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A Framework for Usability Evaluation in EHR Procurement

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Abstract. Usability should be considered already by the procuring organizations when selecting future systems. In this paper, we present a framework for usability evaluation during electronic health record (EHR) system procurement. We describe the objectives of the evaluation, the procedure, selected usability attributes and the evaluation methods to measure them. We also present the emphasis usability had in the selection process. We do not elaborate on the details of the results, the application of methods or gathering of data. Instead we focus on the components of the framework to inform and give an example to other similar procurement projects.

Keywords. Usability, evaluation methods, procurement, electronic health record system, measurement, metrics

1.   Introduction

Electronic health record (EHR) systems suffer from usability problems and end-user dissatisfaction [1]. Focusing on users and their needs during system development should prevent these issues. However, if procuring organizations do not take into account the usability of the candidates they still risk selecting a system with poor usability and end up with a laborious if not even impossible process of trying to improve usability during implementation. Usability issues are argued to be key determinants in successful EHR implementation and adoption, and should therefore be given a high priority in the selection process [2].

Usability evaluation methods were introduced in early 1990s [3], and the number of published studies on their use in health informatics field has increased remarkably since 2005 [4]. However, research on measuring usability during procurement is scarce [4].

In this paper, we present a framework for usability evaluation during EHR system procurement. The framework was developed during a large scale procurement of a client and patient information system ('CAPIS') for tertiary, secondary and primary healthcare as well as social care. We describe the objectives of evaluation, the procedure, applied usability evaluation methods and the principles for quantifying the evaluation results. The results and data gathering methods are not presented. Our objective is to support EHR system selection process with a methodological framework for evaluating usability.

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2.   Background

The ISO standard [5] defines usability as "the extent to which a product can be used by specific users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Also, the five commonly used attributes of usability described by Nielsen are [3]: learnability, efficiency, memorability, errors, and satisfaction. The ISO [5] aspects of usability are widely accepted to concern distinct measures [6]. For example, in a usability test, effectiveness can be measured by counting the percentage of successfully completed tasks and efficiency by the ratio between actual behavior and an optimal solution [3]. Furthermore, usability questionnaires (e.g. SUS [7]) are tools to measure satisfaction in terms of users' responses to questionnaire items or users choosing or ranking interfaces according to preference [6]. Both subjective and objective usability evaluation methods are appropriate to measure usability [6].

Measuring usability during procurement to compare the competing systems poses demands on the evaluation process. The procurement process of governmental entities is often under strict legislation. European Union members must comply with EU wide rules [8] of a transparent process and uniform and equal treatment of vendors.

An established five-step process for measuring usability of EHR systems to support the selection suggests conducting the evaluation in two phases [2]: (1) estimation of relative usability for products using usability walkthroughs (typically in groups moderated by a usability expert) or heuristic evaluation; and (2) short-list evaluation for final selection using usability testing in which numeric goals should form the basis of the evaluation. Other researchers have supported the approach: heuristic evaluation is viewed as a viable method for preliminary assessment [9] and implementing usability testing is argued to give the strongest evidence on the usability of candidate systems [10].

Our framework complies with this approach. Previously, we have introduced two new methods: inspection method (HED) [11] and usability questionnaire (DPUQ) [12] to be used during scenario based system demonstrations. In this paper, we present how usability objectives, attributes and measures form the basis of this two phase procedure. In 'CAPIS' the framework was used to evaluate four vendors in the first phase and two vendors in the second phase of procurement.

3.   Methods and Results

First, we identified the two main user groups, professionals (both from social care and healthcare) and clients or patients. Based on differing roles and tasks, physicians, nurses and social workers were identified as key users. Key contexts were identified based on specific functionalities needed: patient and client portal, intensive care unit, operating room, emergency department, labor and delivery, outpatient clinic, home care, disability services, social assistance and child welfare. The critical and frequent tasks were identified in workshops with user representatives where they wrote user stories describing the client or patient paths. For other professional groups, the central tasks were considered to be mostly derived from the already mentioned.

Second, we defined the objectives of usability for these user groups utilizing widely known usability attributes [3,5] and the established goals of 'CAPIS'. Table 1 illustrates the overall goals, the usability objectives and how these are linked to each other.

Table 1. The overall goals of the procurement and objectives of usability for two main user groups.

Goals of 'CAPIS'	Objectives for professionals	Objectives for clients / patients
(a) unified service and care pathways (b) cost-effectiveness and quality (c) data driven management and development (d) client / patient in the center (e) satisfied users (f) new innovative services	- Improved efficiency and effectiveness (a),(b),(c),(d) - Reduced number of errors (b),(c),(e) - Fluency of taking the system in use: learnability (a),(b),(e) - Increased user satisfaction (e),(c),(b)	- Increased user satisfaction (d),(b) - Increased efficiency (d),(f),(e) - Fluency of taking the system in use: learnability (d),(e),(b) - Reduced number of errors (e) - Accessibility of electronic services (d),(b)

The evaluation procedure was divided into two phases: preliminary assessment (phase A) and short-list evaluation (phase B). Objectives for the usability evaluation in these two phases were as suggested by literature [2]. In phase A the aim was to assess relative usability for competing products, to verify that usability of key functionalities is on a sufficient level, and if these criteria were not met exclude the vendor from further negotiations. Central areas of system use and usability were covered for all three user groups, healthcare professionals, social care professionals and clients/patients. In phase B the aim was to assess the objective usability of the system by measuring it according to strict test principles. The evaluation focused on getting further evidence on the fluency of use and user satisfaction based on actual use of systems. The evaluated areas were further focused to key functionalities in phase B.

The usability objectives described in Table 1 included the attributes to be measured: efficiency, effectiveness, errors, learnability and satisfaction. In phase A, "quality of user interface design" was selected as an overarching concept covering efficiency, effectiveness, errors and learnability. The used measures for the attributes as well as evaluation methods were based on literature and feasibility of collection during procurement. Because 'CAPIS' was a large scale governmental procurement we also developed evaluation methods to fit our needs as efficiently as possible [11,12]. Table 2 lists the usability attributes, evaluation methods and measures used in both phases.

In phase A, usability evaluation contributed 15% of the points given to vendors. The minimum requirement for usability was to receive 10 % of the maximum points available for "quality of user interface design" in each evaluated user scenario. The calculation of points for this usability attribute is described in detail in [11]. The total usability points in phase A were counted based on results from three methods using the following weights: 2/3 * results from usability expert review method (HED or traditional heuristic evaluation) + 1/3 * results from usability questionnaires (DPUQ method).

In phase B, usability evaluation contributed 12 % of the points given to vendors in the final selection, this was 40 % of the points given for evaluation of the functionalities of systems. The weights for the usability attributes were determined separately for the systems used by professionals and by clients and patients (see Table 3). Defining how points were given from each measure required detailed planning, which we are not able to elaborate on in this paper. Some details of quantification of paired-user and usability tests are described in [13].

Table 2. The framework for usability evaluation: usability attributes, evaluation methods and measures.

Attribute	Evaluation method	Measure
Phase A		
Satisfaction	Usability questionnaire (DPUQ [12]) (in scenario based demonstration)	Perceived usability: professionals responses during and after session
Quality of user interface design	HED [11] (heuristic evaluation in scenario based demonstration)	Documented usability issues: heuristic violations, missing functionalities, omitted parts of the user scenario and positive findings
	Task-based heuristic evaluation	Documented usability issues: heuristic violations, missing functionalities and positive findings
Phase B		
Effectiveness	Paired-user / usability test	Percentage of successfully completed tasks
Errors	Paired-user / usability test	Errors made by the user during task completion
Efficiency	Expert evaluation	Number of steps in the optimal solution to tasks
	Interactive scenario based demonstration (group inspection session)	Usability specialist's assessment of efficiency
		Usability specialist's assessment of efficiency of configuring the system
Learnability	Usability questionnaire (SUS [7]) (in paired-user / usability test)	Perceived learnability: learnability factor [14] from users responses after task completion
	Interactive scenario based demonstration (group inspection session)	Usability specialist's assessment of learnability based on professional's verbal answers
		Usability specialist's assessment of learnability of configuring the system
Satisfaction	Paired-user / usability test	Positive and negative markers given by users during task completion
	Usability questionnaire (in paired-user / usability test)	Users responses after task completion (SUS)
		User's rank of systems based on preference after task completion
	Usability questionnaire (DPUQ, summative part) (in group inspection session)	Perceived usability: professionals responses after session
Quality of user interface design	Interactive scenario based demonstration (group inspection session)	Usability professionals assessment based on usability heuristics and professionals' discussions during demonstration

Table 3. Usability evaluation in phase B: weights given to usability attributes.

Usability attribute	Weight for professionals	Weight for clients and patients
Effectiveness	30 %	25 %
Errors	20 %	10 %
Efficiency and learnability	20 %	10 %
User satisfaction	20 %	25 %
Quality of user interface design	10 %	-*

* 30% from accessibility: accessibility evaluation was conducted to complement usability evaluation

4.   Conclusion and Discussion

While we followed the five-step process described previously [2], our framework emphasizes the detailed planning of usability evaluations. There were five key factors in developing and using our framework: Defining (1) the key user groups and use contexts; (2) the central (critical and most frequent) tasks and goals; and (3) the usability objectives, attributes and their importance for the user groups. (4) Applying suitable methods to evaluate these attributes reliably, efficiently and extensively; and (5) quantifying the results for selection purposes. This required intensive collaboration between usability and domain experts because of the complexity of healthcare and social care domains included in the procurement and scarcity in published literature in how to apply theoretical frameworks into practice.

'CAPIS' showed that usability can and should be included in the selection process. The qualitative evaluation had a significant effect on the final selection. Moreover, there was a market court appeal of the procurement but usability methods were not questioned. Including usability already into the selection gives a clear signal to the system vendors: usability should be given high priority throughout the lifecycle of the products.

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