Context Mediated Usability Testing

Craig E. Kuziemsky and Andre Kushniruk

2014

e-Health – For Continuity of Care
C. Lovis et al. (Eds.)

doi:10.3233/978-1-61499-432-9-905

Context Mediated Usability Testing

Craig E. KUZIEMSKY[a,1] and Andre KUSHNIRUK[b]
[a] *Telfer School of Management, University of Ottawa, Ottawa, ON, Canada*
[b] *School of Health Information Science, University of Victoria, Victoria, BC, Canada*

Abstract. Usability testing is an important part of health information technology HIT design. However, usability issues will vary by the contexts where a system is used. To date there are few studies that have described contextual factors of usability testing. This paper uses a case study of a surgical information system to develop a model of four contextual categories that impact usability testing. We discuss each of the contexts in detail and then suggest how they can be used to develop a general framework to enable better understanding of the role of context in usability testing and evaluation of HIT.

Keywords. Usability testing, context, evaluation, health information technology

Introduction

Usability testing is an important part of health information technology (HIT) design. The importance of usability testing has been well documented in the literature for helping to develop safe HIT that also is usable from an end user perspective. However, despite increased usability testing of research and commercial HIT applications, there are still reports of safety and usability issues emerging from HIT implementations [1].

Recent approaches to usability testing have seen the development of approaches that evaluate usability in different contexts. While classic usability methods such as think aloud are good for capturing user interactions with HIT they fail to account for the surrounding contexts that may impact usability. The International Organization for Standardization (ISO) definition of usability testing is *"the effectiveness, efficiency, and satisfaction with which the users can accomplish their tasks in the intended context of product use"* [2]. That definition emphasizes the need to understand the user, technology and contexts of use.

Several different usability approaches exist including heuristics, cognitive walkthrough and think aloud [3]. Recent studies have combined usability approaches and clinical simulation to attempt to emulate actual clinical workflow [4]. However, with the array of usability approaches it can be difficult to understand what approach to use in which setting. There are few studies that have looked at how to position different usability approaches with the situational contexts where HIT is used.

Regardless of how well we design HIT there is frequently a chasm between the ostensive dimension (abstract systems design representation such as flowcharts) and performance dimension (actual measureable circumstances of HIT usage) [5]. Failure to account for the chasm leads to unintended consequences post implementation. If we

[1] Corresponding Author: e-mail: Kuziemsky@telfer.uottawa.ca

can identify specific performance contexts we could better position usability testing to account for these contexts as part of HIT design and evaluation.

Overall, while flow charts or use cases may represent the typical or ideal way that a task is done, the context where the technology is used will impact how the task is conducted in real settings. While general guidelines exist for identifying contexts of use (i.e. user types, attributes, tasks, environment) [1], there is a lack of systematic approaches for developing context specific approaches to usability testing. This paper addressees that shortcoming and develops a model to guide the development of context mediated usability testing. We use a case study of the evaluation of a surgical information system to model different contexts of use and suggest evaluation strategies for the contexts. We then suggest how our work can lead to a general framework for better understanding the role of context in usability testing and evaluation of HIT.

1. Methods

In April 2009 a multi-campus hospital in an urban Canadian City implemented a Surgical Information Management system (SIMS). The goal of SIMs was to bring common data and connectivity across the perioperative spectrum. After implementation the hospital sought to evaluate how the system was being used in the different areas and across the different campuses. From April 2012 to June 2013 we conducted over 130 hours of non-participant observations across all the clinical areas and campuses. We also conducted 8 interviews and 3 focus groups with different categories of users including anaesthetists, nurses and managers.

The observational notes were transcribed into written notes that documented users, activities and processes. The interviews and focus groups were transcribed verbatim. The transcribed notes were then analyzed using content analysis. Our analysis focused on usability issues with SIMS across the different perioperative areas.

2. Results

There are two parts to our results. First, we describe the perioperative patient flow and describe the four contextual categories that influence how users interacted with SIMS. Second, we discuss how the categories can be used to develop a general framework to support usability testing.

2.1. Perioperative Patient Flow and Contextual Categories

The perioperative process starts with a visit to the Pre-Admission Unit (PAU) approximately two to six weeks prior to surgery. Patients are either assessed by a nurse alone, or, depending on their clinical condition, a nurse and an anesthesiologist. Any necessary tests (i.e. lab tests, diagnostic imaging, electrocardiogram) are coordinated during the PAU visit. On the day of the patient's surgery he is admitted to the Same Day Admission (SDA), or Surgical Day Care Unit (SDCU), where their preoperative care takes place prior to going into the Operating Room (OR). Following surgery patients are taken to the Post Anesthetic Care Unit (PACU) for immediate care following their surgery. Patients who are returning home on the same day as their

surgery are returned to the SDCU for continuing care until they meet the discharge criteria. Patients who are being admitted return to SDA to be transferred to a care unit.

Fig. 1 shows the patient flow through the perioperative areas described above. After analyzing our data described in section 1 we identified four overarching contextual categories: task workflow, organizational processes, information entry/retrieval, and temporal factors. Figure 1 also shows how these categories vary across the perioperative areas. Below we discuss each of the contextual categories from the perspective of usability issues.

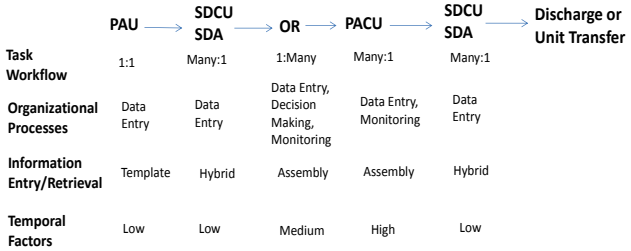

Figure 1. Perioperative areas and contextual category variation by area

2.1.1. Task Workflow

While usability testing typically focuses on a user with an individual system the workflow of the user may also impact usability when carrying out work tasks. PAU is a direct one-to-one relationship as a nurse enters data into SIMS while assessing an individual patient. In comparison, the workflow in the OR involves data entry into SIMS, as well as monitoring of IV pumps, anaesthetic gas machines, blood pressure and heart rate machines, as well as administrating medications to the patient. OR data entry is one-to-many with as many as three systems needing to be looked at. PACU and SDCU also have unique workflows as each nurse is responsible for several patients in SIMs making these areas many-to-one.

2.1.2. Organizational Processes

The processes in which users interacted with SIMS also varied across each area in the healthcare organization. PAU and SDCU/SDA are primarily data entry areas whereas the OR has a more varied set of processes that include data entry, monitoring, and decision making. For example, patients in the OR often receive complex cocktails of anesthesia medication that may have several drugs and percentages. Anesthetists described how a benefit of the previous paper based system is that writing down the complex drug data was part of the decision making process. In SIMS the cognitive aspect is replaced by selection from a drop down list, which anesthetists said did not have the same impact as writing it down. The relationship between collaborative and individual processes also was problematic. For example, a process like handover between the perioperative areas (particular OR-PACU) is a collaborative process. However, individual usability issues with SIMS had impacts on collaborative processes. Nurses and anaesthetists in the OR would at times have trouble finding the specific field they needed for data entry. A solution was to put the data into a generic memo field. A consequence of that is that nurses in PACU may miss seeing the data because they do not routinely look in memo fields.

2.1.3. Information Entry/Retrieval

Information entry and retrieval are common tasks in any HIT. SIMS changed how entry was done and at times it was a substantial change depending on the perioperative area. PAU uses a generic data entry template for all patients organized by body systems (e.g. respiratory, neurologic, cardiology). The usability considerations in PAU are the time and effort it takes to move from field to field or how to enter data not found in the template. Once the patient has surgery it determines the data entry that is done post-surgery. The impact of that is data entry in PACU becomes 'assembly' where the fields (i.e. wounds, drains) are assembled for each patient's context. Usability considerations for assembly data entry include: the time that it takes an RN to first find the data field (i.e. wound), add it to the patient's chart, and then enter in the data values. Information retrieval was also impacted by SIMS. Because of a lack of integration between the different SIMS modules (i.e. between PAU and SDA) some of the patient data is put into the hospital EMR program. Therefore on the day of surgery if a nurse or physician wants to see PAU data they need to open the EMR system, which at times meant toggling two screens to the view current data in SIMS and historical data in the EMR.

2.1.4. Temporal Factors

The length of time that a patient has been in the perioperative spectrum can also cause usability issues. One issue is the amount of data on a patient is proportionate to how long the patient has been in the perioperative spectrum. This issue was particularly significant in the OR and PACU as anesthetists and nurses commented that a patient's blood pressure or presence of pain or other symptoms gets much of its significance from how it compares to previous data points. However, it was not easy to scroll back to find the relevant data points. Another usability issue that grew over time was a 'resolution' problem. Resolution refers to the granularity of data points and was a significant problem in the OR and PACU where patients data included vital signs and medication data. Vitals are done more frequently and to prevent them from looking too condensed on the screen a user would increase the resolution to one hour. The issue with that is if a patient's medication dose is fentanyl 25mcg every 15 minutes and the resolution is set to 1 hour then a nurse sees the 100 mcg total for the hour but not the individual doses. The resolution must be scaled down to see the individual doses. Vitals and medication data have different scales but only one scale can be viewed at a time. Nurses described having a hard time understanding the resolution issue and it does present the potential for patient safety errors because of misreading of medication doses.

2.2. Contexts to Support Usability Testing: Towards a General Framework

The contexts identified above define the complexity of clinical tasks. Furthermore, this complexity varied across different clinical areas, such as the OR, where it requires more complex data entry as the clinical nature of the processes are more complex (where nurses had to use memo boxes to supplement their assessments). We are currently using the four contextual categories described in the case study to develop a framework for modelling contexts and their impact on usability testing. The framework will help explore the relationship of usability to the evaluation of a range of HIT. Although we have found that traditional usability testing can provide insight into task

workflows, it is also necessary to consider the impact of usability at the level of organizational processes in order to fully understand impact of systems (as illustrated in the case study in this paper). In addition, studies focusing on entry and retrieval are central to gaining a full picture of the impact of systems at the contextual level. Finally, usability issues must be considered along a temporal continuum, where usability issues may change, grow or wane over time, making temporal factors an important component of complete usability evaluations.

3. Discussion

The contexts in which HIT is situated and used are complex and we need to incorporate context into the evaluation of HIT. This paper provided insight on contextual considerations of HIT evaluation. We identified four overarching categories of contextual categories and the usability implications of the categories. For example, we identified different variation of tasks such as data entry and retrieval and showed that assembly data entry has more steps and is much more time consuming than template data entry. These differences need to inform usability testing and evaluation of data entry tasks.

We also described the relationship between individual and group usability issues. An individual inability to find a data entry field can resonate into group issues because individual workarounds such as putting data into a memo field can prevent other care team members from finding the data. That issue is a precursor for medical errors.

It is not that one method for evaluating usability is better than another, but rather methods need to be informed by context. Further, multi-method approaches may be required in contextually complex situations. Multi-tasking environments such as in the OR require multi-dimensional usability evaluation such as think aloud, cognitive task analysis and simulation. Collaborative activities such as handover need to be evaluated using collaborative approaches that achieve common ground between individual and group activities. Temporal factors must also be taken into account as usability issues may become more complex with time. Formal development and testing of the general framework we discussed in section 2.2 is the next phase of our research..

References

[1] A. Kushniruk, C. Nohr, S. Jensen, E.M. Borycki, From Usability Testing to Clinical Simulations: Bringing Context into the Design and Evaluation of Usable and Safe Health Information Technologies. *Yearb Med Inform,* (2013), 78-85.

[2] ISO 9241-11: Ergonomic requirements for office work with visual display terminals (VDTs) – Guidance on usability. 1998. www.it.uu.se/edu/course/ homepage/acsd/vt09/ISO9241part11.pdf. last Accessed Jan 7, 2014.

[3] M.A. Jaspers, A comparison of usability methods for testing interactive health technologies: Methodological aspects and empirical evidence, *Int J Med Inform* **78** (2009), 340-53.

[4] A.C. Li, J.L. Kannry, A. Kushniruk, D. Chrimes, T.G. McGinn, D. Edonyabo, et al., Integrating usability testing and think-aloud protocol analysis with "near-live" clinical simulations in evaluating clinical decision support, *Int. J.Med. Inform*. **81** (2012) 761–772.

[5] L. Novak, J. Brooks, C. Gadd, S. Anders, N. Lorenzi. Mediating the intersections of organizational routines during the introduction of a health IT system, *European Journal of Information Systems,* **21** (2012), 552-569.

Acknowledgements *This work was supported by a Discovery Grant from the Natural Sciences and Engineering Research Council of Canada*