus far, the adoption of healthcare IT systems has not been without problems, and even if these systems are implemented in healthcare organizations, healthcare practitioners have often been reluctant to use them. One of the main reasons reported for this reluctance has been the poor usability of IT systems (Schumacher et al. 2009). Instead of saving time and money the practitioners feel that they are wasting their time struggling with hard to use systems: According to a questionnaire study the physicians perceived that the use of healthcare IT systems takes time away and even disturbs direct patient contact and shifts away their attention from the patient and her care (Viitanen et al., 2011).

Poor usability can have even more severe consequences; it can affect the safety of patients and put their lives at risk. For example Han et al. (2005) reported that the mortality rate in a pediatric unit rose significantly after implementation of a commercially available healthcare IT system.

Furthermore, Kushniruk et al. (2005) were able to show that specific usability problems are highly related to the occurrence of technology-induced errors in healthcare IT, with severe problems being associated with the likelihood of errors in entering medications into an IT system.

To improve both the adoption and the safety of the systems, it is important to ensure the usability of healthcare IT systems. There have been previous studies where usability measurements have been applied in the evaluation of healthcare IT, however these studies have usually been conducted after the system has been implemented. At this point in the system development life cycle it is usually hard and expensive to make any major modifications to the system or significantly change it, even if usability has been identified as

a significant problem. That is why usability should be considered early on, even as early as when the IT system to be chosen is being selected during the different phases of the procurement process. Currently the procurement process does not typically include in-depth consideration of usability, despite its critical importance in user adoption and uptake (Jokela, 2010; Schumacher et al., 2009). One of the reasons why this might be is that the procurers simply aren't aware of the importance of usability considerations or don't know how usability should be taken in account in the procurement process. Thus far there has not yet been a body of extensive scientific literature addressing the topic, but the same concerns regarding inadequate usability of healthcare IT systems are beginning to be shared around the world. For example, recent efforts towards improving the procurement process of healthcare IT by deploying usability methods can be found in Denmark, Canada, and France (Jensen et al., 2013, Kushniruk et al., 2010 & Beuscart-Zéphir et al., 2005) and most recently in Finland (Apotti, 2013).

The complexity of this topic is highlighted by that fact that it is actually in the intersection of three fields of study: usability, healthcare informatics and procurement studies. The author of this paper has a background in the field of human-computer interaction and usability, and thus is the point of view for this study. Usability means, as defined in the ISO 9241-11 (1998) standard, "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context of use". There is a great deal of established methods for evaluating usability, which can be roughly divided in two groups: *User testing* with users, such as usability test, where users actually using the product or system, and *usability inspections*, where a usability expert reviews the product or system. (Riihiäho, 2000) In addition to usability evaluation, usability can be included in a procurement process in other ways, such as setting usability as a strategic goal; these considerations are addressed in this work as *usability activities*. Since both the healthcare context and the procurement process create special demands and constrains

on the usability activities and how and what can be implemented, therefore special considerations on planning the activities need to be taken, as is discussed in this work.

Healthcare organizations provide a unique and interesting context for the usability considerations. As mentioned before in the past there has been a lot of problems with the usability of the healthcare IT systems, but on the other hand, the importance of usability and safety in this context are extremely important since lives are at stake.

The procurement process also creates challenges to the inclusion of usability activities. The means of procurement and the legislation change from country to country, however the markets of healthcare IT systems are partly global. In many countries the healthcare is public service, which means that the procurement has to comply with the legislation of public procurements, which adds extra demands for the procurement process. The procurement of healthcare IT systems is seen as demanding also by the healthcare organizations and that is why the *negotiation method* of procurement, which allows the requirements to be specified and redefined during the procurement process and can be discussed with the prospective suppliers, is often used. In the negotiation method of procurement the Request for Proposal (RFP) is released only at the very end of the procurement, compared to the standard form of procurement where the RFP is released in the beginning of the procurement.

Research goals

The research goals of this thesis are to 1) map out how usability can be included in the procurement processes of healthcare IT systems and 2) create a practical framework for procuring usable healthcare IT systems. In the context of this thesis healthcare IT systems are defined as software systems used to collect and analyze information about an individual patient or population such as electronic health record (EHR) systems and other patient data systems and platforms, and as such are a subset of healthcare

information technology (HIT). This definition excludes healthcare equipment and devices (e.g. infusion pumps or carts) or hardware. The scope of this study is the procurement processes of commercial off-the-shelf systems; procurement processes of new systems being developed with the customer are excluded.

To reach the research goals two approaches were applied. In the first phase of the study a scoping review on literature was conducted and a preliminary framework was created based on the literature review. To identify how the framework model was relating to the current procurement process, in the second phase of the study it was used as a bases for interviews of three cases of recent healthcare IT system procurement projects. The framework was then updated based on the results from the interviews of the three cases, and the refined framework is presented as a conclusion.

2. Literature review

In this chapter, work is described in conducting a review of the literature. The objective is to create a comprehensive view on how the topic of including usability considerations to the procurement processes of healthcare IT systems has been discussed to date, and what kind of suggestions for including usability to the procurement process have been made.

2.1. Methods

A scoping review, as described by Arksey and O'Malley (2005) and Levac and colleagues (2010), was conducted focusing on usability in the procurement of healthcare IT systems. Five databases were used in the review; ACM, PubMed, Science Direct and Springer Link and Google Scholar using the search words "usability" AND "procurement" AND "healthcare". The number of articles returned from the search in each database is presented in Table 1.

Table 1: Used databases and the number of articles with the search.

Database	Number of results with the search
ACM	72
PubMed	5
Science Direct	139
SpringerLink	136
Google Scholar	3570

For ACM, PubMed, Science Direct and Springer Link, the author reviewed titles and abstracts of all the articles returned from the search. For Google Scholar, only the first few hundred hits were relevant to the study (with no further relevant articles retrieved after that point); thus only the first 700 articles returned were considered for further review. The selection criteria for selecting an article for inclusion was that the article should address assessing usability and usability measures of a healthcare IT system during the procurement process (i.e. before purchase and implementation), and be written in English. The articles describing usability measures of non-IT healthcare equipment and devices (e.g. infusion pumps or carts) were excluded. If there was more than one published paper from the same research group containing the same results and conclusions, only the most extensive one was included. From the reviewed articles 7 met all the inclusion and exclusion criteria, and thus were selected for detailed review. The articles are summarized in Table 2.

Table 2: Summary of articles

Authors, year of publication	Part of the procurement process addressed	Usability methods used
Jokela, 2010	Request for Proposal	Task completion success rate and design solution success rate.
Schumacher, Webb & Johnson, 2009	Request for Proposal, Preliminary assessment of the technology and short-list evaluation	Interviews, observation, usability walkthrough, heuristic evaluation, Usability testing with scenarios
Carvalho, Borycki & Kushniruk, 2009	Preliminary assessment of the technology	Heuristic evaluation
Hertzum & Simonsen, 2004	Request for Proposal, Contracting	Performance evaluation
Kushniruk, Nohr, Jensen, & Borycki, 2013	Short-list evaluation	Usability testing with scenarios
Kushniruk, Beuscart-Zéphir, Grzes, Borycki, Watbled & Kannry, 2010	Short-list evaluation	Usability testing with scenarios, observing, heuristic evaluation
Chagpar, Cafazzo & Easty, 2006	Short-list evaluation (Request for Proposal)	Usability testing with scenarios (workflow analysis)

2.2. Results

Review of the papers suggests that usability considerations are important in the following three phases of the procurement process of off-the-self healthcare IT systems: Firstly when creating the requirements for Request for Proposal (RFP), secondly when evaluating proposals to create a shortlist of candidates, and finally when thoroughly evaluating the short list candidates (Table 2). Most of the papers focused either on the RFP or the shortlist evaluation, whereas only Schumacher et al. (2009) discussed usability considerations throughout the whole procurement process. Those two phases, RFP and the shortlist evaluation, were highlighted by authors as the most important phases where the usability measures should take place, in particular, usability requirements need to be specified in the requirements of the RFP, because otherwise it will most probably not be included in the offers. On the other hand, including usability requirements only guarantee usability to the extent that they can be validated; therefore the better the usability evaluation of the shortlisted candidates the more confident the procurers can be that they have chosen the system with best usability. In following discussion, the articles that resulted from the literature review are divided up and analyzed based on the part of the procurement process they address.

Request for Proposals

Currently, Requests for Proposals (RFPs) do not include sufficient usability requirements. Along these lines, according to Schumacher et al. (2009) two out of three RFPs for electronic health record (EHR) systems that they examined did not include any criteria for usability whatsoever.

Furthermore, for RFPs that did have some usability requirements specified they were usually only superficial. Jokela (2010) also reports similar results from Finland, where none of the reviewed public call-for-tenders for

software systems included proper usability requirements that would have been verifiable, valid and comprehensive.

So what should be included in the Request for Proposals (RFPs) to advocate good usability? Both Schumacher et al. (2009) and Jokela (2010) use the ISO 9241-11 (1998) definition as a starting point to creating usability requirements: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specific context of use". That is to say that the user, tasks and context should be defined and goals for effectiveness, efficiency and satisfaction created. But how this is exactly done in practice is not always evident, and especially defining the user tasks seems to be difficult and troublesome for the procurers of systems.

Schumacher et al. (2009) identify that the characterization of user groups, contexts and tasks can be based on experience, interviews with experts or direct observations. In Jokela's (2010) case study this characterization was done based on interviews with key stakeholders, managers and initiators for defining strategic usability targets and through the expertise of the requirement team (consisting of a requirements analyst, two healthcare professionals and a usability consultant). Jokela mentions that observation was not included in the process due to resource limitations and the knowledge and experience of the task that the healthcare professionals of the team already had. Chagpar et al. (2006) briefly mention that in their work the requirements in the RFP were elicited from workflow analyses and recommendations of a working group that consisted of representatives from user groups.

As mentioned above, task elicitation seems to be one of the hardest parts of the definition phase for usability requirements. Schumacher et al. suggest that even if a large number of tasks are identified for testing, only a subset of tasks should be used: the most frequent tasks and the most critical tasks. In Jokela's case study they found it unnecessary to categorize tasks according to criticality, since there were no identified tasks where user failure would be acceptable. Schumacher et al. (2009) state that it is not necessary to

specify numerical goals for the tasks in the RFP (even though they do argue that this must be done at some point, even if not included in RFP), while Jokela (2010) argues that including verifiable (numerical) performance requirements in the RFP is of uttermost importance in order to achieve good usability. This difference is most likely due to the fact in Finland, where Jokela's study was conducted, healthcare facilities are predominantly public and therefore are under heavy procurement legislation from both the state and EU. To ensure transparency and fairness, public entities are required to choose the IT system solely by the requirement defined in the RFP. On the other hand in the United States, where Schumacher et al. conducted their study, healthcare is mostly privatized so the healthcare providers can apply more of their own considerations when choosing a system, even if everything is not specified in the RFP.

Regardless of whether numerical goals are included in the RFP or used in the later part of the procurement process, they need to be created, however, the best way to do this has not been solved. According to Schumacher et al. (2009) numerical goals for assessing usability can be found using methods such as the following: observation, interviews, expert analysis, and in addition from business objectives such as required return on investment, ROI. Observation can be used to determine the current user performance (and naturally the goal would be to lead to improvements from the current performance). Experts can for example use human performance modeling techniques for creating the requirements, and the business objectives can be used for example to address questions such as: "How good do these numbers would have to be to create a desired ROI?" Schumacher and colleagues point out that for each task targets for effectiveness, efficiency and satisfaction (as in the ISO definition) should be created, but the authors don't go deeper into how a concrete goal is created.

Jokela (2010) also tried to find numerical goals for effectiveness, efficiency and satisfaction, but didn't find the creation of these numerical targets for usability that self-explanatory. For effectiveness, a measure could consist of the percentage of users that can successfully complete a task, creating a

target is likely the easiest to define. Along these lines, Schumacher et al. (2009) simply set the target at 100% - where all of the patients should be able to complete the task successfully. However in Jokela's case where the requirements are obligatory for the vendor's product to achieve in order to be able to qualify in the tendering, 100% percent might be impossible to achieve in a user test even with an excellent product. In addition Jokela argues that in theory when stating that for example 90% of users can complete the task as goal, to confirm that would require testing a large population. In the end Jokela concludes that to measure the task completion success rate in statistical form the following format is needed: e.g. "95% confidence that 75% of target population completes the task correctly". Even though 75% might seem like a low percentage, it is statistically quite a high score, e.g. with 20 users only one can fail to complete the task. On the other hand, for measuring efficiency and satisfaction Jokela did not find any appropriate direct verifiable targets, due to a lack of benchmarks. For efficiency, this is usually measured by the amount of time required to complete the task, benchmarking could have been required by observing the use of current system, but as stated before this was not possible in Jokela's case study due to financial constraints. The author also considered including guidelines like "necessary steps should be included, and unnecessary steps should be avoided" from the ISO 9241-11 standard (1998), but rejected them in the end since the verification would be solely based on expert reviews, and thus could create problems regarding objectivity that is required from public procurements. For satisfaction, that is subjective evaluation of the users, Jokela also found problems in defining the target values, for the same reasons as with the efficiency. Schumacher et al. did not find this as much as a problem and simply stated: "If there is no current benchmark for satisfaction, a common goal for average satisfaction rating is 4 on a 5 point scale, or 5.6 on a 7 point scale, which is 80% of the scale maximum". To deal with the lack of targets for efficiency and satisfaction, Jokela created an indirect measurement instead, where the design solution success rate is measured by the percentage of users that

have problems with the design. They propose that time spent recovering from errors would affect efficiency and frustration from errors would affect user satisfaction.

Summary

In conclusion, it is clear that Request for Proposals (RFPs) currently do not typically include usability requirements at an appropriate level of detail, as it has been argued that there should be clear numerical targets for set goals regarding usability. However the procurers of healthcare IT systems usually find setting these numerical goals as being troublesome and difficult to do and there currently is no industry standard method for creating them. One possible approach for assessing where target values could be generated from is by observing the use of the current system and setting the goals to improve on those values. Observation is quite an expensive method especially in so early a phase, so expert analysis could also be used. Creating industry standards for setting efficiency and satisfaction levels would make this method more reliable and analogue.

The importance of the RFP is especially highlighted in the procurement process of public healthcare providers, since the healthcare provider is legally bound to choose the product that best corresponds to the requirements in the RFP. In this context it is even more important that the requirements are objectively verifiable, since requirements that are verifiable only by expert review (e.g. guidelines such as ISO 9241-11) could possibly lead to problems regarding agreeing on the results.

Preliminary assessment

After the request for proposals are sent and the vendor's proposals are received, there is usually one more round of cuts before creating a shortlist of solutions for the final evaluation. Usability methods might not always be needed in this phase, as it might be the case that there are only a few vendors competing, or that only few of the candidate systems actually fulfill the must-have requirements from the RFP. For example in the case study

that Chagpar et al. (2006) present, the only mention of this step in the procurement process is that from the five received responses to the RFP, three were chosen to be shortlisted through evaluation based on a predetermined weighted list of criteria. In public procurement this criteria should have already been included in the RFP.

However, if there are a number of good candidate systems, which all (at least on paper) fulfill all the requirements and criteria from the RFP, creating the shortlist may not be done by conducting thorough usability testing, as there may be too many systems to test making this approach impractical and not cost-efficient. In this case Schumacher et al. (2009) suggest three relatively quick and cheap usability methods for eliminating the non-viable systems from the shortlist: usability walkthroughs and heuristic evaluation, as well as task efficiency modeling (i.e. using the human information processor model). These methods give only estimates of the usability of the system (as they are predictive evaluations), so they should not be used as a sole information source for the final decision, but the estimations should be good enough for selecting the shortlist systems. Usability walkthroughs are described by Schumacher et al. (2009) as a group event where the representatives of different user groups go through the interface step by step recording their impressions and discussing the findings. Schumacher and colleagues suggest that with some training the users could even do walkthroughs by themselves individually, although they add that including usability expert in the process could bring out the most value from using this method.

Using the two other methods however, the assistance from a usability expert is a necessity. Heuristic evaluation is conducted by a usability expert, who evaluates the interface step-by-step against a set of predefined heuristic. Carvalho et al. (2009) also view heuristic evaluation as being a viable method for preliminary assessment of candidate healthcare information systems, due to its low-cost and quickness. Those authors also developed their own set of 38 heuristics specifically designed for evaluating medication administration systems. However only 12 of the heuristics they developed

are applicable using the standard method of heuristic evaluation, where the usability expert conducts the step-by-step analysis outside of the context of real system usage and workflow. To utilize the remaining heuristics a more comprehensive understanding of the purchaser organization would be needed. Also Schumacher et al. (2009) mention the fact that the usability expert might not have sufficient domain expertise as being the biggest drawback to the method, but they continue that this can be helped by also allowing the expert to carry out observations and conduct interviews with the users.

As the final method, Schumacher et al. (2009) propose that usability experts can model task efficiency to estimate the efficiency. This is done by estimating the time required to complete the tasks based on averages how long it takes to do all the individual activities needed to finish the task e.g. clicking a button or deciding among alternatives. Even though this method only addresses efficiency and works best for repetitive tasks, Schumacher et al. point out that this method is often used when it is hard to get some of the actual users involved in the process.

Summary

In choosing systems for the shortlist, usability considerations and issues are not likely to be obvious from simply comparing the offers from vendors to the requirements and selection criteria. Some usability estimation can be used in this phase to weed out and eliminate non-viable systems. The estimation approach used should be quick and cheap. In this regard, heuristic evaluation, usability walkthroughs and task efficiency modeling are suggested. Along these lines, Carvalho et al. (2009) have created evaluation heuristics specifically for healthcare IT systems.

Shortlist evaluation

Shortlist evaluation is an extremely important part of the procurement process since it should provide enough information that the final decision can be made and the procuring organization can be sure that the best system is chosen. It is important that the selection is based on real evidence

regarding usability in the specific context the final use, since even though some system might be usable in some other organization this does not guarantee the fit of the system in the procuring organization, where there might be different workflows and environments.

For the other parts of the procurement process several different usability methods have already been presented above in this review. However, for the shortlist evaluation there seems to be one method that from the literature appears to be most promising, and that is high-fidelity usability testing.

Kushniruk et al. (2010) suggest that implementing usability testing (possibly along with some complementary methods such as usability walkthroughs) gives the strongest evidence regarding the usability of candidate systems during procurement. This method, though recently being applied using different variations, is described in all of the four papers returned from the literature search that discuss the evaluation of the shortlist. Usability testing refers to observing and recording user interactions with a system (or realistic prototype) while they perform tasks appropriate to their user group in a real or highly realistic simulated context. The collected data is then evaluated by the usability expert e.g. for efficiency, task completion, usability problems and errors. Afterwards observing users carrying out tasks, there is usually also a questionnaire and/or interview with the users to determine their subjective satisfaction with the computer system being tested. Usability testing is not however currently a common method for system evaluation when selecting a healthcare IT system. In contrast, instead of applying usability testing, the decision is often done after observing demonstrations of the system use carried out by the vendor to a selection committee that may have some representatives from the user groups (Kushniruk et al. 2010). Hands-on access to the candidate systems is in this case very limited. By carrying usability testing of candidate systems before selection, it is argued that the procurer could be much more confident of the fit of the system to the buying organization (Kushniruk et al., 2010).

There are some variables that have an impact on the fidelity of usability testing method. One is the quality and coverage of the scenarios and tasks the users perform during the usability testing. There are several ways of creating the tasks or scenarios that the users will perform in the usability testing. If the key users groups and contexts as well as the user tasks are already carefully identified in the Request for Proposal as required testing, it may be possible that no additional research is needed for creating the tasks and what may be left to do is to choose the tasks that will be used in the usability testing. Kushniruk et al. (2010) report a scenario creating process based on their experiences with system selection at the Mount Sinai Medical Center in New York. Selection team members, who are also practicing physicians, created the scripts employing work-flow based scripting. The scripts were then reviewed by practitioners from multiple specialties. In the case study of Chagpar et al. (2006) first a superset of the tasks used in the scenarios was determined through shadowing of users (i.e. where they were followed around and notes taken about their use of systems in the context of real use). Then the tasks were rated for their importance by a survey to the users, and the scenarios were developed to focus on the most important tasks, though some secondary functionality was also included in the scenarios developed. After the scenarios were created they were once more validated with a working group of representative users. In the best case the user could of course perform at least partly their real tasks in their actual environment as was done in a second case study reported by Kushniruk et al. (2010) describing the process that takes place at Lille Regional University Hospital in France.

An interesting difference is that while Schumacher et al. (2009) recommend that the usability measurement be carried out only with scenarios for the most frequently performed and critical tasks, Kushniruk et al. (2013) argue that the scenarios developed for the tasks should range from the routine to the complex, from the typical to the atypical and from the urgent to the non-urgent. This difference might be due to the different goals of the two authors. The main goal of Schumacher and colleagues is increasing the

usability in the procurement to ensure the systems adaption in general. In this case it makes sense to be cost-efficient and mainly focus on the tasks that users carry out most of time and that are the most critical. Kushniruk and colleagues, on the other hand, appear to be approaching the goal from the safety point of view and so also included rarer scenarios as being important, since it is often the exceptions that create the most dangerous situations (Kushniruk et al., 2010).

Another factor in addition to considering the tasks and scenarios for testing, that would have a major impact on the strength of evidence that usability testing provides, is the ecological validity of the context where the test is conducted i.e. how well it represents the actual use context. One place for testing can be a specialized usability laboratory, if the context can be made realistic enough. Chagpar et al. (2006) used simulated clinical environments, with simulated patients i.e. computer-controlled mannequins. Similarly Kushniruk and colleagues (2013) describe how usability testing of candidate systems for a major healthcare IT system procurement in Denmark was carried out in a simulation laboratory specialized in evaluating clinical information systems. However, as with the tasks, where practical, testing in the actual use context is always the best possible setting. As mentioned above in the second case study reported by Kushniruk et al. (2010) from the Lille Regional University Hospital, the usability testing was conducted in the actual context of use, where the two candidate systems were test installed and clinicians in the hospital tried out both systems in real use. In some cases using the organizations own space (as opposed to testing in a usability laboratory) can also make the testing more cost-effective.

Usability testing can be also complemented with other methods to obtain even stronger evidence of fit between candidate systems and the buying organization. Kushniruk and colleagues (2010) describe their second case study from Lille Regional University Hospital belonging to the far end of a continuum of evidence ranging from weak to strong, as it employed heuristic evaluation in addition to usability testing. Carvalho et al. (2009) also report that heuristic evaluation is a good complimentary method that

can be used in addition to usability testing in selecting systems. Schumacher et al. (2009) state that if a certain user groups are unavailable it is possible for those user groups to perform usability estimation similar above in the section on preliminary assessment, while conducting usability testing to the other user groups.

Summary

User testing is the most highly recommended method for evaluating the shortlist of candidate systems for the final selection. For the most reliable evidence regarding system usability, the usability test should be conducted in the actual context of use with actual user tasks, or at least as close to the real context and tasks as possible. For increasing the validity of the method even further, it can be complemented with other usability methods such as heuristic evaluation.

In user testing the goal is not only compare candidate systems against each other, but also to assess the objective usability of the system. Thus, even if the best system has some problems, they can be corrected and the system customized before the implementation (as described in Kushniruk et al., 2010 regarding the Lille case study).

Contracting

Hertzum & Simonsen (2004) suggest that the importance of requirements could be taken even one step further in evidence-based system development, making them a critical part of the contracting. They describe how the numerical goals and how they are realized after the implementation can be linked to the payment for the system purchased i.e. if the product does not fulfill the usability requirements as specified in the contract, the vendor would receive less payment. In their case study for a home-care management system they did discover that that measurable effects could be formulated (e.g. "Home-care providers rate of being "satisfied" or being "very satisfied" with the information they receive from hospitals when patients are discharged and home care is resumed"). However they do acknowledge that there might be aspects of usability and adoption in the

healthcare domain like quality of care and nursing that might be difficult to quantify in measurable term, as is also discussed in the Request for Proposals section above. Also receiving full payment for deployment of a system only after implementation and testing regarding level of usability achieved might be considered a problem for some vendors, and is not yet part of typical current healthcare IT contracts.

2.3. Discussion

All and all it is clear that even though efforts aimed at increasing consideration of usability in procurement can be found in the literature, use of these methods is not yet common. Beuscart-Zéphir et al. (2002) describe the typical healthcare IT system procurement process as follows. First, a list of desired functions is created for the Request for Proposal (RFP) and the vendors reply with a detailed description of their application. Analyzing those written descriptions is usually complemented with demonstration sessions, where the vendor representative goes through the system and demonstrates it to the selection team, and by visiting reference sites where the system is already running. Kushniruk et al. (2010) concur that currently the main information source for the final system selection is based on the vendor presentations. The problem with vendor presentations is that they don't provide any sort of strong evidence on how the system would work in the actual context of implementation in the real hospital setting of the purchasing organization. It is also possible that when giving the presentation the vendor will emphasize only the good parts of the system while downplaying the problems (Kushniruk et al., 2010). Both Beuscart-Zéphir et al. (2002) and Kushniruk et al. (2010) agree that this level of evaluation doesn't guarantee the usability or the safety of the system. Kushniruk et al. (2010) suggest that a stronger level of evidence can be obtained from the evaluation if additional methods are used, resulting in more confidence in the buying organization that the system will likely be usable, safe and a good fit. Methods used to do the system selection are

placed in a continuum ranging from weaker evidence to stronger evidence as shown in Figure 1 (Kushniruk et al., 2010). The weakest evidence comes from simply observing vendor demos of the candidate systems before making a final selection decision. This may or may not include use of “CLIPS”, which refer to clinical information processing scenarios used to provide artificial patient data for test cases. As Figure 1 illustrates usability testing (involving study of representative users interacting with each of the candidate systems) is located in the right side of the continuum, further emphasizing the result from the literature search that usability testing can provide a strong basis for system selection based on improved evidence of system-organization fit.

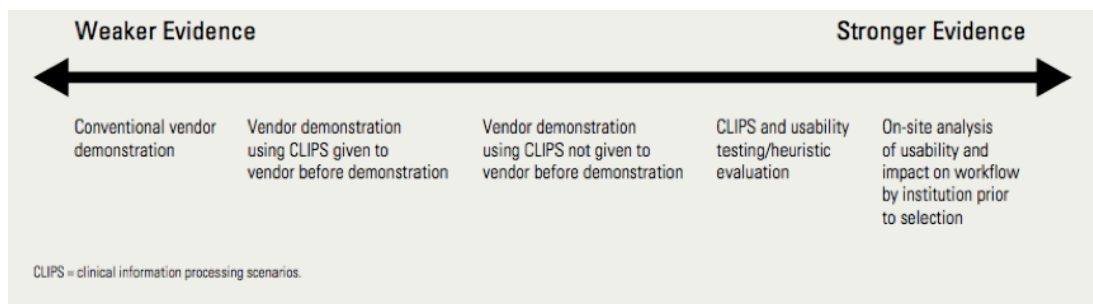


Figure 1: Continuum of evidence to support system selection (Kushniruk et al. 2010)
[reprinted from Healthcare Quarterly with permission]

Referring to the process of healthcare IT system procurement described by Beuscart-Zéphir et al. (2002), the current level of Request for Proposals (RFPs) is not adequate as well. Simply listing the functionalities of candidate systems is clearly not enough, and usability requirements should be included in the RFP too. If usability is not required (in a verifiable way) it cannot be expected either. As Jokela et al. (2013) argue if usability is not in the requirements, it makes no sense for the provider to add usability measures, because they will most likely add to the cost and make the offer less competitive. Creating good and comprehensive requirements will also benefit the later parts of the procurement process. Along these lines, Beuscart-Zéphir et al. (2005) state that the user requirements document

was indeed the most important document throughout the management of the system selection process.

According to Schumacher et al. (2009) the main sources for RFP content for the healthcare providers are the purchasers themselves, the government and professional associations. So to increase usability considerations in procurement it would be important to get the government authorities and professional associations to endorse and require the role of usability and usability testing in selecting healthcare IT systems.

Kushniruk et al. (2013) and Schumacher et al. (2009) both speculate that one of the reasons why usability methods are not largely deployed is because they are seen to be too expensive. Therefore methods that didn't include testing with users, like heuristic evaluation, were initially deemed more suitable for evaluation of healthcare IT systems. However, in recent years usability testing has also been proven to be a cost-effective method that can be carried out efficiently and rapidly (Kushniruk et al., 2013). It should also be considered that the usability test results can be used not only for selecting the system, but to finding the possible usability problems so that the chosen vendor can fix them before the system is implemented (e.g. Beuscart-Zépher et al., 2002, Chagpar et al., 2006). If the problems are identified and fixed before the implementation, it is a good investment also financially and can lead to savings up to 80% as compared to letting the problems go through to post implementation and fixing them after the system has been deployed for real use (Baylis et al. 2012).

In addition to increased expenses another perceived problem with involving users with the testing is that users may not be accessible - healthcare professionals are busy and possibly unwilling to attend testing sessions. This however might not be as big problem as previously thought, for example Martikainen et al. (2011) report that according to a questionnaire conducted with a large number of Finnish physicians, the majority of respondents indicated they were willing to participate in such evaluations. Similarly, Chagpar et al. (2006) state that when conducting their usability testing, they had almost too many volunteers for testing the system.

In addition, in many cases only a limited number of users may be needed in the first place. Chagpar et al. (2006) tested with 17 users, but in conclusion recommend testing with a maximum of 8 users, for saving resources and avoiding the misconception that the users are “voting” for the system (e.g. that only users subjective opinions affect the decision, rather than objective performance). Schumacher et al. (2009) also state that often no more than 8 to 12 users from each user group is needed. Kushniruk et al. (2013) describe that the usability testing of shortlist systems that will be conducted in a simulation lab in Denmark will involve 18 doctors and nurses from different specialties. In addition, even though the usability test might require preparation from the selection team, for users the time investment should not be impossible. Consistent with this, Chagpar et al. report that their usability testing took approximately 20 minutes to complete for the users, Kushniruk et al. (2013) mention that testing took less than 2 hours of the users’ time. Also as mentioned before, if some users groups are unavailable to participate in the usability testing it is also possible to use other methods, such as heuristic evaluation, for assessing the usability of the system from the point of view of those users groups. Jensen et al. (2013) also suggest that one way of involving the users groups that are not participating in the scenarios of the usability testing would be to invite them to observe the testing.

A theme that is commonly described in almost all the papers that resulted from the literature search was that including a usability/human factors expert in the procurement process early on is highly recommended if not even necessary for the success of the project. Even starting from creating the requirements for the Request for Proposals, if usability requirements are included some form of usability expertise is most likely needed. For applying the methods and processes needed to obtain stronger levels of evidence regarding systems usability, some knowledge of usability and the methods described in this review is needed (Kushniruk et al. 2010).

Special considerations for healthcare system procurement in public settings

For public healthcare providers, legislation often restricts decision-making in a way that creates some challenges for including usability considerations as a part of the procurement process. First of all the importance of the RFP is especially highlighted in the public procurement process. This is because the public healthcare providers are typically restricted to following exactly the selection criteria specified in the RFP; they typically cannot be changed, reconsidered or specified afterwards. The public process also demands that the requirements and selection criteria are objective and transparent i.e. the vendor must be able to independently replicate the test if so needed. This increases the need for numerical requirements. More research on what these requirements should include and how can they be measured is needed.

Secondly many of the traditional usability testing methods return qualitative results, while the public procurement process demands that the comparison should be precise and uniform, which in practice would be easier with quantitative results. There has been a recent effort to bridge this gap by Jensen et al. (2013). They describe how usability testing will be used as a part of procurement of a major electronic health record (EHR) system in Denmark. When the users are playing out the scenarios, two things will be recorded: One observer will record the number of tasks the user is able to complete (effectiveness, i.e. fulfillment of tasks) and another observer will record how many times the user fails to use the system features as they are set up (ease of use). This way the authors expect the results of the usability testing will be in a quantitative, easy-to-compare format. It is notable that these measures are essentially the same measures that Jokela (2010) suggested be used as requirements for usability in the RFP for public procurers. In the method Jensen et al. (2013) describe observation is complemented with a debriefing interview and questionnaires for capturing the users' subjective preferences. Jensen et al. (2013) highlight the importance of describing the scenarios used in usability testing in much

detail in public procurement in order to ensure the fairness of comparison between the vendor products being compared.

2.4. Conclusion

A literature review was conducted for analyzing the current literature about best practices and methods for including usability in the procurement of healthcare systems. Since the search returned only a handful of articles it is clear that this topic needs more attention.

The literature recognizes two main reasons for including usability measures in the procurement of healthcare IT systems: increasing the probability of adoption of the final selected system and ensuring the safety of that system. If the system is not usable it will most likely not be adapted. On the other hand even if adaptation is not a problem and the unusable system is adopted, that can cause even bigger problems – potentially endangering the safety of the patients, as severe usability problems have now been shown to be statistically related to medical error (Kushniruk et al., 2005). Therefore it is extremely critical to buy usable systems. However if no measurement of usability is done during the procurement process, the usability and the fit of the system is left to chance. According to the literature the most critical phases of procurement process where usability considerations should be incorporated are including the usability requirements in the Request for Proposals (especially for public healthcare providers) and the high-fidelity usability testing of short-listed candidate systems. However, currently requests for proposals seldom include any usability requirements and even the ones that do have usability requirements are not sufficient (Schumacher et al. 2009, Jokela 2010), and the selection of final system is not based on information from high-fidelity user testing, but rather from observing vendor demonstrations that give only very weak evidence regarding the system's usability (Kushniruk et al., 2010). Finally, as most of the papers that resulted from the literature search were focused on one specific part of the procurement process (in relative isolation of the others), there appears

to be a need for clearer frameworks for how usability considerations should be addressed throughout the whole procurement process.

3. Preliminary Framework based on the Literature Review

The results from the literature review as described in chapter 2 were indicating that there was a need for a framework on how usability should be considered throughout the whole of the procurement process of healthcare IT systems. In this chapter a preliminary framework based on literature is proposed. The preliminary framework is later refined based on interviews from existing procurement projects of healthcare IT systems presented in chapter 4 and the refined framework is presented at chapter 5.

3.1. Creating the framework

The framework consists of phases of procurement and usability activities that are related to each phase. In the context of this work usability activities refer to any kind of considerations for usability for example setting usability as a strategic goal, not only to activities relating to actual usability evaluation.

The existing literature on procurement of healthcare IT systems suggests usability considerations in Request for Proposals (RFP) and System Evaluation phases are especially critical, therefore those phases are highlighted as the most important phases in the framework. System selection and implementation is also mentioned in the literature, and thus was added as a last phase to the framework.

The phases of procurement process found in the literature of usability in procurement of healthcare IT systems were then compared to the procurement processes from more general literature of procurement processes (for reference see Taylor, 2002; p. 222, Schiessl & Duda, 2007, and Jobber, 2007; p. 156-161) to find possible gaps that the current literature wasn't addressing. The models consisted from six to ten phases of procurement. These general models do not naturally give any suggestions on what kind of usability activities should be done during the procurement, but were used observe what were phases of procurement where usability was currently not considered. Creating Requests for Proposals was the first

phase being addressed in the literature of usability in procurement of healthcare IT, however phases preceding RFP that could plausibly also include usability considerations were found from the general procurement models: Defining strategic goals to the procurement and market research. These phases were thus added to the preliminary framework before the RFP phase, with suggestions for possible usability activities relating to these phases. The viability of these suggestions will be established with the interview study.

3.2. Framework

The Framework (figure 2) consists of five phases of procurement process and corresponding usability activities for each phase. The usability activities are explained in closer detail in the following.

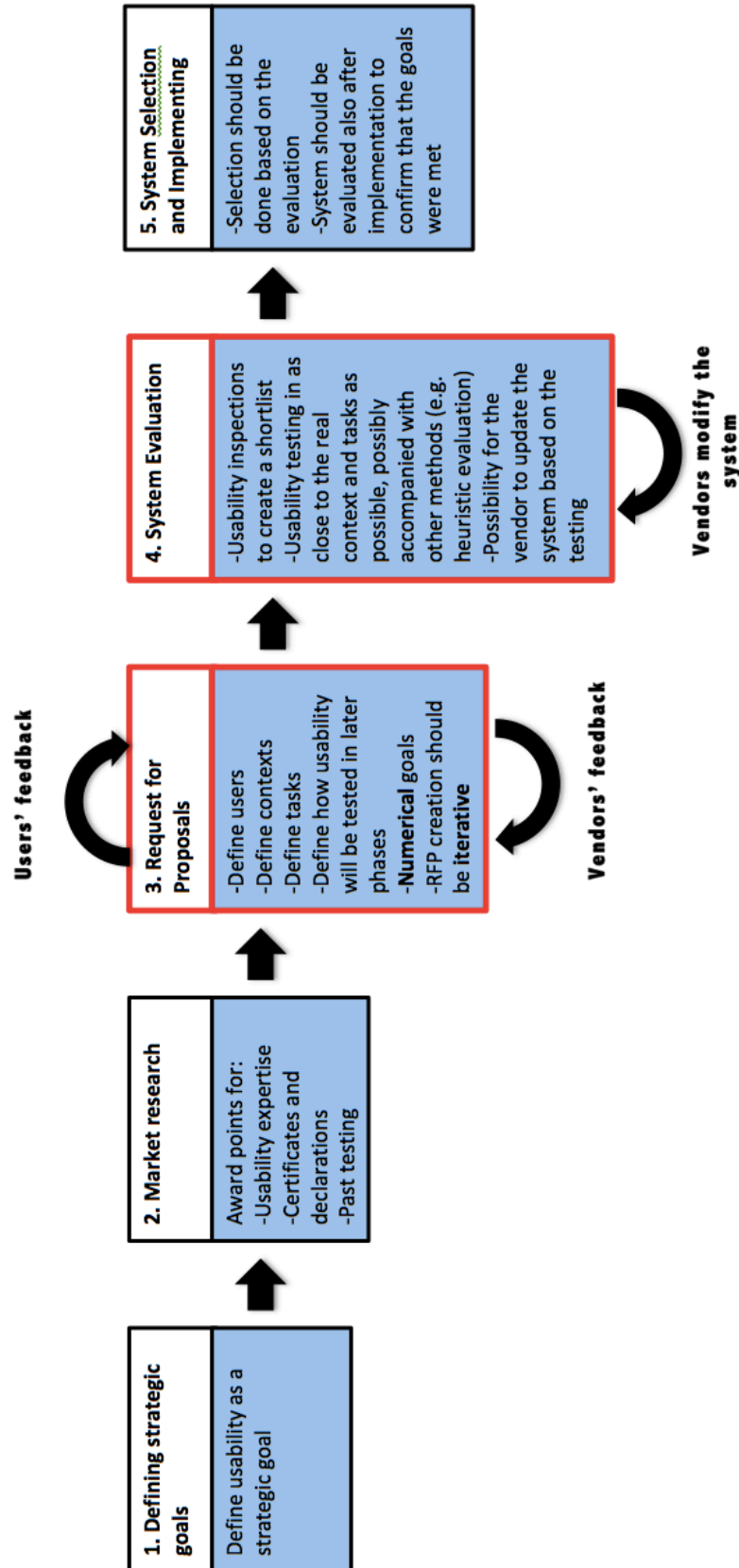


Figure 2: Preliminary framework for including usability throughout the procurement process.

1. *Defining strategic goals*

Procurement process usually starts with deciding what is procured and what are the expectations for the system (Taylor, 2002; Schiessl & Duda, 2007). It is important that the need for the final system being procured to be usable is recognized from the beginning, similarly than in the process of human-centred design process it starts with identifying the need for human-centered design (ISO 13407). If usability is acknowledged as a strategic goal of the procurement, it makes it easier to conduct the usability considerations and activities in the later parts of the process. This way the organization can assure that they have appropriate usability expertise in the procurement team and that enough time and funds can be allocated for the usability activities.

2. *Market Research*

Market research is a part of the procurement processes for finding prospective candidate systems. The literature review on usability considerations in the procurement of healthcare IT systems did not return any suggestions for considering usability in this phase of the procurement, however it was a common phase in the general procurement models in form or another, for example “Supply Market research” in Taylor’s model (2002), “Search for and qualification of potential sources” in Jobber’s model (2007), and “Research suppliers” with Schiessl & Duda (2007) .

It might be possible to pay attention to the usability already in the initial search for vendors and mapping out the supply. One way to do this is to consider the suppliers’ previous success in usability testing. However it should be emphasized that even though these previous results can give some preliminary hints of the products usability, usability is by definition connected to specific context, and therefore the results from usability testing results from other organizations should not be given excess importance, and should not be used as basis for final system selection.

According to Thoren (2004), one promising approach for including usability in the procurement process could be awarding points from 3rd party usability certificates and supplier declarations, e.g. Common Industry Format (CIF) specifies the format for reporting the results of an evaluation that produces usability metrics that describe how usable a product is in a particular context of use. But as is with the results from previous usability testing, certifications can only give some indication of the systems usability. Thus they should be used only as preliminary indicator of the usability as they offer only weak evidence of the usability in the actual context of use.

3. Request for Proposals

Creating system requirements for Request for Proposals (RFP) is one of the most critical phases in the procurement process for ensuring the usability of the system: If no usability is required it cannot be expected either. In the RFP, usability should be included in the requirements rather than in the selection criteria, since as a selection criteria usability could be ignored in favor of some of the other criteria. However it is not enough just to have any usability requirements, the requirements concerning usability should be verifiable, valid and comprehensive (Jokela et al., 2013). Creating the usability requirements can start with following activities (Jokela, 2010; Schumacher et al., 2009):

- a. Defining the users
- b. Defining the contexts
- c. Defining the tasks

The definitions can be done based on the selection groups experience or interviewing and observing the users. The requirements should be elicited from the results of these activities.

The usability requirements need to be verifiable, otherwise they won't serve their purpose. For example "The system is easy to learn" is not a good requirement since it is later on very hard to verify explicitly. In practice so that the requirements can be verified they should optimally be numerical. As

suggested by Jokela (2010) possible numerical requirements could be setting a goal value to the percentage of users that can successfully complete a task and the percentage of users that have problems with the design. In addition to these, a goal value for user satisfaction could be set as a requirement as well. RFP should also describe how these requirements will be verified later in the procurement process. Jensen et al. (2013) describe how the requirements described above can be verified by clinical simulation.

Since the RFP is so critical part it is recommended that the process of creating the requirements is iterative. For example in the case study Jokela (2010) describes, ten iterations of requirements was needed. At least two rounds of iteration is common: First round of requirements can be created for example with shadowing (Chagpar et al. 2006) or with the expertise of the selection team members (Kushniruk et al., 2010), and then in the second round validated with preventative users. If negotiation method of procurement is used the prospective vendors can also be included in the discussion of requirements.

4. *System evaluation*

Another extremely crucial part for ensuring usability of the system is the evaluation phase. It is important that necessary measures are taken. If there are initially too many viable systems for it to be financially sensible to test them all thoroughly, lightweight usability inspection methods, such as heuristic evaluation or cognitive walkthrough, can be deployed for creating a shortlist of systems that will then go through the final round of evaluation.

The evaluation of the shortlisted systems is an extremely critical phase, since it should provide the procuring organization the needed evidence for making informed decision on system selection. It is considered that one of the most reliable ways to gain strong evidence on the systems usability is through usability testing with as realistic tasks and in as realistic context as

possible. Clinical simulation has been successfully employed for this purpose in several cases (Kushniruk et al., 2010; Jensen et al., 2013). For increasing the validity of the method even further, it can be complemented with other usability methods such as heuristic evaluation.

The goal of usability testing is not only compare candidate systems against each other, but also to assess the objective usability of the system. Thus, even if the best system has some problems, they can be corrected and the system customized before the implementation (as described in Kushniruk et al., 2010 regarding the Lille case study).

5. System Selection

The final selection should be done based on the usability evaluation and other requirements defined in the Request for Proposals. It is not enough that the usability testing is conducted, but the results need to have an actual impact in the decision making. Since unusable systems will be not only ineffective and less likely to be adopted, but can also contribute to serious medical errors, it is necessary that the results from the usability play a critical role in the system selection.

Ideally system should be evaluated also after implementation to confirm that the goals were met (Jobber, 2007). The results from testing after the implementation can be used also as the baseline in future procurements.

3.2. Discussion

Acknowledging the importance of good usability of the healthcare IT system already in the strategic goals of the procurement gives good basis for implementing necessary usability activities later on the process. This way the organization can ensure they have the necessary usability expertise for the needs of the project and can allocate appropriate time and funds for the usability activities. Jensen et al. (2013) describe a case where it was a strategic aim of one of the procuring public entities involved in the procurement that all healthcare IT systems will be evaluated using clinical simulation before implementation, which supported the inclusion of

usability testing to the process. Also in the process that Jokela (2010) describes, strategic usability targets were first defined with key stakeholders, managers and initiators before more detailed usability targets were created for RFP. So that the healthcare organizations are able to set usability as strategic goal, they need to be informed about the importance of the usability of the healthcare IT systems. For example governments and professional organizations could play a role in raising the awareness.

Usability could be taken into account when doing the market research phase of the procurement for example by looking into the systems past success in usability testing and usability certificates for some prediction of the usability of the system. For example in the case study that Kushniruk and colleagues (2010) report, the vendor that got the highest score from the usability testing during the procurement process was able to use these results in their advantage also in subsequent procurements. However, as stated before, these indicators can only be considered as a weak evidence of the systems usability as the actual context of use in the procuring organization is not taken into account, and thus they should not be used in the final decision making. Currently there are not yet certificates for healthcare IT systems that comprehensively evaluate their usability, but with increasing acknowledgement of the importance of usability for healthcare IT systems there are some indications that in the future the certifications might include also usability. For example usability is rated as a trial as a part of the Certification Commission for Health Information Technology (CCHIT) Certified 2011 Ambulatory EHR Certification Program (CCHIT, 2011). However, since in this process usability is rated by a jury observing a regular inspection rather than testing with real users in actual use context, the current usability rating in the CCHIT certification can not be considered as a thorough evaluation of the systems usability. National Institute of Standards and Technology (NIST) in USA is also currently in the process of creating a principled framework for measuring the usability of healthcare IT systems (NIST, 2013).

Creating verifiable, valid and comprehensive usability requirements for the Request for the Proposals and later on validating these requirements by thorough usability testing with realistic tasks in realistic environment are the two key phases of the framework process and at in these two phases most resources for usability activities in the procurement process is needed. The importance of including verifiable usability requirements in the Request for Proposal (RFP) is especially highlighted for public procurement of healthcare IT systems, since the legislation usually compels the public organization to choose the final system based on the requirements stated in the RFP. Thus even if usability testing would be later included, the results would not be able to affect the system selection.

In this paper, one suggestion for creating verifiable, numerical usability requirements by Jokela (2010) is presented. However there is still not an established way on how and what kind of usability requirements should be made, and thus more research on this topic is needed. Generally the procurers are lacking guidelines for making concrete usability requirements, as can be seen from case study of Markensten (2003) where the procurers described creating usability requirements as “the hardest thing they’ve ever done” and felt that they didn’t have proper tools for creating such requirements. According to Schumacher and colleagues (2009) the three main sources for RFP content are the purchasers themselves, the government and professional organizations. Therefore it would be important that governments and professional organizations would provide guidelines on creating usability requirements. This however is currently not the case. For example there has been the recent efforts for creating official recommendations for enhancing the procurement of healthcare IT systems by European Union (Vogt et al., 2012), but these recommendations failed to address the role of usability in the process. A guide for user-centered procurement process of Swedish Agency for Public Management, which is responsible for the support of public IT procurements in Sweden, mentions similar phases for extracting the

usability requirements as presented in this framework (defining the users, defining the contexts and defining the tasks) and methods how to perform these activities, but does not offer guidance how the results from these activities can be converted into verifiable requirements in practice (Lif et al. 2007).

The system evaluation phase in the framework includes both the preliminary assessment and the shortlist evaluation. In many cases preliminary assessment on usability is not even needed if the number of suitable vendors has been small from the start or they have been qualified for other reasons. If preliminary assessment is needed before the short-list cut, lightweight usability evaluation methods can be applied. The focus and the most resources should be allocated to the usability evaluation of the short-listed systems. For the shortlist evaluation there seems to be one method that appears to be the most promising, and that is high-fidelity usability testing. Kushniruk et al. (2010) suggest that implementing usability testing (possibly along with some complementary methods such as usability walkthroughs) gives the strongest evidence regarding the usability of candidate systems during procurement. However if the thorough usability testing is not possible for financial or other reasons, it is always better to apply even the more lightweight usability inspection methods, like heuristic evaluation or cognitive walkthrough, than have no usability testing at all. But when considering the costs, it should be realized that even though including usability testing and inspections in the procurement process requires some funding, this investment can lead to significant savings, since fixing the usability problems after the implementation is significantly more expensive and bad usability also increases the training costs (Baylis et al. 2012).

However even the most thorough usability testing is only purposeful if it actually affects the final decision-making. Sometimes the results from the usability testing may indicate that none of the candidate systems are

currently usable in the context of the organization. In this case rather than just choosing the one with least bad results, the organization should discuss with the vendors about customizing the system or consider other systems altogether. Usability should also be monitored after the system selection. Herzum and Simonsen (2004) even suggest that the payment for the system purchased could be tied to the results from usability evaluation after the implementation i.e. if the product does not fulfill the usability requirements as specified in the contract, the vendor would receive less payment.

3.2. Conclusion

The framework presented in this chapter suggests that usability should be included as a critical part of the procurement of the healthcare IT systems throughout the whole process. It should be the goal of the procurement from the very beginning to find the most usable system for the organizations context, and throughout the process gather as much evidence on the candidate systems usability as possible.

Creating valid and verifiable usability requirements in the request for proposal and high-fidelity usability testing in the system evaluation phase are highlighted in the framework as the most important usability considerations in the process.

In the next chapter the preliminary framework will be reflected on three example cases of healthcare IT system procurement processes, where special considerations for including usability in the process have been made. The preliminary framework will be then further developed and refined based on the results from interviews from the three cases.

4. Interview Study

In this chapter, three cases of healthcare IT system procurement processes are discussed. Six interviews were conducted to identify how usability was considered throughout the procurement process in these projects. The cases were chosen on the basis that special considerations for including usability to the procurement process were taken. Case 1 is a large public procurement of a client and patient data system in Finland, Case 2 is a large Danish regional procurement of electronic health record system and Case 3 is procurement of an electronic record system for a Finnish student healthcare organization. In Cases 2 and 3 the system selection was already done by the time the interviews were conducted, while Case 1 is still currently ongoing, the final decision expected to be reached by the beginning of the year 2015.

Cases 1 and 2 were massive projects that included several regions including the capital region of each country and dozens of hospitals, while in comparison Case 3 was from a single smaller healthcare organization. The three procurement project cases can be considered as state-of-the-art in regards of including usability in the procurement of healthcare IT systems and thus can be expected to give good insights on the matter. All of the cases the healthcare organizations were procuring commercial off-the-self systems. The system being procured in cases 2 and 3 was an electronic health record (EHR), while the system in case 1 is a client and patient data system service. The biggest difference between the two is that the former is record system for healthcare services, while the latter includes also social welfare systems (e.g. elderly care, substance abuse services) so its scope is even larger.

4.2. Methods

The three cases were studied by interviewing people involved with the projects. The interviews were conducted as semi-structured interviews. The questions and themes of the interview were based on a framework of

usability activities in the procurement process of healthcare IT systems that was created based on literature review (see chapter 3). Following phases of procurement and if and how usability was considered in that phase was discussed:

1. Defining strategic goals of the procurement
2. Researching vendors
3. Creating Request for Proposal and the requirements
4. Evaluating candidate systems
5. Selecting and implementing the system

The interviews were audio recorded and after the interviews the notes that were done during the interviews were checked and expanded based on the audiotapes. These refined notes were the basis of the analysis that is presented in this chapter. For each case all the interviews concerning that case were compiled and analyzed together. The five phases of procurement above were the basis of the analysis, but other emerging themes were also gathered. After the individual analysis of all the cases they were compared to each other to find similarities and differences.

The interviews from projects in Finland were conducted in person and in Finnish and the interviews concerning the Danish project were conducted via video conferencing tool and in English. The author of this work conducted all of the interviews. The interviews were conducted 20.1. - 27.3.2014 and the durations varied from 30 minutes to 75 minutes. The interview plan and the full list of the prompt questions can be found at appendix 1.

Subjects

Six interviews were conducted, three interviews relating to Case 1, two relating to Case 2 and one from Case 3. From all of the cases a project director or equivalent, a person in charge of the whole projects, was interviewed as well as a person involved with the practical planning and executing the usability activities. Since cases 1 and 2 were large projects

with the system being selected having tens of thousands of end users, multiple interviews were needed to gather insights from both of these point of views. The interviewees consisted of two men and four women. The roles and areas of responsibilities of the interviewees are described in table 3.

Table 3: Interviewees roles in the procurement processes

	Procurement process	Role	Area of Responsibility	Date of the interview
Interviewee 1	Case 1	Project Director	Project as a whole	Jan 20 th 2014
Interviewee 2	Case 1	Operations manager	Usability Evaluation, Operations development in special health care, Champions	Feb 4 th 2014
Interviewee 3	Case 1	Product Development manager	Functional properties of the product	Feb 14 th 2014
Interviewee 4	Case 2	Project manager (IT-Eksperimentariet)	Usability evaluation by clinical simulation	March 14 th 2014
Interviewee 5	Case 2	Project Director	Tendering process, Head of legal team	March 24 th 2014
Interviewee 6	Case 3	Project Director	Project as a whole	March 27 th 2014

The subjects were found through existing connections and snowball sampling, i.e. if an interviewee felt that they were not the right person to answer some of the questions, they were asked to recommend a person to be interviewed on that matter.

Analysis

The analysis of the interview answers was done by comparing answers of each interviewee from the same project to each five phases of procurement discussed, to create a comprehensive view on each phase in each project. Due to the semi-structured nature of interviews, not all interviewees answered all the specific questions (appendix 1), however each did give their description on usability activities in each of the five phases and answers from each phase were combined together for each case. Depending on the expertise of each interviewee the precision of each description varied, for example the person in charge of creating the usability testing could give the most explicit description on the details of the testing and cover other phases more briefly, while other interviews on the same case could cover the test setup in short and focus more on other phases. The interviews therefore supported each other. However, in case 1 where the project was still ongoing and the plans were being specified and updated all the time, if there was contradiction between answers of two interviewees the answer from the latest interviewees was thought to be the most up-to-date, especially since there was almost four weeks between the first and the last interview from case 1 (see table 3).

4.3. Results

Case 1: Large public procurement of a client and patient data system in Finland

Case description

Four municipalities and the regional health care district in the capital region of Finland and are procuring a client and patient data service for social welfare and health care services. A preliminary project for mapping of health record system was run in 2010 and the procurement was launched at

the end of August 2013. The process is still ongoing and thus some of the information regarding the process and the methods to be used is not public yet. Also since the project is not finished yet some of the topics discussed in the interviews might still be subject to change. The procurement process utilizes the negotiation method. From this project three interviews were conducted.

Usability considerations throughout the process

Usability has been involved in the process from the beginning – it was already brought up in launch meeting of the procurement process – however in the beginning there was no clear plan how it should be approached. More concrete plans on how usability could be included in the process started forming after a usability expert was hired to the procurement team. It was regarded that both the substantive competence of the clinicians and usability expertise was needed for creating a plan for evaluating usability. The first concrete usability activities took place in the requirement specification for the preliminary request for proposal, when usability requirements were created as a part of the non-functional requirements.

In the strategic goals of the procurement project “usability” was in the form of “satisfied users”. However according to one of the interviewees usability was “coming through” from other project goals too: For example with the goal of information-based management, information can’t be used for management if the users don’t produce information, and they won’t produce it if the system is hard to use or produces wrong information. Similarly common procedures (another strategic goal) won’t be practiced if it’s easier to do it the wrong way than it is to do it right.

Users have been involved throughout the procurement process. Especially involved are champions; users from different fields of expertise that have been involved in the process from the start and that have also received

training on choosing a good system. For example, the scenarios to be used in the usability testing were created with champions.

When creating the functional requirements the users were very much involved. Requirements related to usability did come up, such as “has to be easy to use” or “summary view should be like this and this”, but there were no specific usability requirements. Usability is part of the non-functional requirements, and they were created by a usability expert and the IT experts, and were mostly derived from known heuristics. The first versions of the usability requirements were created for the preliminary request for proposal, but as the other requirements they are being specified during the procurement process in dialogue with the vendors. It is also possible that there might be also minimum requirements regarding usability in the final request for proposal, if an objective way of specifying them can be determined.

The strongest role that usability has in the procurement process is in product comparison. Each competing system will receive points for its success in usability testing, and the scores are used for comparing the systems. Usability of the candidate systems will be evaluated in two phases of the procurement: with lighter methods before creating the shortlist of vendors, and then high-fidelity usability testing to the shortlisted systems. On the first phase of usability evaluation both users and usability experts will evaluate the candidate on System Usability Scale (SUS) -type of a questionnaire based on vendor presentations. The vendors present scenarios provided with them seven weeks earlier. In the second phase the remaining shortlisted systems will receive more rigorous usability testing that will include hands-on testing with both the users and usability experts. What the exact methods of usability testing in the second phase will be are not available for publishing at time of writing due to the process being currently ongoing. The results from usability evaluation especially from the

second phase of testing will nevertheless have a notable weight in the final system selection.

There are plans that usability testing will be included also in the configuration phase of the selected system. This is seen as very important since the modern healthcare IT systems allow them to be tailored to a great extent so if the configurations are not done carefully, they could end up decreasing the level of usability of the system.

Case 2: Large public procurement of an electronic health record-platform in Denmark

Case description

Two large regions in Denmark, including 20 hospitals and serving 2.5 mill citizens, were procuring an EHR-platform through public procurement process. The project started in March 2012 and the decision for selecting the vendor was made at the end of 2013. The procurement process utilized the negotiation method. From this project, two interviews were conducted: A member of the team who created the method for usability testing using clinical simulation and a project manager.

Usability considerations throughout the process

Usability testing became part of the project in the relatively late in to the process in a form of system evaluation for the shortlisted systems. The vendors were informed already soon after the preliminary announcement that there would be user testing as a part of the procurement process, even though it was not mentioned as the part of the preliminary announcement. It was a strategic decision of one of the procuring regions that all healthcare systems shall be tested in clinical simulation before implementation.

Users were involved in the functional requirement creation via workshops that several hundreds of the users participated in. The requirements were

based on requirements that were created in other Danish regions before, but the users could modify and add to them and tell their opinion in the workshops. Some use cases were also created with the users. Usability requirements were created by people in charge of creating the requirements for the architecture layer of the system and were based on heuristics.

Usability was tested from the three systems in the final round with two methods: Clinical simulations and vendor presentations.

In the clinical simulation method the users would go through scenarios of their daily work in a clinical simulation laboratory that is designed to resemble an actual hospital environment as close as possible. After testing the system the users would fill in questionnaires with 11 point scale on their experience regarding individual requirements of the system (not general impressions of the system). Data was received also from observations: While the user was going through the scenarios in the clinical simulation, the number of tasks the user was able to complete and how many times the user failed to use the system features were recorded. In addition to these quantitative results also a lot of qualitative data was received. 18 clinicians from different fields participated during duration of 10 days, testing each system for three days.

450 clinicians took part in the vendor presentation, where the vendors presented a subset of the scenarios used in the clinical simulation. After the presentations the users filled in SUS –type of questionnaires.

How much the results from these evaluations affected the final system selection could not be specified, however the clinical simulation was said to have a greater weight than the vendor presentations.

One of the biggest challenges in including usability testing and especially clinical simulation in the procurement process was the disparity between the requirements and clinical simulation as a method. People conducting the clinical simulation felt that they should have been included already in the creation of the requirements, since they are aware of what kinds of things

can be tested with the clinical simulation and how it can be used for a full gain. From the clinical simulation point of view the created scenarios were too technology oriented and not related in clinicians daily work and the requirements didn't capture the context of work. For the project management, the point of the biggest concern was that the requirements associated with the clinical simulation testing or the test results would not be objective or quantifiable enough, since that could have legal consequences if the vendors would feel that they are not treated equally. However there were no complaints from the vendors regarding the clinical simulation in the procurement. Finding enough users willing to take part on the project for longer periods of time than few hours or one day was also seen as a problem in this project, as the practitioners were not as eager to participate than expected.

Case 3: Smaller public procurement of an patient record system in Finland

Case description

A Finnish student healthcare organization was procuring a new patient record system to replace the old system that was in the end of its life cycle and no longer fulfilled all the official requirements. The system will have 350-400 end users. Implementing the new system will require extensive organizational changes, as the practices will also have to change considerably since the old system didn't require all the reporting that is actually now mandated. Project director of the procurement was interviewed.

Usability considerations throughout the process

When defining the strategic goals, terms like "user friendly" and "easy to use" had been brought up, but it was not clear what the terms would mean in practice. It was concluded that there was not enough usability expertise inside the organization for the needs of the procurement, so a usability-

consulting firm was hired to help with including usability testing to the process. In the preliminary announcement of the procurement it was already briefly mentioned that there would be usability testing in the final tendering phase, and that systems will be scored based on it.

In the preliminary technical requirements there were 14 usability requirements: For example, that using the system has to be role based, and that the interface should be consistent. In the final over 700 requirements, there were some requirements regarding usability (e.g. one-time registration), but no explicitly defined usability requirements. The functional requirements were created with users in workshops, first with bigger groups and finishing up with smaller groups based on areas of responsibility. Requirements were also defined based on the dialogue with the vendors. Project director along with clinical insight provided by directing senior physician and a dentist created the use cases. The use cases were planned to represent the normal daily activities and the activities that recur often.

In the system evaluation phase usability considerations included user satisfaction questionnaire during a vendor presentations, heuristic evaluations conducted by a usability expert and group evaluation with users testing the systems hands-on in groups.

The group evaluation was conducted in the health organizations own premises in conference rooms. The groups tested each of the three systems during the same day, and during the three days of testing 26 people participated in the group evaluations. After each test session, participants filled in questionnaire with 5-point Likert scale and also gave the system a general grade on a scale 4 to 10. The questionnaire was originally created by the usability-consulting firm, but was then modified by the healthcare organization so that the terms used in the questionnaire would be the ones the users were familiar with. Users also answered some open-ended questions, such as "What were strengths and weaknesses of the system?"

and “Did you need to ask help and when?” The comments from the open-ended questions we used to check if they matched with the given scores and more importantly as a material for planning the personnel training for the selected system. While the users were doing the group testing there was also always an observer from the procuring organization present. The observer’s task was to observe the users reactions and how often problems would arise and when and where. Since the vendors were only given a relatively short time (20 min) to introduce the system, a vendor’s representative was allowed to stay in the room for the duration of the testing, but were instructed to help the team only if they got completely stuck. The observer was also monitoring the interactions with the vendors’ representative and users. The goal of the group evaluation from the procurement point of view was only to test and score users satisfaction with the systems and that is the only aspect of usability that the vendors got a score for from the group evaluation. This kind of testing and especially with observer recording where the users got stuck or had problems with can also reveal usability problems. However, this information was not directly used in the grading and selecting the systems. The secondary goal for the testing was to gather material for planning the personnel training in the implementation phase.

Usability expert conducted a heuristic evaluation on the systems using essentially same use cases that were used in the group evaluation; however, since the usability expert did not have the clinical expertise, some of the use cases were slightly simplified.

Since it was the first time in the organization including the usability testing as a part of the procurement process and as such was done in trial basis, the results from the usability tests had only a small weight on the system selection, and the group evaluation and heuristic evaluation had had the same weight. However since the trial had been considered very successful and both the group evaluation and heuristic evaluation had gathered a lot of

valuable insights, they felt that in future the weight should be bigger, especially the weight of the results from the group evaluation.

4.4. Discussions

First, the results from all the three cases are brought together and compared based on the themes of interviews. Next, other themes that arose from the interview are discussed.

Defining strategic goals of the procurement

Usability per se was not mentioned in any of the strategic goals of any of the cases. However “user satisfaction” or “user friendliness” in some form or another was mentioned in the strategic goals of all of the projects. In Case 3 of the Finnish Student healthcare organization, it was actually the mentioning of “user friendliness” in the strategic goals that eventually led to the inclusion of usability evaluation to the project; The term had been continuously brought up, but not defined, prompting the project director to look into the matter. Case 1 had “user satisfaction” instead in their strategic goals. Even though user satisfaction is an important part of usability and connected to the acceptance of the system, it is however not as good goal as usability, since it doesn’t include other parts of usability such as safety and efficiency. Also just measuring user satisfaction can be achieved with lighter methods than usability testing, so it doesn't necessarily incite adding usability expertise to the project.

In Case 2 usability expertise was added to the project only after the requirements were created, and that’s why the requirements didn’t comport with the usability evaluation in an optimal way. That might have also have a part in why it was difficult in the end to pinpoint what was the weight of the usability evaluation in final system selection. If usability had been already in the strategic goals it might have supported adding usability expertise in the project even earlier. However, even though usability wasn’t part of the strategic goals of the procurement project itself, it was a strategic goal of

one of the municipalities taking part in the procurement, that all healthcare information systems will be tested with clinical simulation before their implementation. The experience was that before this was added as strategic goal, the procurement projects found it hard to find time and resources to do it, even though there had been problems with usability before and they had good experiences with clinical simulation to find the problems. Altogether it can be said that even though it is not impossible to have usability strongly included in the process even if it is not explicitly mentioned in the strategic goals of the procurement, as was in Case 1, having usability in the strategic goals gives the project a better probability for usability considerations becoming part of the project and that it's incorporated in the project early enough.

Researching vendors

There had not been considerations for usability during the market research phase in any of the three cases. Partly this was because in these procurement processes the first cut of vendors was not done based on the product itself, but based on the vendors' qualities such as financial stability and size. Even though, as one of the interviewees pointed out, it could give an impression of the level of quality in terms of usability of the systems in the market, in the market research phase usability considerations would not have much of an effect in practice.

In all three cases in general the vendors did not present results from any previous usability testing. Only in one case one of three vendors had conducted their own usability testing that was known to the procurers.

Creating Request for Proposal and the requirements

Creating the suitable requirements is indeed one of the biggest challenges in the procurement process. All the three cases used negotiation method meaning that the final requirements were created in dialogue with the vendors. This was done because the organizations were not always sure of

what could be reasonably required from the systems. In all the cases also the users were involved in both requirement generation and use case creation at least to a some extent. However even though these approaches both add valuable perspectives to the requirements, they don't guarantee that the requirements address usability sufficiently. In cases 1 and 2 the usability requirements were based on design heuristics, as discussed in chapter 2 in such requirements verifiability is a problem. In Case 3 however in the final requirements usability requirements were not specified. More research is still needed on how the usability requirements should be optimally created in practice, however some pointers can be already found from the literature and the case studies and will be discussed in detail in chapter 5. Minimum requirements for the usability can be an additional way of including usability into the contract: an idea that is being looked into in Case 1 and will be used if a objective way of creating the minimum requirements is found.

Evaluating candidate systems

The value in usability testing as a part of the procurement process was seen in all cases. In addition to the benefits of usability testing that have been discussed earlier in this work, the interviews also raised another benefit that having usability test in the procurement process can have: Hands on testing reveals how much training is needed and what are the problems that need to be addressed. This kind of information cannot be gathered from vendor demonstrations or from a heuristic evaluation with a usability expert.

In all of the cases other supplementary usability methods were used in addition to the usability testing. In Case 3 heuristic evaluation and user satisfaction from vendor demonstrations were used in addition to usability testing. Especially the heuristic evaluation was found to be a good combination with the usability testing since it brought up very different insights than what they got from the usability testing. In Case 2 user satisfaction from vendor demonstration was the other method of evaluation

usability in addition to clinical simulation. However they found the results from the demonstration to be less significant than the results from the clinical simulation. In Case 1 lighter usability evaluation methods, such as user satisfaction evaluation and heuristic evaluation based on vendor demonstration will be first used in order to decide what systems qualify for the final round and then the remaining systems will be tested with more high fidelity usability testing, with the users and experts testing the systems hands on.

Usability testing as a way of internal marketing was also brought up. Also, modern healthcare IT systems can be modified to a high extent, which makes it important to keep usability in mind also when doing the modifications. In cases 1 and 2 there were plans to use similar methods for assessing usability also during the implementation of the systems to ensure that the usability is not compromised by the configurations.

Selecting and implementing the system

Surprisingly, even though the projects included high-fidelity usability evaluation in the procurement, the role of the results in the selecting the final system wasn't always straightforward. In Case 2 the effect of the usability evaluation in the final system selection could not be pinpointed, and in Case 3 the weight of the results was very low, less than ten percent. Only in Case 1 the weight of the results from the usability evaluation is planned to be substantial, however the exact weight of the results is not published at the time of writing.

In Case 3 the weight of the results from the usability evaluation was set low because the organization was very unfamiliar with the topic and was including usability evaluation in the procurement for the first time. However they were very pleased with the valuable insights gathered from the usability evaluation, so in the future they want to increase the role of usability evaluation and especially user testing in the system selection. In Case 2 the unclear role of the usability evaluation might have been a consequence of the usability considerations being included in the project in

so late part of the project. Luckily in both of these projects the system that did well on the usability testing won the procurement.

Certainly having usability evaluation as part of the procurement process has also other benefits than finding the most usable system, such as collecting material for the personnel training, involving users into the procurement process and as a internal marketing method. However since good usability of the system is extremely important for not only the acceptance and efficiency of use but also to the patients' safety, choosing the most usable system should not be left to a chance and as such the role of usability evaluation in the procurement process should first and foremost be in affecting the system selection.

Other themes

The three cases give a good example on different ways of acquiring the needed usability expertise to the procurement project. In Case 1 the procurement project hired a usability expert on its payroll, in Case 2 usability expertise was already existing in procuring organization and in Case 3 it was acquired from externally from a usability consultancy. Nonetheless, whatever are the means of attaining the usability, the most important factor is that it should be done early enough in the process – namely before the requirements are created. As can be seen from the Case 2 including usability expertise too late in the project can be problematic, since if the requirements are not done with the upcoming usability testing in mind they don't necessary comport the testing in an optimal way.

In the Case 2 recruitment of clinicians was seen as a problem, especially when the clinicians would have been needed for longer periods of time than one day or few hours, as was the case with clinical simulations. They were not able to recruit clinicians from all the fields they would have liked and also had no-shows, clinicians prioritizing other things for example from their department over the testing. In addition the motivation of some of the users participating in the vendor presentations was also slightly questioned,

for example in the cases where the participant would give full scores for several systems from every single category. In the other two cases 1 and 3 no difficulty on recruiting the clinicians was reported. However in Case 3 longer periods than one day was not even required from the users to participate and in Case 2 the final evaluation that possibly might require more than one day time commitments from the participants is not executed yet, so the availability of participating clinicians is still hard to predict. Future research on what kind of organizational or cultural factors affect the clinicians' eagerness to participate in the usability testing during the procurement of healthcare IT systems is suggested.

In all of three of the cases it was declared that the users of the system were not only the clinical and administrative personnel of the healthcare organizations but that also the customers or patients, as in people using the healthcare services, should be able to use the system. However the customer users were not involved in the usability testing in any of the cases. The reason for this at least in the Case 3 was that the procurement process requires that all the vendors have to be evaluated in exactly the same way, but the customer portal part of the systems was not ready enough in all the systems so that they could have been equally tested. The usability of the customer interaction is however an important factor, especially if the use of the system from the customers side is based on customers using it voluntarily. In addition, it is expensive to have training for the personnel, but giving training for the public is practically impossible. Therefore in the future research on how the usability testing with the clients and patients as users should be included in the procurement process of healthcare IT systems is needed.

4.5. Conclusions

In all the three cases it can be seen that even though in all of these projects there was a clear wish for including usability to the project there was also a

lot of uncertainty how it could be achieved in practice. This supports the findings from the literature review that there is a need for a clearer framework how usability can be included in the procurement process. Especially problematic or unsure was how the usability requirements should be created.

The cases strengthened the assumption from the literature that usability testing with the actual users is important as it gathers more valuable insights of the systems usability than for example expert reviews or vendor presentations, even though these can be used as supplementing methods. The interviews also revealed that including usability evaluation in the process, still doesn't guarantee that the results have a clear effect in the system selection, this is problem that needs to be addressed in the future. In the interviews it was also discovered that there is a need for usability testing also after the procurement during the implementation, for the reason that the modern healthcare systems are highly configurable, and thus the systems usability doesn't get hindered by the done configurations. The summary of usability activities in the three cases examined is presented in table 4.

Table 4: Summary of Usability activities in the three cases

	Case 1	Case 2	Case 3
<i>Usability mentioned is the strategic goals</i>	No (User satisfaction)	No	No (User friendly, easy to learn)
<i>Vendors presented results from previous usability testing or usability certificates</i>	No	No	No
<i>Usability requirements</i>	Non functional requirements, based on heuristics	Part of Architectural requirements	Not specified (14 in preliminary technical requirements)
<i>Users involved with creating the requirements</i>	Yes	Yes	Yes
<i>Dialogue with the vendors about the requirements</i>	Yes	Yes	Yes
<i>Heuristic evaluation</i>	Yes	No	Yes
<i>Users testing the system hands-on</i>	Yes	Yes	Yes
<i>Users testing the system in a clinical context</i>	No	Yes	No
<i>Vendor presentations</i>	Yes	Yes	Yes
<i>The weight on usability testing on the system selection</i>	Not published yet (but will be substantial)	Not specified	Small (<10%)
<i>Usability testing planned for the implementation phase</i>	Yes	Yes	No

5. Conclusions: Refined Framework

The goals of this research were to map out how usability can be included in the procurement processes of healthcare IT systems and to create a framework for procuring usable healthcare IT systems. To meet these goals a literature research and interviews from three recent procurement projects of healthcare IT system that had included usability evaluation to their process were conducted. A preliminary framework was created based on the literature review in chapter 3, and it was refined based on the interview study in chapter 4. As a conclusion the most important findings from both the literature review and interview study were compiled into a refined framework that is presented in this chapter (figure 3). The framework consists of five phases of procurement and what usability activities should be carried out in each phase.

The five phases of procurement are

1. Defining strategic goals
2. Creating the requirements
3. System evaluation
4. System selection
- and
5. Implementation and training, after the procurement,

which will be discussed in detail in the following, bringing together the conclusions from both the literature review and the interview study.

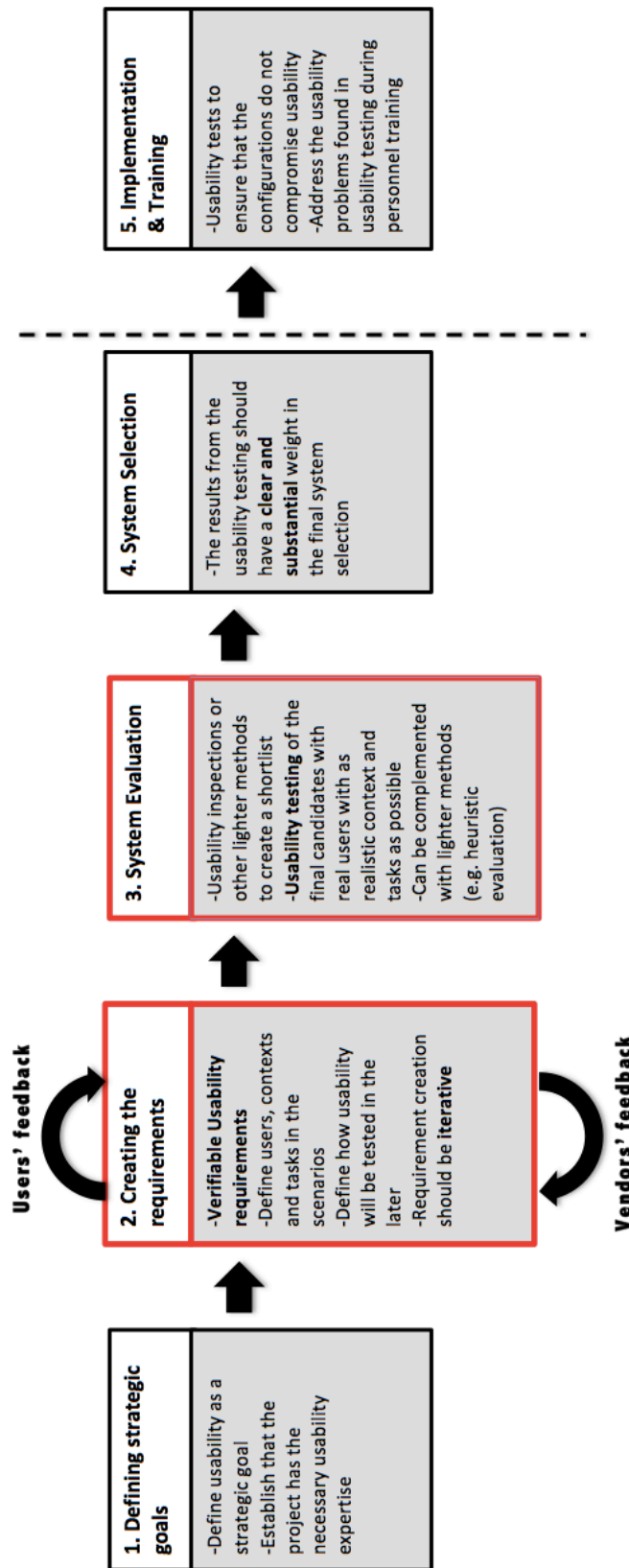


Figure 3: Framework for including usability in the procurement of healthcare systems

1. Defining strategic goals

Good usability of the system should be defined as a strategic goal of the procurement. Including usability in the strategic goals enables the project to allocate enough time and resources for the usability activities from the start.

It should be also established in the very beginning of the process that there is the necessary usability expertise in the project. If the procuring organization doesn't already possess enough usability expertise inside the organization, usability expert can be hired to the project or buy it from outside. Regardless of how the usability expertise is acquired, the essential factor is that it's included in the process early enough: The later the usability is included in the process the harder it will be. This can be seen for example in one of the cases presented in chapter 4, where even though the usability expertise was acquired from inside the organization, it wasn't added to the project until in the evaluation phase and thus the requirements didn't optimally comport with the usability evaluation method.

In the cases presented in chapter 4 usability wasn't mentioned in the strategic goals as such in any of the cases, however "user friendliness" was mentioned in one of the cases. This example clearly demonstrates how including a strategic goal can lead to usability being considered also in later parts of the process: Even though originally in the organization it was not clear how user friendliness or usability could be included in the procurement, or even what these terms actually include, because it was mentioned in the planning of the project, the project director started research and ask around about the subject, which eventually led to the inclusion of usability evaluation to the procurement process. In another case even though usability was not the in the strategic goals of the procurement, it was a strategic goal of one of the organizations included in the procurement that all healthcare systems being procured must be tested for usability with clinical simulation. The experience there was that even though usability had been talked for a long time, the projects were reluctant to add the usability in to the procurement before it was made as a strategic

goal. Therefore adding usability in the strategic goals of the procurement gives good basis for usability being considered throughout the process.

2. Creating the requirements

Including usability requirements in the requirement creation phase is extremely important, since if usability is not required it cannot be expected either. The usability requirements should be verifiable, valid and comprehensive, meaning that it should be possible to objectively confirm if the system meets the requirement and the requirements cover the system extensively enough. How the systems' usability will be later evaluated should also be considered already when creating the usability requirements, so that the evaluation comports with the requirements.

Currently there is still uncertainty on how the usability requirements should be created. So that the usability requirements would be verifiable, they should be based on users' performance, rather than general requirements, such as "the system should be easy to use", or design heuristics or guidelines like "The user should not have to remember information from one part of the dialogue to another", since these cannot be objectively tested (Jokela et al., 2013). If the requirements are based on users' performance it supports the inclusion of user testing in the process, even necessities it. In all of the three cases of the interview study the creating the usability requirements was found problematic, and the requirements were either based on known heuristics or not specified at all. It is clear that more research on how the requirements should be created is needed. In one of the cases of the interview study creating minimum requirements for the usability is also considered, if a way for setting the minimum requirements objectively can be found.

Jokela (2010) suggests that goal values could be set on tasks completion percentage and design solution success rate i.e. the percentage of users that have problems with the design. Jokela further suggest that these goal values

could be set in statistical form the following format is needed: e.g. "95% confidence that 75% of target population completes the task correctly". In addition to these target for user satisfaction could be set too. User satisfaction was measured in all of the three cases in the interview study. Measuring user satisfaction might be relatively easy, but where to set the target level might be harder to pinpoint.

Both substantive competences of the users and usability expertise are needed in creating the usability requirements. To be able to create requirements that support the users work users should be included in the requirement creation process. For creating the requirements users' roles, tasks and contexts should be specified. Also vendors can be included in a dialogue about requirements. The process of creating the requirements should be iterative.

How the usability will be evaluated later on in the process should also regarded already in the requirement creation phase – otherwise there the requirements might not match optimally with the usability testing method. This was the case in Case 2 of the interview studies, where the requirements that were created based on traditional design guidelines did not match the usability evaluation method of clinical simulation. It was the wish of the people who carried out the clinical simulation that they could have been involved already in the creation of the requirements so that the requirements could have been better created to match the potentials of the method, and possibly clinical simulation could have been utilized already in the requirement creation phase.

3. System evaluation

When the systems are evaluated the usability of the systems should be evaluated as well, since that is the only way of really verify the systems usability. Results of the literature review were suggesting that the best way

for gaining confidence that the system being procured is usable is to test the systems with high fidelity usability testing. Lighter usability evaluation methods (such as heuristic evaluation) can be used in preliminary assessment for creating a shortlist of systems and as a complementary methods for the usability testing.

According to Kushniruk et al. (2010) implementing usability testing gives the strongest evidence regarding the usability of candidate systems during procurement. Also from interviews from projects that had employed usability testing in their procurement process the experience was that the usability testing gave good basis for selecting the final system and gave a lot of valuable information about the system that couldn't have been discovered other way. Even though the high-fidelity usability testing requires investment of both money and time, it should be remembered that fixing the usability problems after the implementation can be significantly more expensive and system with usability also requires more training that is also costly (Baylis et al. 2012).

High fidelity usability testing means testing the candidate systems with real users testing the system with as realistic tasks and context as possible. In order to create realistic tasks users should be involved in creating the use cases or user stories. This was done in all of the three projects included in the interview study. However testing in realistic context was addressed only in one of the three cases, where the systems were tested with clinical simulation that mimics the real work context of the clinicians. The simulation has some differences to the real-world situation, such as fewer patients and therefore the clinicians are in less of a hurry still creates an acceptable replacement of the real environment. From literature an example of testing the systems in the real hospital context was also found, case from Lille Regional University Hospital described by Kushniruk and colleagues (2010), and it was very successful in evaluating the actual usability of the systems.

In addition to high fidelity usability testing, other lightweight usability evaluation method can be applied as supporting methods. This is especially true for the preliminary evaluation: If there is initially too many vendors for it to be feasible to test them all with high fidelity usability testing, lighter methods can be used first to create a shortlist of system that qualify for the final evaluation round. Examples of lighter usability evaluation that can be used in alongside with usability testing are usability inspections such as heuristic evaluation and usability walkthroughs. Carvalho et al. (2009) have created a set of heuristics specialized in the evaluation of healthcare IT systems. Even though usability testing creates the strongest evidence on the systems usability, the lighter methods still provide valuable complementing insights. Especially heuristic evaluation seems to complement usability testing well. In the case of the interview studies that applied both usability testing and heuristic evaluation, one of biggest surprises for them was how the heuristic evaluation and usability testing produced very different insights, however both were seen valuable. Heuristic evaluation was suggested as a good addition for usability testing in the literature as well (Kushniruk et al. 2010, Carvalho et al., 2009).

4. System Selection

The results from the usability testing should have a clear and substantial weight in the final system selection.

All the usability activities done during the procurement should culminate in the system selection phase: It is not enough to evaluate the usability of the systems but the results from the usability evaluation should have a significant weight in the system selection. Of course the system selection has to have other criteria too, but since usable system is not only more efficient to use and more likely to be adopted by the users but also safer, it is critical that usability has a notable role in the system selection. The need for this

emphasizing came from the case studies, from where it became apparent that including usability testing in the procurement processes, didn't necessarily mean that the results from the usability testing had a straightforward effect on the system selection: There was a case where the effect of the results was hard to pinpoint and in another one it was other very low. Luckily, in these projects the final system being chosen was also succeeding in the usability testing, however this should not be left to chance. Even though usability testing admittedly has several positive by-products, such as internal and external marketing of the project, the benefits of selecting system with good usability clearly exceeds the other benefits of usability testing. Therefore the role of usability testing in the procurement process should be first and foremost to affect the final system selection. This further highlights the importance of good usability requirements especially in the case of public procurement, since only if usability is required it can affect the system selection.

5. Implementation and training (after the procurement)

Usability evaluations should be done also during the implementation to ensure that the configurations will not compromise the usability. The usability problems found in the system evaluation phase should be addressed during the personnel training.

Usability activities should continue also after procurement process, during the implementation phase. The main reason for this is that the modern healthcare IT systems are so highly configurable that even if the system with best usability is chosen, it is possible to reduce the systems usability with wrong kind of configurations. To avoid this, usability should be tested while the configurations are made and when the system is going to be put to use. Also the learning's from usability evaluation during the procurement can and should be utilized during the personnel training before and after the systems initialization. The usability evaluations detect the problems that the

users have with the system so those issues should be especially emphasized in the training.

Development of the Framework from the Preliminary Framework

From the interviews of the three cases of healthcare IT system procurement in chapter 4 many important insights were gathered that also led to a need for updates in the preliminary framework, that was created only based on the literature. The biggest changes to the preliminary framework are described in the following.

The procurement experts that were interviewed pointed out that in the marketing research phase the properties of the system itself, including usability, are not the things that are looked for, but rather the qualities of the company such as financial stability. This is why the marketing research phase from the framework was removed, as the possible usability considerations could not have a significant effect on that phase. This is however not to say that the vendors should not provide results from past usability testing as it is still valuable information for the procurers when they are trying to get a sense of the quality level of the systems. Vendors modifying the system after the evaluation phase was also removed, since the interviewees indicated that there rarely is possibility for modifications in the off-the-self systems. However there are a lot of possibilities for system to be configured, and that should be considered in the implementation phase.

In the preliminary framework a phase that included creating the requirements was named 'Request for Proposal and' preceded 'System Evaluation' phase. However when the project is using negotiation method for the procurement, the process of creation of the request for proposals overlaps with the evaluation of the systems. Therefore in the final framework the name of Request for proposal-phase was changed to 'Creating the requirements' to avoid confusion.

The 'System selection and Implementation' phase form the preliminary framework was split in two for the refined framework to emphasize each phases importance as separate. The system selection phase needed to be emphasized since the interviews revealed that inclusion of usability evaluation didn't necessarily mean that the results had a clear impact on the system selection. On the other hand the importance of including usability testing activities to the implementation phase was seen as ever more important, since as several of the interviewees expressed, the modern healthcare systems are so modifiable that if the configurations in the implementation phase are done without usability considerations, the system could be rendered unusable. The interviews also revealed another use for usability testing results gained during the procurement process that had not been mentioned in the literature: They provide good material when planning the personnel training.

6. Limitations

In this work the different policies and legislation of individual countries or regions regarding the procurement process are not discussed, instead it aims at discussing the matter in a more general level, so that the results would be applicable internationally. This point of view was a natural choice since the thesis was written partly in Finland and partly in Canada. The policies and laws of individual countries of course have a great impact on the procurement process, and research on this would most interesting and should be discussed in the future. However since the basic problem of how to include usability in the procurement process of healthcare systems is universal, it should be also addressed as a universal matter. Kushniruk and colleagues (2012) reviewed the progress of ensuring safety of health information technology in Canada, United States and England and concluded that sharing and communication of ideas, methods, findings and recommendations across nations is recommended for significant progress. The importance of non-country-specific point of view is further promoted

by the fact that the markets for healthcare IT systems are already international with the same vendors operating around the world.

From the international point of view it can however be seen as a limitation that all of the three cases included in the interview study were public procurements (The case of Finnish Student health organization, which is not government ruled, still complied to the public procurement process). In the countries where these projects were carried out, in Finland and Denmark, this is the norm since the public healthcare services constitute the overwhelming majority of all healthcare services. However globally this is not the case as in other regions healthcare services are largely privatized. Therefore an example from private sector procurement process would have been an interesting addition. Nevertheless, since the public procurement legislation is usually stricter than that of procurement processes in the private sector, the practices and processes that are applicable in a private procurement processes might not be applicable in the public procurement processes, but if a process is suitable for public procurement it should be usable also in the private sector.

As briefly discussed in chapter 2 the method used for the literature review was scoping review. Scoping review resembles systematic literature review, but the difference is that a scoping review can also include grey literature (Levac et al. 2010). Scoping review was chosen as a method as the goal of the research was to create as broad view of the current practices as possible even though the current literature on the subject was scarce. Scoping review is also a very common method in healthcare related research in general. The literature research as such included a paper by Schumacher and colleagues (2009), a white paper from a usability consultancy, and two papers from Healthcare Quarterly, that is not a peer-reviewed journal. However omitting these articles would have created a much more incomplete picture of the current state of the field.

7. Discussions & Future work

One of the most critical problems identified in this work was the need for clearer directions on how the usability requirements could be set in a way that they are verifiable and support the inclusion of usability evaluation and comport with it optimally. Inclusion of usability in the requirements is of uttermost importance, since if the usability is not required, even if usability evaluation is included in the process, the results can't affect the system selection. Currently it is still not clear how these requirements should be ideally set and what should they encompass, therefore this question still needs more attention and future research.

It is also important to recognize that the role of usability evaluation in the procurement process is twofold. Of course the primary function of the usability evaluation is to compare the candidate system and find the one with the best usability – as one of the interviewees put it “in tender everything is about winning and loosing”. For this reason the usability evaluation has to be able to produce clear, unequivocal and preferable numeral results that makes it easy to rank the candidates from best to worst. This however, is not enough: If usability is seen only as a ranking tool, the result might be that chosen ‘best’ system is just the least bad. Therefore the systems absolute usability should also be evaluated. For this purpose also qualitative data from the evaluation can be extremely valuable, even though it couldn't be used in the quantitative comparison of the systems. The qualitative results can be for example used in the negotiations, in the planning of customizations for the system and how much and what kind of training is needed for the staff.

Even though as the literature researched showed usability of the healthcare IT systems in the procurement hasn't not been covered a lot yet, recently the progress has been positive, as the problems with the usability of the systems have been recognized even in the public media around the world. One of the

steps being taken towards ensuring usability of the healthcare IT systems has been trials of creating general certification for usability of healthcare systems. One example is Certification Commission for Health Information Technology (CCHIT) Certified 2011 Ambulatory EHR Certification Program (CCHIT, 2011), where usability is as a trial rated as a part of the certification. Of course, as discussed before in this paper, the certification can demonstrate the system's usability only to a point, since usability by definition is context dependent. Therefore the real solution for implementing usable healthcare systems can't come from the certifications, but from applying procurement processes that include testing the usability of the system with the actual users performing realistic tasks in a realistic context.

There has also been recent efforts for creating official recommendations for enhancing the procurement of healthcare IT systems by the European Union (Vogt et al., 2012), however these recommendations did not address the role of usability in the process. In US, National Institute of Standards and Technology (NIST) has been however creating a principled framework for measuring the usability of healthcare IT systems (NIST, 2013). For a review of the measures took for ensuring safety of health information technology in Canada, United States and England, see Kushniruk et al. (2012).

It is the wish of the author that this contribution will further promote the awareness of this issue and that the framework introduced in this work can ease the inclusion of usability consideration in the procurement of healthcare IT systems in the future.

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Appendices: Interview structure

Introducing self and the project.

The participant is asked for the permission to record the interview.

General questions:

- What was/is your role in the procurement process?
- Do you have previous experience on similar procurement processes?

Semi-structured prompts based on the framework:

1. Defining strategic goals
 - How were the strategic goals defined in the project you were involved with?
 - Who were involved?
 - Was usability mentioned in the goals?
 - How was it defined?
2. Researching Vendors
 - How was the search for vendors done in your project?
 - What kind of criteria when searching for the vendors?
 - Were certificates or declarations that the vendors might have considered in this phase? Especially about usability?
 - Did the vendors success in past usability tests come up?
3. Request for Proposals
 - What was the process for creating request for proposals?
 - How were the requirements created?
 - How were the selection criteria determined?
 - Who was involved?
 - Was usability mentioned in either of these?
 - Defining the users? Defining the context? Defining the tasks?
 - Who did?
 - Were the requirements revised? By whom?
 - Were the users involved in the creation?
 - Were the vendors involved in the creation?
4. Evaluating systems
 - Was there a separate phase to create a shortlist of systems for further evaluation?
 - How were the systems evaluated?
 - By whom? Was usability considered in the evaluation of candidate systems?

- If so, how was usability evaluated/considered?
 - Users involvement?
 - How was the RFP in previous phase involved in doing the evaluations?
 - Was the system refined after the evaluation?
5. Selecting and implementing system
- Did you feel that the evaluation phase gave good basis for selecting the final system?
 - Did usability play a part in the selection of the system, if so, how? (please describe)
 - Was the system tested/will it be tested after the implementation too?

Thank the participant for their help.