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AIM - Agile Instrumented Monitoring for Improving User Experience of Participation in HealthIT Development

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Abstract. Participation of healthcare professionals in information technology development has emerged as an important challenge. As end-users, the professionals are willing to participate in the development activities, but their experiences on the current methods of participation remain mostly negative. There is lack of applicable methods for meeting the needs of agile development approach and scaling up to the largest implementation projects, while maintaining the interest of the professional users to participate in development activities and keeping up their ability to continue working in a productive manner. In this paper, we describe the Agile Instrumented Monitoring as a methodology, based on the methods of instrumented usability evaluation, for improving user experience in HealthIT development. The contribution of the proposed methodology is analyzed in relation to activities of whole iteration cycle and chosen usability evaluation methods, while the user experience of participation is addressed regarding healthcare professionals. Prospective weak and strong market tests for AIM are discussed in the conclusions for future work.

Keywords. Agile development, electronic health record, usability evaluation, user experience

Introduction

Usability evaluation in various forms has been proposed as a powerful methodology for assuring fitness for use in electronic health record systems [1]-[3]. Studies point out that there are different methods regarding their suitability at certain stage of EHR acquisition and type of development approach, such as Low-Cost Rapid Usability Testing incorporated into agile development of healthcare IT [4]. In addition to this, different methods are found to provide complementary capabilities on finding out usability problems [5] to be fixed and thus more than one method is preferred to get reasonable impact on applying usability evaluation methodology in practice. The most important methods can be prioritized based on their efficiency in finding usability problems, but overall impact remains unexamined. The challenge in figuring out the overall impact of the methodology is the lack of existing and comparable cases to study. In practice, it would also be waste of resources to duplicate any forthcoming real-world project solely for the interest of comparison.

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In a context of large scale EHR development, the scalability of the methods, knowledge and practical settings plays a huge role. Martikainen et al [6] have confirmed that physicians have been highly critical of their experiences of the current means of participation and lack of it in a Finnish nationwide survey. Against general assumption that there is lack of willingness by the users to participate in systems, the survey results suggest that physicians would be willing and should be given an opportunity to participate in systems development in reasonable ways. In complex and wide functional spectrum of a major EHR implementation, both the scalability of the methods and the accessibility of domain expertise are thus relevant enablers to apply the methodology.

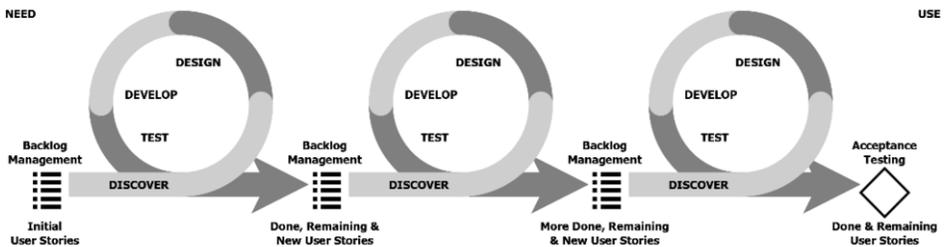


Figure 1. Illustration of three development cycles in an iterative software implementation project.

Iterative development approach (Figure 1) in development of modern EHR capabilities is already evident [7] and have been suggested to be highly effective with time boxed iterations to meet clinicians' needs and expectations. This would allow projects to operate with predictable amount of resources while the produced quality is the most flexible result parameter if the obligatory requirements for the system are met. Delivery time and major cost factors are fixed, and any compromises should be justified by the need of ensuring the obligatory requirements of minimum quality. Molich et al [8] emphasize increasing focus on quality and quality assurance, and preventing methodological mistakes in usability testing such as skipping high-priority features, giving hidden clues or writing usability test reports that are not fully usable.

The objective of this paper is to assess the fit of AIM to HealthIT development considering participants' user experience using the following criteria:

- a) How activities of the agile development can be associated with chosen usability evaluation methods and what's their primary contribution to a whole cycle of iteration?
- b) What's the potential of AIM to complement (or even outperform) the other methods in their primary contribution, especially concerning user experience of participation?

Topics for further discussion are the possibilities to gather weak and strong evidence on performance of the method in comparison with the other methods and on the cost-benefit structure of the method itself.

1. Related Usability Evaluation Methods

Usability evaluation methods suitable for guiding iterative development include both formative methods for identifying usability problems to get rid of and characteristics to

keep as well as summative methods to assure that definition of done is achieved for development targets defined by user stories and desired capabilities. The level of user involvement and required expertise varies between the methods and thus affect their use of resources. Productivity of the methods is defined by the quality and amount of contribution in relation to the activities of development (Table 1). Chamberlain et al [9] characterizes user involvement in agile development being where: the users were invited to give opinions or test prototypes, the users were interviewed, observed or questioned for research purposes, or the user's interaction with the product was considered in detail. In addition to EHR users (clinicians, patients, administration), the efforts by software designers and usability experts drive the objectives and outcomes of the methods while causing resource constraints as their limited skillsets and availability for spending their time in laborious usability evaluation activities especially in large-scale implementations.

Table 1. Acts of iterative software development and how usability evaluation methods can transform different sources into relevant contribution.

Act	Contribution	Sources	Evaluation method
(NEED)	Initial user stories	(Known needs)	(Field observation)
DISCOVER	New user stories	Unknown needs	Semi-structured interview
DESIGN	Refined user stories	Unmet needs	Cognitive walkthrough
DEVELOP	Done user stories	Conceptualized means	Heuristic evaluation
TEST	Tested user stories	Demonstrated means	Usability testing
(USE)	Accepted user stories	(Validated means)	(Usability survey)

Semi-structured interview in user-centered design has been described by Woods [10] as a methodology for structuring interviews with users to assist and analyze in modeling their work in early phases of application development. Interviewing people provides insight into their world; their opinions, thoughts and feelings, but is a resource-demanding data collection method, because activities such as planning, conducting and analyzing are time-consuming by nature and interviewees have to spend time on a "non-productive" activity [11].

Cognitive walkthrough, according to Rieman et al [12], "is a technique for evaluating the design of a user interface, with special attention to how well the interface supports "exploratory learning," i.e., first-time use without formal training." The evaluation can be performed by the system's designers in the early stages of design, before empirical user testing is possible, making it well-suited into agile development.

Heuristic evaluation, according to Nielsen [13], "is a usability engineering method for finding the usability problems in a user interface design so that they can be attended to as part of an iterative design process. Heuristic evaluation involves having a small set of evaluators examine the interface and judge its compliance with recognized usability principles (the "heuristics")," which is well in tune with agile development.

Usability testing "is a technique used in user-centered interaction design to evaluate product by testing it on users" [14]. Molich et al [8] have demonstrated that the effectiveness of a usability test in general is dependent on the chosen tasks, the methodology, and the persons in charge of the test. On the other hand, a follow-up study of cognitively-based usability testing by Kushniruk et al [15] indicated consistently a ten-fold decrease in the average number of user problems through problem identification, produced recommendations and suggested modifications.

2. Agile Instrumented Monitoring

Usability evaluation methods with different levels of instrumentation have been introduced for gathering user collected information on actual events of use. The critical incidents method for remote usability evaluation by Castillo [16], distributed usability evaluation by Christensen & Frøkjær [17] and user-triggered usability testing Pitkänen et al [18] apply video recording of the user's computer screen for context information about collected events. User-initiated event markers are collected by pressing a button in case of an emergent usability issue experienced by the user. Typically, there are two or three buttons to indicate at least negative and positive issues while the third one may be used for indicating any other types of remarks or issues with lesser significance. User comments on the issues are collected either as spoken comments by audio recording or written notes along the other recordings.

Agile development practices require a quick turnaround for any interventions during a development cycle and continuous applicability would be even more preferred. Agile Instrumented Monitoring takes the means of existing instrumentation concepts for usability evaluation to be exercised in large-scale information systems development in an agile manner. The scope of applying the monitoring is in summative testing for traceable documentation of development outcomes against Definition of Done (DoD) criteria, and in formative testing for capturing and resolving issues as seen by the user or developer while exploring or using the system under development.

Pre-requisites for applying the Agile Instrumented Monitoring include an identified user group and developers capable of running the monitoring tools. Availability and willingness of the users for contributing the development in the proposed way affects the applicability of the approach and user experience on applying the method is of a great interest to make it sustainable. Furthermore, the developers' domain expertise on system use is a differentiating factor on dividing the usability evaluation work between the users and developers.

3. Analysis of AIM Applicability in Healthcare

Initial experiences on using AIM related tracing capabilities are based on the summative evaluation of two EHR systems for procurement scoring [19] where usability represented 20% of the overall quality criteria and usability testing contributed 74,4% of the usability scoring along other methods, such as heuristic evaluation. Price-to-quality (40%+60%) consideration resulted to final scores of 89,76 vs. 92,23. A contract was awarded to the system vendor with a one fifth higher bid price (385M€) compared to the other system (320M€). As the actual deployment of the chosen system requires tailor made development and configuration, the outcome and data from the comparison testing can be taken as a starting point when applying the AIM in this case.

For development purposes the comparison testing data already includes some useful summative data as well as observations for formative evaluation. Successfully performed tasks would meet a definition of done criteria related to the associated user stories behind them while failed task executions would suggest some further development to meet their definition-of-done criteria. During the test sessions, the users could mark up any negative or positive experiences of use by pressing an associated button (☹ or ☺) and the test moderator also marked up major and minor problems, and

positive perceptions (--, -, and +). Negative experiences or problems would suggest development efforts to be allocated on solving the underlying issues behind these kinds of observations while positive ones would suggest on keeping up the ideas behind the good experiences.

Suitability of the AIM for a given development phase can be analyzed by assessing the relevance of outcomes for guiding the development efforts. Successfully performed tasks by all the users can be considered as done. Tasks with no success by any of the users get the highest priority on a development backlog. Task failures can be traced back to the problems encountered while performing a certain task. Now the suitability of the AIM can be addressed by examining the data gathered about the problematic events and considering whether there are self-evident solutions to the problems when reviewed by the developers.

Table 2. Potential contribution of the AIM to complement the other evaluation methods.

Contribution	Evaluation method	AIM complementing
Initial user stories	Field observation	Operational evidence
New user stories	Semi-structured interview	Real-world tasks
Refined user stories	Cognitive walkthrough	Trace of issues
Done user stories	Heuristic evaluation	Record of demonstration
Tested user stories	Usability testing	Traceable results
Accepted user stories	Feedback survey	Operational statistics

User experience of participation becomes a topic of interest during the actual development phase, since the comparison testing represented mostly a traditional way of usability testing as seen from the users' viewpoint. Now this semi-instrumented usability evaluation method can be applied as a means for discovering real-world evidence on the tasks which may not be fully supported by the system yet (Table 2). Trace of issues and record of demonstration remains to be produced mainly by the configuration analysts during design and development, but the AIM would enable them explore the system capabilities in a more naturalistic way considered that most persons in this role have a working experience as representative users of the system in our case of interest. Testing with real users becomes more feasible during iterations and acceptance phase as the instrumentation for testing can be taken into use for every agile team without a need for heavy usability lab facilities and preparations required by traditional testing approach.

4. Discussion and Future Work

New approaches for usability evaluation with trained software development practitioners and end users with minimalist training have been suggested by Bruun & Stage [20] to reduce three critical obstacles related to resource constraints, limited understanding of the usability concept and methods as well as resistance adopting usability practices. The approach with user participation is found highly effective in overcoming the obstacle of resource constraints. The approach with software developers increases awareness and reduces resistance towards usability testing results, which boosts the impact of the evaluations on the system's usability. [20]

Sustainability of usability practices driven by software developers and user experiences related to large-scale crowdsourcing approach still lacks systematic studies. Although Bruun & Stage have suggested the new approaches being mostly relevant in small companies [20], we continue studies on them with large scale information system

projects for more agile development and look for comparable evidence on their performance against existing practices. For a weak market test of the AIM we suggest addressing the participating users with the questions about how meaningful, beneficial and motivating they would consider the approach.

Martikainen et al [6] have concluded that physicians to contribute, better methods of participation need be to developed and applied, particularly for the procurement, deployment and on-going development of commercial off the shelf applications. For a strong market test, we look for ways to practice the AIM in chosen sub-projects of a large-scale healthcare information system project to get commensurate evidence on the performance, and insight on user experience of participation when applying the approach.

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