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Effects-Driven Participatory Design: Learning from Sampling Interruptions

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Abstract. Participatory design (PD) can play an important role in obtaining benefits from healthcare information technologies, but we contend that to fulfil this role PD must incorporate feedback from real use of the technologies. In this paper we describe an effects-driven PD approach that revolves around a sustained focus on pursued effects and uses the experience sampling method (ESM) to collect real-use feedback. To illustrate the use of the method we analyze a case that involves the organizational implementation of electronic whiteboards at a Danish hospital to support the clinicians' intra- and interdepartmental coordination. The hospital aimed to reduce the number of phone calls involved in coordinating work because many phone calls were seen as unnecessary interruptions. To learn about the interruptions we introduced an app for capturing quantitative data and qualitative feedback about the phone calls. The investigation showed that the electronic whiteboards had little potential for reducing the number of phone calls at the operating ward. The combination of quantitative data and qualitative feedback worked both as a basis for aligning assumptions to data and showed ESM as an instrument for triggering in-situ reflection. The participant-driven design and redesign of the way data were captured by means of ESM is a central contribution to the understanding of how to conduct effects-driven PD.

Keywords. Effects, interruptions, experience sampling, electronic whiteboard, learning, nurse coordinator, health information technology, interdepartmental

1. Introduction

Healthcare information technologies are developed and deployed at considerable cost, yet it often remains unclear whether their introduction in healthcare organizations yields the expected benefits [1–4]. We contend that participatory design (PD) can play an important role in obtaining benefits from healthcare information technologies but that it requires feedback from real use of the system, or a pilot version of the system. Feedback from real use is necessary to anchor PD in local contexts and to foster reflection on gaps between the contexts and the effects pursued with the introduction of the system. In this paper, we describe a PD approach that revolves around a sustained focus on the pursued effects and relies on the experience sampling method (ESM) for collecting information about effects realization. The focus on effects and the use of

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experience sampling set our approach apart from PD methods that aim to envision new work practices in workshops not informed by feedback from real use.

Effects-driven PD [5–7] is a method for managing projects concerning the technical development and organizational implementation of information systems. Simply put, its overall idea is to capture the purpose of the system in terms of effects that are measurable and meaningful to the users, to measure whether these effects are attained during pilot use of the system, and to use these measurements as guidance for subsequent development and implementation activities. To illustrate the use of the method, we analyze a case that involves the introduction of electronic whiteboards in all departments of a medium-sized Danish hospital. The purpose of the whiteboards (available on wall-mounted displays, stationary computers, and mobile devices) was to support the clinicians in intra- and interdepartmental coordination. By making core information readily available on whiteboards, the hospital aimed to reduce the number of phone calls necessary to coordinate work. Phone calls were considered a major source of interruptions, and therefore, a reduction in the number of phone calls was one of the effects pursued with the whiteboard. We collected feedback about this effect at the operating ward by developing an experience sampling app for the nurse coordinator's phone. This app provided quantitative data about the number of phone calls and qualitative feedback about how the phone calls were interruptive to the nurse coordinator's work.

In Section 1, we describe our method of effects-driven PD and the method of experience sampling that provides a means of obtaining information from clinicians during their work. Section 2 introduces the electronic whiteboard project to set the stage for the case and describes the research method. Section 3 is the case analysis. We analyze iterations of experience sampling and associated effects-driven PD in the operating ward. In Section 4, we discuss the lessons learned from the case. The lessons concern (a) general insights into the role of interruptions in healthcare work (b) experience sampling as a cost-effective means of fostering situated reflection about work practices, and (c) the effects and the data about them as a vehicle for focusing PD on the consequences of system use instead of on decisions about system design.

2. Effects-driven Participatory Design

In the terminology of the effects-driven PD method [6], an *effect* is the result of a change in how users perform their work. Examples of effects we have worked with include improving clinicians' overview of their work in a stroke unit [8], increasing the amount of time emergency department clinicians spent with patients [9], and reducing patients' fasting period before surgery [10]. The method entails a sustained focus on effects. This focus is in contrast to a focus on system functionality, as well as to a process driven by pre-use expectations about the improvements that will follow from the introduction of a system. When a system is developed for a use organization then, ideally, effects-driven PD starts with the technical development of the system. In these cases, it aims at bridging the frequent gap between the technical development and organizational implementation of systems [6]. Conversely, when effects-driven PD is applied after the technical design of the system has been finalized then the focus is to work with the organizational implementation of the system. In these cases, the system vendor is not involved in the process, but the system may be configurable and thus allow the use organization to fit the system to local circumstances. Figure 1 illustrates

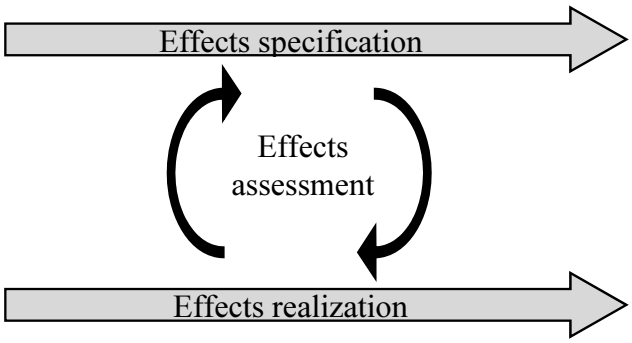

Figure 1. Effects-driven PD

the three activities that enter into effects-driven PD when it is conducted during organizational implementation.

At the beginning of a project, effects are specified. *Effects specification* involves identifying, formulating, and prioritizing the effects that motivate the introduction of a system. Usually, a workshop format is suitable for effects specification. Because managers and end-users tend to perceive systems differently, we have had the best experiences with organizing separate effects-specification workshops for managers and end-users. End-users mainly specify effects related to their work tasks, whereas managers tend to specify overall or strategic effects [11]. Through the specification of effects, attention is directed to the desired outcome of using the system rather than its functionality. The introduction of the system, by itself, however, is not sufficient for the effects to materialize. Instead, the effects specification provides guidance and structure for the activities of effects realization and effects assessment. Importantly, the effects specification is likely to evolve over time in response to effects assessments, emergent opportunities, experienced adverse consequences, and changes in the contextual conditions.

Effects realization is the set of activities involved in (technically developing and) organizationally implementing a system. That is, the system is configured for the organization, the work procedures are adjusted to utilize the system, and interventions are performed to kick-start changes, follow-up on emergent possibilities, and address adverse consequences. The long-term purpose of effects realization is to benefit the organization; the shorter-term purpose is to provide a basis for effects assessment. Although full organizational implementation is necessary for the former purpose, pilot implementation is sufficient for the latter and makes it possible to assess effects earlier and at a lower cost. In a pilot implementation [12], the system is used for real work but by a limited group of users and for a limited period of time. An additional characteristic of pilot implementation is that the ensuing learning can inform the full implementation. Many studies have shown that effects realization is a slow process that often congeals prematurely [13–15]. When this happens, the rationale for introducing a system and the outcome of introducing the system become dissociated from each other.

In effects-driven PD, the means of relating the rationale to the outcome, that is, the specification of effects to their realization is *effects assessment*. The effects of a system on daily organizational practices cannot be assessed in the laboratory. Thus, it is imperative that effects are assessed in the field, through either full or pilot implementation of the system. Assessments may involve quantitative measurements, qualitative evaluations, or a combination. While quantitative measurements are restricted to pre-specified effects, qualitative evaluations may capture emergent effects that have not been considered but may, nevertheless, be attractive to attain or important to avoid. The assessment results are fed back into effects specification and may lead to effects being added,

dropped, or revised. For effects not yet attained, interventions may then be performed to realize these effects, followed by a new round of assessment. We consider effects assessment an important extension of PD: The assessment extends the scope of PD from facilitating users in articulating what they want to facilitating them in a process of working systematically toward getting what they want [8].

In several of our previous studies, data collection for the effects assessments was resource-demanding to the point of restricting the assessments [6]. To address this problem, we need a resource-efficient instrument that can be integrated in the existing work practice in an unobtrusive way and that collects data as close to the moment of the phenomenon under investigation as possible. The instrument also needs to be easy for the study participants to use. These requirements point to the use of the *experience sampling method* [16]. ESM belongs to a family of research strategies for "studying social-psychological phenomena as they occur in the ebb and flow of everyday life" [17]. Ecological momentary assessment [18], diary methods [17], ambulatory assessment [19], and intensive longitudinal designs [20] are all variations of the same approach to elicit data from study participants via their repeated self-reporting. Self-reporting often happens through either an open diary format or a closed questionnaire-like format. To gain insights into an experiential phenomenon where no prior evidence exists, experience sampling lends itself to establishing a data-based foundation and thus testing initial hypotheses about what effects to pursue. Further, the act of collecting data and analyzing the aggregated results allows for further exploration of the problem and respecification of the effects.

We propose the use of ESM in effects-driven PD because recent advancements in mobile technology enable the automatic prompting of participants for feedback. Smartphones are a common property and a convenient medium for the distribution of prompts for either qualitative diary-like or quantitative survey-like data elicitation. With an Internet connection, the feedback is also easily returned, and prompts can be triggered at specified intervals, at random, or what is referred to as "event-contingent." The latter requires the ability to infer use-context events programmatically and, then, trigger a prompt when certain events occur. Software packages that support experience sampling include MyExperience [21], LifeData, and AWARE [22].

3. Setting and method

In 2009 a medium-sized regional hospital in the southern part of region Zealand, Denmark, replaced the dry-erase whiteboards in the emergency department with electronic whiteboards. The replacement was part of a region-wide project to support the emergency clinicians' overview of the status of the patients in the department by means of electronic whiteboards. We took part in the design, implementation, and – in particular – evaluation of the electronic whiteboards [9]. In 2012 the hospital extended the substitution of electronic for dry-erase whiteboards to all departments in an effort to support the interdepartmental coordination of, for example, patient transfers. A frequent kind of patient transfers occurs when patients are transferred from the bed units to the operating ward for surgery. These transports are coordinated by the nurse coordinator at the operating ward with the support of other staff and the electronic whiteboard. The interruptions case we analyze in this paper revolves around the nurse coordinator at the operating ward. The role of nurse coordinator is usually filled by an experienced nurse because the nurse coordinator has a number of responsibilities in addition to assisting

in surgical procedures. In the operating ward, a nurse coordinator is present on each of the two units located on the 1st and 2nd floor, respectively. The nurse coordinator maintains an overview of the patients scheduled for operation by using the electronic whiteboard, which is updated by the bed units as well as by the nurse coordinator.

The involved participants in the interruptions case included a project team, meeting every second week. The team consisted of three researchers and three project participants from the hospital, one of which was an experienced nurse coordinator from the operating ward (in the following referred to as project nurse coordinator). In addition, eight nurses who often had the role of nurse coordinator acted as a reference group for the project nurse coordinator and facilitated the data collection. The other nurses at the operating ward were only participating in the initial presentation of the ESM framework and in the second assessment of the collected data (see Table 1). We built our ESM app using AWARE [22], an open-source Android and iOS framework that acts as an interface for a number of sensors on current smartphones. AWARE includes an experience sampling sensor for displaying survey-like pop-up questions on the phone as single- or multiple-choice or as free-text. The answers are timestamped and sent to a central server. Our app was implemented to prompt the nurse coordinator for feedback right after every phone call. For visualizing the answers we made a webpage displaying the collected feedback as charts (see Figure 3 for an example).

4. The interruptions case

In this section, we present the interruptions case. First, we describe how the effect "fewer interruptions" was specified. Then, we describe the iterations of realization, assessment, and respecification.

4.1. Specification

The project started during the fall of 2014 with four effects specification workshops (see Table 1) attended by a total of 31 clinicians from the hospital. These workshops led to the proposal of a number of hospital-wide effects to work with. Two effects were prioritized as very important. The effect we focus on in this paper was "fewer interruptions" by phone calls among clinicians. The initial hypothesis concerning this effect was phrased as follows: "By using the electronic whiteboards, you can reduce [the

Table 1. The activities in terms of iterations through the effects-driven process cycle

Iteration	Date	Activity
Specification	Fall of 2014	Hospital-wide effects specification
	Apr 10, 2015	Project team effects specification
1st iteration	Apr 24, 2015	Introduction of the ESM and design of the mock-up
↓	May 8, 2015	Presentation of ESM framework
↓	May 22, 2015	Technical configuration
↓	Jun 16, 2015	Organizational adaptation
↓	Jul 2-10, 2015	Pilot use
↓	Aug 21, 2015	First assessment of collected data
2nd iteration	Sep 18 - Oct 22, 2015	Second data collection
↓	Sep 28 & 30, 2015	On-site observations
3rd iteration	Oct 2, 2015	Reconfiguration of the ESM framework
↓	Oct 23 & Dec 4, 2015	Second assessment of collected data

number of] phone calls and avoid unnecessary interruptions" (November 7, 2014, Physician). The workshop participants believed, that many phone calls were made to provide or ask for information that was (or should have been) available on the electronic whiteboards. Thus, by carefully configuring the electronic whiteboards to the clinical needs it would be possible to reduce the number of interruptions substantially.

Working with the "fewer interruptions" effect was assigned to the local project team. The project team decided to investigate the frequency and characteristics of the interruptions experienced by the nurse coordinators on the two floors of the operating ward. The nurse coordinator is exposed to numerous phone calls and, thereby, frequently interrupted in one task in order to attend another. It was expected that many of these interruptions could be avoided if the electronic whiteboards were used more effectively.

Having specified the effect at the local level, arrangements were made to initiate its assessment, including the investigation of the extent to which the phone calls were perceived as interruptions. The assessment was to be performed during the nurse coordinator's everyday work.

4.2. First iteration

The researchers introduced the team to experience sampling as a method of collecting data about interruptions. To use a contemporary digital ESM setup, the mobile phones in use at the operating ward had to be replaced with a smartphone able to run the ESM application. Based on a quick presentation of the ESM app described in Section 3, the team considered what type of ESM question should be used when the nurse coordinators were interrupted by a phone call. To reduce the effort of answering, the nurse coordinators preferred a number of predefined answers they could choose from.

Based on a discussion of what kinds of interruptions occur during the nurse coordinators' work, many predefined answer categories came up. Four categories of phone calls were identified and considered to capture the calls that were unnecessary interruptions and could potentially be avoided by using the electronic whiteboard. In addition the team specified that the options for answering should be understood in the context of the electronic whiteboards. If the caller could have avoided calling by consulting the electronic whiteboard, the option to be chosen was "column not read". If a call was about information that was not available on the whiteboards but should have been provided, the option to be chosen was "column left blank". If a call concerned information for which there was no field on the whiteboard but probably should be, the appropriate option was "column does not exist – wanted". If a call was considered an interruption but not related to the whiteboard, the appropriate option was "not related to whiteboard". Finally, if the call was considered necessary or desired, then the nurse coordinator should choose the option "not an interruption" (see Figure 2).

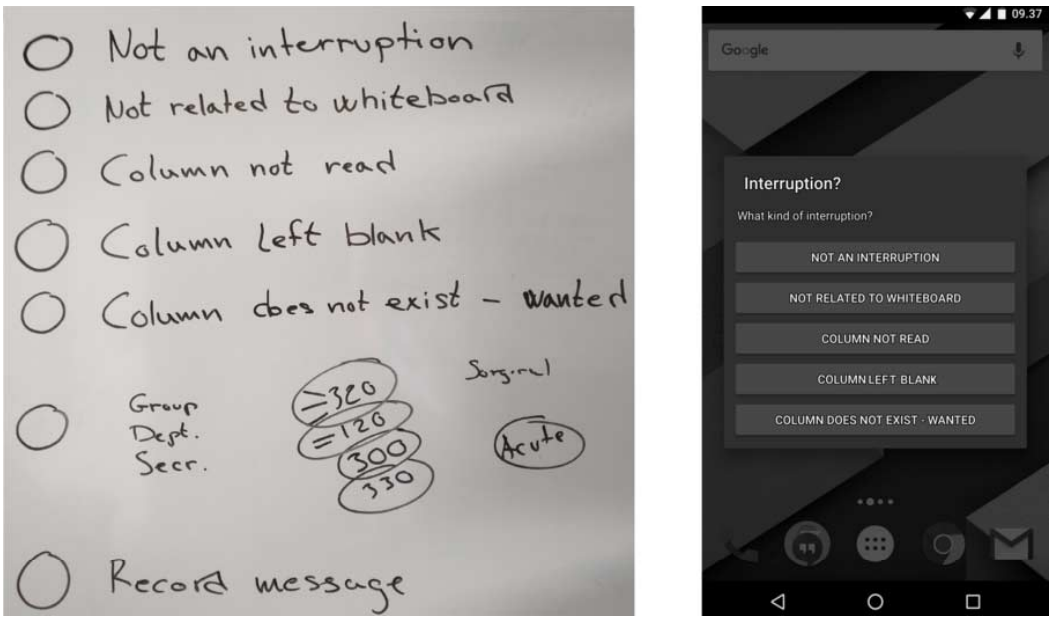

Figure 2. Mock-up (left) and screenshot (right) of the ESM app - reconstructed and translated from Danish

To uncover the origin of phone calls, the team first discussed which other departments it was relevant to include in the data collection. At a later stage, the project nurse coordinator chose which departments and staff roles to include as response options for this second question. This was based on her assumptions about the departments that most frequently called the nurse coordinator at the operating ward. The question for categorizing the caller appeared immediately after the nurse coordinator had answered the question about the type of interruption.

In parallel with the design of a mock-up of the ESM app, a number of preparations were made for the upcoming prototyping activity, such as buying phones, a charger, and protection for the display, a subscription plan (SIM card), contact information for relevant departments on the phones (phone setup), and so forth. To get from a mock-up to a working prototype, the project team held a workshop. During this workshop, the categories defined in the mock-up were converted to an ESM schema in a plugin to the AWARE app (see Figure 2). During the workshop, the app was designed so that incoming and outgoing calls would trigger the two ESM questions and so that answers could be provided with as few clicks as possible.

The final preparations before introducing the ESM app to the rest of the nurse coordinators included installing and testing the app on two smartphones. The tests ascertained that the existing phone system was able to handle the switching back and forth between normal mobile phones and smartphones.

A researcher and the project nurse coordinator went through the call-forwarding procedure and made calls to and from each smartphone to make sure that the smartphones could actually place and receive calls. They also confirmed that the ESM questions appeared on the smartphone right after a call was ended. Based on the tests of the forwarding procedure, we made a small written guide that described how to enable and disable call forwarding. By manually disabling the smartphone and, thereby, the data collection, less experienced nurse coordinators had the option to opt out from using the smartphone. This way, participation in the data collection was made optional. Finally, the phones were set up with the relevant contact information for the clinicians who would be using the phones during data collection.

The first data-collection period lasted 7 days and involved only one of the two units of the operating ward because data were only collected when the project nurse coordinator was either acting as the nurse coordinator or was on call and available to support the nurse coordinator. During this pilot period, 134 phone calls were registered. The data about these phone calls were presented to the participants using the web-visualization (see Figure 3 for an example). Initially, the assessment focused on the data collection instrument itself. Two issues were identified and reflected upon. First, a problem related to the call forwarding meant that the phone number of the caller was not visible for hospital-internal calls but shown as "hidden/private number". Relatedly, calls from the smartphone displayed the new phone number of the smartphone on the called clinician's phone instead of the internal phone number with which the clinicians were familiar. This was important because knowledge about who was calling affected whether the nurse coordinator's calls would be answered. Some physicians, for example, did not answer a call if they were busy and they did not know who was calling. This problem resulted from using new phones for the data collection; it would not have existed if it had been possible to run the ESM app on the normal hospital phones. The problem was never solved. Second, the call forwarding depended on the internal hospital phone system. On some occasions during the data collection period, this feature malfunctioned. When this happened the smartphone could not be used.

Assessing the data revealed that few calls were recorded as interruptions (32 of 134 calls) and even fewer as interruptions related to the whiteboard (5 of the 32 interruptions). The assessment made the complexity of interruptions evident and revealed that it was often difficult for the nurse coordinator to categorize a phone call. The following quotation shows the complex nature of interruptions and that answering the ESM question triggered reflections during the assessment of the data: "There was a call from outside [the hospital] where I had to say 'can you call in 10 minutes?' because I was about to take the underpants off a patient. But I have the nurse coordinator's phone, so I had to answer it – like twiddle off the glove and down in the pocket and… It was [name] who called. That means a call from outside and it is not related to the electronic whiteboards, but is it interrupting? In a way it was, but then again not, because I have asked her to contact me, but she could not see what I am doing […]. I answered [i.e., chose the call categorization] that it was not an interruption, but actually it was" (August 21, 2015, Project nurse coordinator).

Because the nurse coordinator had made an appointment to be called in 10 minutes, she experienced that the call had been arranged and in that sense was not an interruption, yet she felt interrupted. It became obvious that some of the calls categorized as "not interruptions" were, in fact, interruptions and could possibly have been avoided. The categories "not related to whiteboard" and "not an interruption" included calls that could be interpreted as interruptions and as relevant. The following quotation illustrates the nurse coordinator's deliberations: "I have been standing with the phone and been in doubt about what to answer. When you have to choose whether it is an interruption, one might pick "not an interruption" because it is a relevant call, but in fact, you were actually interrupted in what you were doing. That is probably a registration error, but you have to decide quickly" (August 21, 2015, Project nurse coordinator).

4.3. Second iteration

The first iteration was followed by a second iteration during which the two smartphones were introduced to all nurse coordinators on both units of the operating

ward. The introduction included a tutorial on how to use the smartphone and the ESM app. Because fewer interruptions than expected were related to the electronic whiteboards, we felt that additional information was needed to analyze the interruptions and the factors that caused them. To investigate the situations in which interruptions occurred, the project team conducted two days of observation of the nurse coordinators. The observations consisted of shadowing the nurse coordinator on one of the operating units. The observer recorded the same information as the app, along with a qualitative description of the content of each call and the situation the nurse coordinator was in when calling or being called.

4.4. Third iteration

On the basis of the observations, the ESM app was reconfigured. The meaning of the concept of interruptions had been clarified during the first and second iterations. It had evolved from something always undesirable into recognizing all phone calls as interruptions—some desirable, others disruptive, and still others disruptive-and-related-to-the-whiteboards. In the light of the problems the nurse coordinator experienced when confronted with the option "not an interruption", the project team decided to remove this category. The category was interpreted as negatively loaded and, in addition, any phone call could be considered an interruption. The category "not related to whiteboard" was reconceptualized as "any call other than those related to the whiteboard" disregarding the nature of the interruption. This was done to focus the data collection on events related to the pursued effect of fewer interruptions specifically related to the whiteboards.

The second round of data collection with the ESM app involved both smartphones and both operating units. A total of 637 phone calls were registered, see Table 2. The assessment comprised an initial analysis conducted by the research team (October 23, 2015) and a workshop for all nurses in the operating ward during which the data visualization was presented and discussed (December 4, 2015).

Of the 637 calls, 185 times the set of questions was either partially or not answered. Of the remaining 452 calls, 410 calls were categorized as not an interruption or not related to the whiteboard. Eight calls were categorized as column not read, 33 were categorized as column left blank, and one was categorized as column does not exist – wanted; see Figure 3 (left). Nearly half of the 452 calls were between the nurse coordinators on the two wards; see Figure 3 (right).

The nurses' first discovery was that the proportion of intra- to interdepartmental calls was high. However, one nurse was quick to translate the numbers into a practical explanation: "It does not surprise me, because when we talk together on the 2nd floor it is by phone because we have so many closed [i.e., doors closed to maintain sterile conditions] rooms […]. If you have two or three closed rooms in use, then the phones are really busy."

Table 2. Data collection numbers

	1st floor operating unit	**2nd floor operating unit**
Active days	10	16
Total time active	53 h 43 m	123 h 48 m
Total no phone calls	195	442
Average number of calls per hour	3.63	3.57

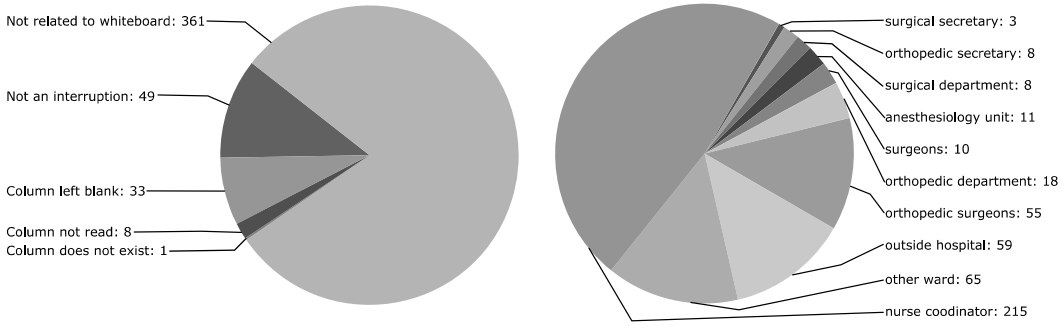

Figure 3. The distribution of the answers on the categories of interruptions (left) and callers (right)

A second discovery was that although the number of calls related to the electronic whiteboards was low compared to the total number of calls, they were "clear-cut evidence" of the specified problem of interruptions. This discovery stimulated constructive reflections on what to do about the problem. A nurse observed the following about the calls related to the electronic whiteboards: "It is not that many calls in 40 days. It is astonishingly few times we called the physicians [to get their attention that the patient is ready for operation]." This observation was, however, countered by another comment, which called attention to some physicians' underuse of the electronic whiteboard: "If they [the physicians] had just looked at the electronic whiteboard and seen that now a patient is ready [for operation], then they could have been informed [without issuing an interrupting phone call]."

Reflecting on design solutions, a nurse stated, "We were [once] told that there was SMS functionality in the electronic whiteboards, which we thought was really neat in relation to sending messages." Another nurse added, "Such a functionality [SMS notification] could give a notification [e.g., patient ready for operation] – with the result that you could get rid of calling all the time." Text messages (i.e., SMS notifications) triggered by clinical events are a clinical use of the same technology as we use for experience sampling. The physicians might consider text messages that arrive on their phones preferable to building a habit of regularly consulting the electronic whiteboard.

During the assessment workshop, the nurses raised the challenge of using the smartphone consistently throughout the data-collection periods. Consistent use of the smartphone was made difficult by its inability to display phone numbers. In addition, repeatedly answering the same questions was perceived as tedious. However, the nurses also expressed that they would like to use the smartphones more consistently because the workshop demonstrated the value of the data: "You could say that it is also a lesson for us […] It gives a completely different perspective when you see how data like this can be visualized. [During the data collection] you were just answering the same damn question, which actually was a bit annoying."

5. Lessons learned

In this section we discuss the lessons learned about interruptions in hospital work, about ESM as a technique for data capture, and about effects-driven PD in general.

5.1. Learning about interruptions

The starting point of the project was that the electronic whiteboard would, if it were used consistently, reduce the number of phone calls because information that previously had to be obtained via phone calls would instead be available on the whiteboard. A reduction in the number of phone calls was considered attractive because phone calls are a frequent source of interruptions in hospital work. Coiera [23] reports that clinicians were interrupted an average of 11.2 times per hour. Another study showed that clinicians in coordinating roles were interrupted even more and that phone calls constituted an average of 6.8 of these clinicians' hourly interruptions [24]. In this project, the nurse coordinator was interrupted by phone calls about 3.5 times an hour. Interruptions at these frequencies are believed to influence clinicians' work by prolonging tasks, causing errors, increasing mental workload, deteriorating situational awareness, hampering critical thinking, increasing stress, and decreasing job satisfaction [25]. For example, Westbrook et al. [26] find that clinicians failed to return to 19% of the interrupted tasks. For resumed tasks, interruptions lead to delayed task completion and to hurried task execution, probably in an effort to make up for the time lost during the interruption.

Given the negative consequences of interruptions, it makes sense to reduce their number. At the same time, interruptions, such as phone calls, are inevitable in hospital settings, which involve clinicians handling multiple simultaneous threads of work [27]. Against this background, it is interesting how the nurses' perception of the relation between phone calls and interruptions evolved over the course of this project. Initially, the clinicians perceived phone calls as interruptions only if the calls were unnecessary. If a phone call was necessary for patient treatment, the clinicians tended to perceive the call as a legitimate part of their work, not as an interruption that, temporarily, shifted their attention away from their work. As much as 91% of the phone calls were seen as necessary and thus as something the clinicians had to handle in order for them as a group to accomplish their work. Only 9% of the phone calls were categorized as interruptions related to the whiteboard. These phone calls were experienced as interruptions because they were unnecessary; they could have been avoided had the caller consulted the whiteboard instead of picking up the phone. This perception of interruptions resembled the study by Berg et al. [28] in which interruptions relevant to patient treatment were not experienced as disruptive, except during periods with high workloads.

Only gradually, and with some hesitation, did the clinicians in this project start to acknowledge and discuss the disruptive nature of all phone calls. Before this gradual shift, the overall conclusion drawn from the collected data was that the number of interruptions was modest but also that it was instructive to know their distribution across categories. For example, only one interruption was categorized as the result of the whiteboard lacking fields for recording relevant information, whereas 33 interruptions were categorized as the result of failures to record relevant information in the existing whiteboard fields. Thus, the interruptions pointed to a need to use the whiteboards more consistently by consulting the electronic whiteboards instead of a need to reconfigure it to match the clinicians' work better by making new information available.

With the gradual acknowledgement that all phone calls interrupted the flow of the nurse coordinator's work, it became increasingly clear that the whiteboard could support only a modest reduction in the number of interruptions. The clinicians revisited the effect pursued in the project to discuss whether their new insights into the relations between the whiteboard, phone calls, and interruptions pointed to a respecification of

the effect. A possible respecification would be to focus more on reducing the number of phone calls that interrupt the nurse coordinator and less on the whiteboard as the means of achieving the reduction. Such a respecification would be consistent with the aim of effects-driven PD in allowing the participants to devise the best means of achieving the pursued effect. The most promising method for reducing the number of phone calls may be to reduce phone calls internally at the operating ward because they accounted for 48% of the phone calls that involved the nurse coordinator.

5.2. What we learned from experience sampling

The original reason for introducing ESM in effects-driven PD was that it is difficult to get people to do the work involved in manually collecting effects-assessment data. ESM has an apparent ability to merge into a real-world work setting in an unobtrusive way and enable data collection while the work is being performed. According to Chen [29] the digitization of ESM has potential as a resource-efficient method of collecting data. A generic mobile tool for this purpose should be easy to operate, modify, and adapt to different contexts and effects, and its use should produce useful insights.

The data collected about the distribution of the phone calls on the categories of interruptions and callers were assessed by the nurses and compared with their initial assumptions about interruptions. Some of their assumptions were confirmed, for example the number of daily calls and the high incidence of internal calls between the two nurse coordinators were as expected. However, other assumptions were disproved by the data: They had thought that they were interrupted a lot but, in fact, there were fewer calls related to the electronic whiteboards than expected. In addition, there were fewer calls to and from physicians than expected. This indicates that early ESM data is suitable for aligning initial assumptions with workplace realities. Importantly, the alignment works two ways in that it serves to assess the assumptions as well as to assess whether the collected data are meaningful. The qualitative feedback was valuable for understanding the more complex nature of interruptions as indicated in Section 4.3. The combination of quantitative data and qualitative feedback provided a basis for aligning assumptions to data but it also showed that ESM can be used as an instrument for exploring and triggering reflections on an issue such as interruptions.

The use of ESM in a work setting might be opportune but what we have seen in the case on interruptions is that it is not necessarily easy to implement. A pragmatic reason is that the technique introduces an additional workload on the participants because they have to provide feedback according to the sampling scheme. Furthermore, the switch from a traditional mobile phone to a smartphone seemed straightforward but was hampered by the inability of the smartphone to display phone numbers on incoming calls that were forwarded. A recent study by Grandhi et al. [30] sheds light on the importance of information such as caller identity to informed call handling. The missing phone numbers made it impossible for the nurse coordinator to identify the caller prior to answering the call and, thereby, also made it impossible to infer the purpose and urgency of the call. This limited some of the nurse coordinators' willingness to use the smartphone. Another complication in the use of ESM was that each ESM prompt generated a new interruption, which is an ironic side effect of a study aimed at reducing the number of interruptions. It was, however, imperative to capture the nurse coordinators' experience of the phone calls in close proximity to the phone calls. We see the ability to stimulate reflection on the problem under investigation as one of ESM's most powerful implications for effects-driven PD.

5.3. What we learned about effects-driven participatory design

When the quality of participation in PD is explored, participation is traditionally considered political and pragmatic. In the political sense, at stake are issues related to participants' influence on their own working conditions. In the pragmatic sense, the focus is on the practical need for more knowledge in the design process: IT designers seek to gain an understanding of the users' work practice or organization, and user-participants need knowledge from designers about the technological options [31]. Furthermore, participating in the process of designing technology should enable users to "take advantage of the new technologies, to (re-)configure and appropriate them and to redesign their practice in positive ways over time" [32]. PD aims at having participants take ownership of the project and the system being designed, thereby assuming responsibility for the resulting effects. Effects-driven PD increases the likelihood that participants take ownership because they specify the project goals in terms of desired effects.

The nurse coordinators were keen to investigate interruptions in their local context because they recognized them as a problem in their own work. Following an effects-driven PD approach they specified and assessed a desired effect. In doing so, they designed the way to collect data about interruptions from phone calls and conducted the data collection to learn about the interruptions. They took advantage of smartphone technology and ESM, which we customized to their needs as the project progressed. This way they learned about the size of the problem in terms of the number of disruptive phone calls, and they learned about the nature of the problem in terms of reflections on what an interruption is. The transitions between organizationally defined effects and local efforts to achieve them are characteristic of effects-driven PD and paramount to understanding and solving complex problems. ESM played an important role in these transitions by providing a participant-driven way of designing and re-designing what data to collect and what sense to make of them.

However effects-driven PD requires a lot of work and is dependent on a strong commitment from the participants. We had such a commitment from the participants in the project team. At the project meetings we, as researchers, facilitated reflections but left the reflective work to the participants. The central project nurse coordinator was able to explain the project aim to her fellow nurse coordinators and succeeded in engaging them in designing and conducting the data collection. We acknowledge that the learning from the project was strongest with the nurse coordinators who were closest to the data collection and expect that the local knowledge about interruptions is held by the nurse coordinators – most prominently the project nurse coordinator.

6. Conclusion

Effects-driven PD is a method for systematically pursuing the effects desired from information systems by iteratively specifying, realizing, and assessing the effects. The interruptions case analyzed in this paper yielded outcomes for the users as well as for us as researchers. The users took on the task of investigating how much the nurse coordinators at an operating ward were interrupted by phone calls. From this investigation they learned important lessons about interruptions in their local context. In particular, it turned out that far fewer interruptions than expected could be avoided by consistent use of the newly introduced electronic whiteboard. For us as researchers the outcome of the project relates to the practical use of experience sampling as a way of capturing quanti-

tative data as well as qualitative feedback locally and in real time. The data and feedback collected with the ESM app were instrumental to the project because they challenged assumptions and fostered reflection.

The effects assessments in the interruptions case focused on a single clinical role – the nurse coordinator. It was initially, but incorrectly, assumed that this clinical role was particularly exposed to interruptions that could be avoided by means of the electronic whiteboard. That is, future work to reduce the number of interruptions of the nurse coordinator must identify and pursue other means of achieving the reduction. While the measurements of the frequency of interruptions are local to the operating ward, similar investigations can be conducted at other wards using the same ESM app. We contend that the ESM data resulting from such investigations will be valuable to projects applying effects-driven PD.

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