

Real-Use Evaluation of Effects: Emergency Departments Aiming for ‘Warm Hands’

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ABSTRACT

Embracing real use in an iterative approach calls for systematic formative evaluation. Effects-driven IT Development has been suggested as a way of supporting a Participatory Design (PD) process involving implementations that expose mature prototypes to real work practices. This is followed by evaluations of how specified and desired effects are obtained. We present results from a project where high-level political goals (‘More Warm Hands’; i.e., clinicians spending more time at the patient bedside) are aligned with the local clinical organization and practice. We demonstrate how to combine quantitative and qualitative methods to address various levels of ‘use’ from overall politics to actual practice. The project concerns the introduction and use of an electronic whiteboard system to support clinical overview and logistics at emergency departments (EDs). The nurses succeed in getting ‘warmer hands’ while the physicians have good reasons for not pursuing this aim after all. The study contributes to a growing bulk of literature on how to include PD in the later stages of iterative development.

Author Keywords

Real-use evaluation; effects specification; implementation; formative evaluation; Effects-driven IT Development; aligning different stakeholders; combining quantitative and qualitative methods.

ACM Classification Keywords

H.5.3 [Information interfaces and presentation] Group and Organization Interfaces–Evaluation/methodology.

INTRODUCTION

In the past decade, PD approaches applied in IT projects have increasingly extended beyond initial design and development and also included implementation and use (Simonsen and Robertson, 2012).

The Design Collaboratorium (Bødker and Buur, 2002) involves having PD workshops with games, mockups, prototypes, etc. at the physical workplace where the technologies are to be used once they are implemented. On-the-spot experiments (Björgvinsson and Hillgren, 2004) are also conducted at the workplace and they entail that the technologies are used for real work. This was possible because the technologies were low-prize off-the-shelf

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products. The WorkSpace project (Büscher et al., 2004) developed IT from scratch using future laboratories (discussing real work during workshops), in-situ prototyping (resembling the Design Collaboratorium), and bricolage (using mature prototypes for real work). The AwareMedia project also developed IT from scratch and evaluated its use through a string of explorative socio-technical experiments described as a means to “break the dichotomy between designing the technology and implementing the technology in an organizational setting” (Hansen, 2006, p. 2). Some of these experiments were traditional PD experiments using e.g. mock-ups, while others resembled the bricolage method using prototypes as an embedded part of real clinical work. The experiments were driven by hypotheses describing real-use situations, thereby combining the social organization of work with the technical prototype. Effects-Driven IT Development (Hertzum and Simonsen, 2010; 2011) uses pilot implementation as a ‘field test’ of real use (Hertzum et al., 2012), which resembles the bricolage method, and effects specification, which resembles the hypotheses of socio-technical experiments, to manage systematic formative evaluations.

We demonstrate the kind of insights that real-use evaluations might provide. The empirical basis for this demonstration is an ongoing project developing and implementing an electronic whiteboard system in Region Zealand – one of five healthcare regions in Denmark. The system replaces existing dry-erase whiteboards and is evaluated at the region’s four EDs. The region plans to introduce electronic whiteboards at all its hospital departments to support logistics and facilitate coordination and articulation work.

We first describe the project context, the specified effects, and the quantitative and qualitative methods used to evaluate these effects. Then, we present results from the evaluation, and we conclude by outlining the implications for practice and research.

AIMING FOR ‘WARM HANDS’

The healthcare sector in Denmark is undergoing massive centralization, including the building of a small number of ‘super’ hospitals. Multiple local EDs have been closed and merged into larger EDs inspired by EDs in US and Canada that provide a single point of entry to the hospitals for all acute patients. New electronic whiteboards are developed to support the increased patient flow. Region Zealand decided to develop and implement an electronic whiteboard system at the regions’ four EDs to get a system tailored to regional needs and to assess its effects prior to a coming bid for electronic whiteboards at all

hospital departments. A collaboration was established with the Norwegian IT vendor Imatis and the authors, where we were responsible for the effects specification and evaluation.

The desired effects were specified in fall 2009 at two full-day workshops with more than 25 participants including representatives from all four EDs, the vendor, and regional IT project managers. During 2009-2010 clinicians and designers collaboratively designed and implemented electronic whiteboards at two of the four EDs. A working group with representatives from these two EDs has met regularly since the initiation of the project. This group also facilitated the last two EDs in their implementation of the system during 2011. Systematic effect evaluations were conducted at these two EDs in 2010-2011 to assess whether the desired effects were obtained at the EDs that had not participated in the initial design work but merely implemented the electronic whiteboard as a configurable standard product. In this paper we report from the third ED that has started using the system. This ED implemented the system in January 2011 and the preliminary results of our effects evaluation was reported to the ED in December 2011.

The ED was a 10-bed department at a medium-sized hospital in Region Zealand. The ED comprised an acute area with approximately 15000 patient admissions a year. The ED also had a fast-track area treating an even larger number of less urgent walk-in patients: This is however, not part of our analysis. Patients for the acute area arrived most often by ambulance, were triaged and received initial treatment and a diagnose, and, in most cases, were later transferred to another department for full treatment. The ED staff included 25 physicians and 35 nurses. In addition to these two staff groups, which were directly involved in our study, the ED was staffed with laboratory technicians, secretaries, and management.

The ED was physically organized with a central coordination center where three large electronic whiteboards were installed. The center receives incoming patients from the ambulance crew, maintains an overview of the status of all patients and available clinical resources, manages incoming calls, handles laboratory orders and results, etc. The coordinating nurse is permanently located at the coordination center, where the physicians also have computers for looking up X-rays, recording patient data, etc.

The effects desired from the system were discussed with the ED at a full-day workshop a couple of months before this ED started using the system. Different stakeholders' effects were aligned in an effects hierarchy (Hertzum and Simonsen, 2011) as exemplified in Table 1. A key political concern at the national and regional level is to use technology investments to get more 'warm hands': While administration, coordination and articulation work among clinicians is perceived as 'cold hands', 'warm hands' refer to the time spent on core clinical work treating and nursing the patient.

The electronic whiteboard system provides an overview of the patients at the ED and those reported to arrive soon (e.g., underway by ambulance). The system, which is permanently displayed at the coordination center of the

ED, is also accessible through the computers in the patient rooms. The distributed access to overview information is supposed to support the clinicians in allocating, prioritizing, and coordinating their resources without always needing to return to and spend time at the coordination center. The desired net effect of this is that the clinicians spend more time at the patients' bedside.

Hierarchy	Effect
Environment (political)	Centralized healthcare with higher specialization. <i>More 'warm hands'</i>
Regional strategy	Optimized patient flow and logistics in and between wards
Emergency Department	Improved resource coordination and prioritizing related to patient flow
Clinical work process	Improved overview of incoming and current patients
IT system	List of all incoming and current patients, resource allocation, plan, status, etc.

Table 1. Effects specification in a means-end hierarchy.

METHOD

To evaluate the effects of using the electronic whiteboard, the authors designed and conducted a series of quantitative effects measurements in November 2010 prior to system implementation and May 2011 after four months of system use: This allowed the clinicians to get acquainted with the system and November and May are also comparable regarding patients and clinical resources. The effects measurements comprised location tracking of physicians and nurses, noise-level recordings at the coordination center, mental-workload measurements of the coordinating nurse using the system, and time spent using different applications on the computers in the patient rooms. The location tracking aimed at analyzing whether the clinicians got 'warmer hands' and is the only measurement discussed in this paper.

During November 2010 and May 2011 all nurses and physicians at the ED were asked to carry a small battery-driven tag that emits an inaudible high-frequency sound every 20 seconds. Receivers were installed in all patient rooms and at the coordination center. The receivers recorded the location of the tags by listening for their sound signal and transmitting the recordings to a server. We distinguished between two groups of tags: those worn by nurses and by physicians. It remained unknown which person wore which tag. This way the clinicians were anonymous, and the measurements recorded only when and for how long a nurse or physician was at the coordination center or in one of the patient rooms. No other locations were tracked. Participation in the location tracking was optional but 89% of the clinicians participated.

To supplement and help interpret the statistical analysis of the quantitative measurements of whether the specified effects were met, we also made qualitative analysis on the basis of observations and interviews. During November 2010 and May 2011 the authors were present at the ED for several hours on all weekdays informing about the measurements and observing ED work. In total, approximately 50 hours of observation was made. After analyzing the quantitative data and our observations we con-

ducted interviews prompting reflection on our results. This included four interviews in June 2011 with two physicians and two nurses each lasting 45-60 minutes. In December 2011 this was followed up by a 90 minutes focus group interview with one physician and three nurses, and, finally, five ten minutes interviews with nurses to verify specific results.

RESULTS

The results of the location tracking are summarized in Table 2. The table shows that the nurses got significantly ‘warmer hands’ while this was not the case for the physicians. While the nurses spent 17% of their time in the patient rooms when the ED was using dry-erase whiteboards this increased to 28% after the ED had started to use the electronic whiteboard system. This is equivalent to nurses spending an average of 44 minutes *more* at the patient bedside on each 8-hour shift. Our control variables confirm that the two measurement periods were comparable with respect to daily admissions, patient age, and triage level, suggesting that the increase in nurse time in patient rooms was related to the introduction of the electronic whiteboards. The physicians did not experience a similar change. Rather, the result for the physicians was a change toward spending more time at the coordination center (from 52% to 59% of their time).

N = 663 shifts	Physicians		Nurses			
	Before	After	Before	After		
Patient room	19	20	***	17	28	
Coord. Center	**	52	59	**	55	44
Other	***	29	20	27	28	

Table 2. Time spent in patient rooms versus at coordination center (given in %) before and after system implementation ($p < 0.01$, *** $p < 0.001$).**

The nurses experienced a successful *distribution of coordination* that apparently decreased the need for regularly returning to the coordination center to check the current status of the ED. As one nurse explained: “You can also see [the system’s overview of the patients] in the patient room – Oh! now three more patients have arrived. It is now much more current [up-to-the-minute] and more of a shared responsibility to update the board [...] and it happened all by itself”. The chief physician in charge of the initial patient examination also took a more active role in updating the electronic whiteboard, according to one coordinating nurse because they now have this “fancy technology available”. While some of this apparently happened “by itself” as an ‘emergent change’, other elements were deliberately planned as opportunity-based change (Orlikowski and Hofman, 1997): Shortly after the implementation the medical secretaries in the ED’s reception (receiving walk-in patients, phone-calls/referrals from general practitioners, etc.) were instructed to initiate new patients in the system. Formerly they filled in paper forms and handed them to the coordinating nurse. After some weeks the medical laboratory technicians also received smart-keys to log on the system so they could update the status of blood samples – this was earlier done orally and by paper forms and always via the coordinating nurse.

The *increased visibility* of patient information is another determining factor that both physicians and nurses em-

phasized. While the physicians pointed to increased legibility (compared to the handwriting on the dry-erase whiteboard) as an improvement leading to higher confidence and patient safety, the nurses stressed the improved overview of incoming patients. This overview supported “being at the forefront of the situation [for the near future, i.e. the next minutes or hours]”. The clinicians made a default configuration of two dedicated screens in the coordination center with one listing the patients at the ED and the other listing the patients announced to arrive. By accessing this latter screen on the computer in the patient rooms (the system was logged to be used an average of 25 minutes per day per patient room) the nurse can maintain an overview of incoming patients and either complete the current patient quickly if many new patients are about to arrive or take some extra time to nurse an anxious patient if the situation at the ED is calm and a nurse already has been assigned to any incoming patients. At our focus group interview the nurses asked to have this screen installed as the screensaver in the patient rooms. Before, this overview of incoming patients was only visible through a list of paper forms on the table in front of the coordinating nurse and patients were not listed on the whiteboard until they arrived at the ED.

A likely reason why the physicians did not get ‘warmer hands’ may be the Danish way of staffing EDs as part of the rotation training system: All recently qualified young physicians must enter a yearlong rotation period where being at an ED is a mandatory part. At the ED, 15 out of 25 physicians were young physicians who are replaced every six months. Thus, the majority of the ED physicians are young and have little experience in ED work. With acute patients and an intense and often hectic atmosphere, young physicians often become uncertain and are likely to seek an environment where other physicians are present and can be consulted, rather than to seek more time on their own with the patients (possibly with an apparent nervousness). The chief physician was frustrated about this state of affairs but did not know what to do about it and explained that in practice they are only two experienced physicians at the ED at any one time. Because the young physicians tend to stay at the coordination center the chief physician felt that he often needed to do so too to support and guide them.

The nurses’ success in achieving ‘warmer hands’ as compared to the young physicians points to a difference in the ability to work independently and utilize the time alone with the patient. This is confirmed by a study of communication patterns at a British ED: This study showed that the communication load for the coordinating nurse decreased when more nurses were on duty, increased when more young physicians were on duty and was unaffected by the number of experienced physicians (Woloshynowych et al., 2007).

DISCUSSION

The case provides results regarding *practice* and the clinicians’ attempts to comply with the demand for ‘warmer hands’ by adopting a new technology – results that originate from using the electronic whiteboard system for an extended period of time for real ED work. The results

challenge the expectations and needs voiced before the system was put into use.

We asked the coordinating nurses both before and during the implementation whether the ED would make use of the potential of the technology to distribute coordination. They were consistently reluctant toward this possibility because they were concerned that they would lose control and overview if nurses and physicians updated the whiteboard without noticing them beforehand. However, as they gained experience with the technology the coordination became more distributed which may be explained by the result of both emergent and opportunity-based changes.

While the nurses succeeded in getting 'warmer hands' this was not the case for the physicians though they actively supported this need at the effects specification workshop prior to the implementation. The chief physicians, especially, argued for 'warmer hands': They know from experience that patient record-keeping is more efficient when done at the bedside with few interruptions and no need to return to the patient with follow-up questions. They have also experienced how staying at the patient bedside supports them in making observations and building knowledge of the patient's condition. But this turned out to be difficult to convey to young and less experienced physicians who are more uncertain about diagnoses and their proper treatment. The young physicians' situation was not explicated before the implementation, possibly due to unawareness. Alternative explanations include that the young physicians could not make themselves heard at the workshop and that they considered it inappropriate to question a rational argument from the chief physicians with reasons grounded in uncertainty and inexperience. For the chief physician who has the role of executive consultant at the ED this has resulted in frustration (not being able to organize work as envisioned) but also in an increased awareness of the young physicians' situation and needs.

From a *methodological* point of view we observe that the effects specifications and quantitative measurements support a sustained focus on aligning overall political goals with the effects the clinicians obtain from adopting a technology. This is a strong argument for a sustained PD process throughout design and organizational implementation (Hertzum and Simonsen, 2010). Quantitative measurements document the degree to which desired effects are obtained and provide input for prompting reflection during observations and interviews. The ensuing elaboration fosters a mutual learning situation in which the clinicians interpret and reflect on the statistical results.

In relation to earlier *research*, our results demonstrate the value of evaluating effects resulting from implementations and real use of mature prototypes. Such formative evaluations provide the means for extended iterations and stepwise implementations supporting improvisational change management (Orlikowski and Hofman, 1997).

Our results highlight the potential for PD approaches to include implementation and use (Simonsen and Robertson, 2012) and how this can support sustained user partic-

ipation (Hertzum and Simonsen, 2010). Our study includes identifying and evaluating slipped, adverse, and emergent effects resulting from real-use. Unintended effects are impossible to analyze in the Design Collaboratorium (Bødker and Buur, 2002) as this is a controlled laboratory experiment; hard to imagine will happen in on-the-spot experiments (Björgvinsson and Hillgren, 2004) because of their short and temporary character; and potentially possible with bricolage and socio-technical experiments (Büscher et al, 2004; Hansen, 2006) though not an explicit part of them. Unintended effects are however systematically pursued with Effects-Driven IT Development (Hertzum and Simonsen, 2011).

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