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Hertzum, Morten; Simonsen, Jesper

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Effects-Driven IT Development: Status 2004–2011

Morten Hertzum[1] and Jesper Simonsen[2]

[1,2] Roskilde University

[1] mhz@ruc.dk, [2] simonsen@ruc.dk

Abstract. Information technology (IT) is a means to an end, yet many IT projects assign primacy to technical development and attend comparatively less to the organizational change effort that is required to attain a good fit between organization and IT system. This entails a risk of not capturing the benefits of the deployed system. Effects-driven IT development aims to counter this risk by providing an instrument for managing IT projects through a sustained focus on the effects desired from the use of the IT system. A sustained focus on effects entails that the specification, realization, and assessment of effects become central systems-development activities. In this chapter, we describe the six empirical projects we have conducted in our work on effects-driven IT development during the period 2004–2011 and we discuss the experiences gained so far. The empirical projects indicate that the desired effects can be specified and measured, though we have mixed experiences with ensuring that effects are measured. An effects hierarchy has been devised and appears suitable for working with effects at different levels of abstraction. A key challenge with which we still have insufficient experience concerns how a partnership with close relations between a customer and a vendor can be established. Finally, we have yet to address whether and how to incorporate an effects-driven approach in the contractual regulation of IT projects.

Keywords: effects-driven IT development, partnership sourcing, pilot implementation, evaluation.

1 Introduction

Many information technology (IT) projects do not produce the effects the customer aims to achieve. From the customer's point of view, such projects are full or partial failures, but the vendor may nevertheless have fulfilled the contract by delivering the specified system functionality. Effects-driven IT development – our attempt at addressing this situation – supplements functional specifications of systems with (a) specifications of the effects the customer wants to achieve and (b) measurements of whether these effects are in fact achieved during the pilot use of the system. The rationale for making measurements of specified effects a part of IT projects is to establish and maintain a focus on the ends for which the system is a mean and to make organizational implementation an integral part of IT projects. We contend that a sustained focus on desired effects will make it easier for customer representatives to take part in IT projects and that vendors will be able to extend the scope of their business with elements of the management of organizational-change processes.

Effects-driven IT development is an instrument for the management of iterative, participatory, and experimental projects concerning the technical development and organizational

implementation of large, complex systems. Due to the size and importance of such projects, effects-driven IT development aims to establish a strategic partnership characterized by trust, mutual learning, and collaboration between customer and vendor. Effects-driven IT development focuses on (a) effects rather than products and processes, (b) measurements rather than expectations and estimates, and (c) effects specification rather than functional specification. Starting from these characteristics the customer and vendor develop IT systems with measured effects on the customer's work. Effects measurement is an important tool in the mutual adjustments between the customer and the vendor about how far they have progressed.

We believe effects-driven IT development is generally applicable to large IT projects but particularly to complex and business critical projects. In our empirical work, we have so far focused on the development and implementation of electronic patient record (EPR) systems in the Danish healthcare sector. Two reasons for this focus are that the development and deployment of EPR modules is, at present, a prominent example of large and complex IT projects and that the complexity has both technical and organizational elements. In addition, there is a large need for achieving – and documenting – actual benefit of the substantial EPR investments. This need is exacerbated by bad experiences from previous projects based on a linear development model with insufficient focus on organizational implementation.

Our work on effects-driven IT development started in 2004 and was until 2007 part of the HealthcareIT project. Since 2008, we have continued the work in the context of the SourceIT project. In this chapter, we describe our experiences with effects-driven IT development during the period 2004–2011 and we discuss the status of our research questions. We start by describing effects-driven IT development and then give an overview of the six empirical projects through which we have developed and applied effects-driven IT development. Following the overview of the empirical projects, we discuss our experiences, assess the status of our research questions, and point toward focal areas for our future work on effects-driven IT development.

2 Effects-driven IT development

The cost–benefit relation in many IT projects is unclear, and IT systems often do not lead to appreciable benefits. Two related characteristics of IT projects appear to contribute to this unsatisfactory state of affairs. First, the relationship between the customer and the vendor is in most IT projects regulated through a specification of the functionality of the system. This means that an understanding of the users' needs is transformed to a specification of system functionality, which then defines the system. It is, however, well-known that functional specifications may not fully match users' actual needs. This mismatch becomes particularly evident in situations where the vendor argues that the basis for determining whether the contract has been fulfilled is whether the system meets the specification, whereas the customer's experience of the system concerns whether it meets the users' needs. The effects the customer seeks to achieve are in focus during the early stages of an IT project but thereafter they are often replaced by functional specifications though such specifications have known shortcomings.

Second, IT projects tend to focus on technical development while the importance and complexity of organizational implementation are often underestimated. However, the customer does not attain the desired effects until both technical development and organizational implementation succeed. Many IT projects end before the customer has achieved the effect that was the rationale for introducing the system and, thereby, also before there is evidence that it is possible to achieve this effect with the new system.

Effects-driven IT development (Hertzum & Simonsen, 2004, 2010b, 2011; Simonsen & Hertzum, 2005, 2008, 2010) aims to counter the shortcomings of functional specifications through a sustained focus on the effects the customer seeks to achieve by adopting and using a system. The overall idea of effects-driven IT development is to specify the purpose of the system in terms of effects that are both measurable and meaningful to the customer and to systematically assess whether these effects are achieved when a pilot version of the system has later been developed and subjected to realistic use (see Figure 1). Effects are in many ways similar to key performance indicators (KPIs) and to the notion of benefits in benefits management. A sustained focus on effects emphasizes that the functionality of a system is a means to an end, but it also entails that effects must be specified as well as measured within the timeframe of the IT project. Thereby, effects-driven IT development blurs the distinction between technical development and organizational implementation in favour of a focus on the complete process from business case through development and deployment to the achievement of effects. This implies that effects measurements are formative in the sense that they are an instrument in a typically iterative process where the results of the individual measurements provide important guidance to subsequent activities. In contrast, summative evaluations aim to measure the end result of a process. While summative evaluations are well-known from, for example, research studies of IT systems, formative use of effects measurements as an instrument in the development of IT systems is specific to effects-driven IT development and a few other approaches to information systems development.

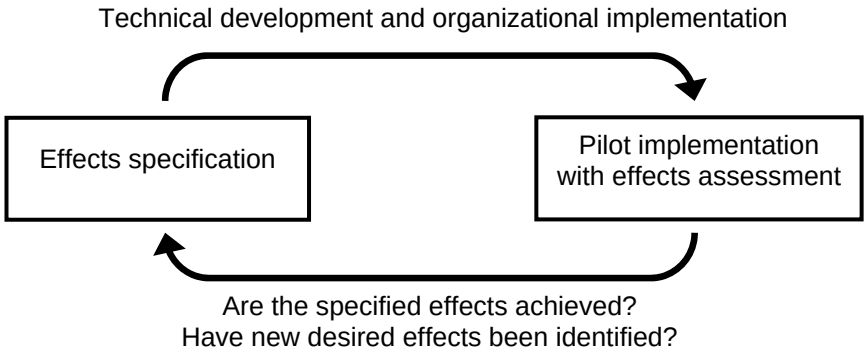

Figure 1. Effect-driven IT development entails a sustained focus on effects.

Concrete examples of effects include that a physician can complete her or his medical ward round without being escorted by a nurse. This makes the physician's medical ward round more efficient and the nurse can focus on caring for the patients. Another example can be a reduction in the clinicians' mental workload during the daily, cross-disciplinary team conference. A lower workload reduces the risk of errors in the clinicians' treatment of the patients. The effects desired from a system often form a hierarchy where high-level effects specify why effects at lower levels are desirable, while effects at lower levels specify how

higher-level effects can be achieved. The primary focus of effects-driven IT development is typically on the direct effects on the users' work. The main reason for this is that these effects can be specified most accurately, whereas high-level political and strategic effects tend to be more indirect and thereby more difficult to relate to an IT system in a concrete and measurable manner. A supplementary reason is that the success of a system is critically dependent on the users' attitude toward the system and thereby on the extent to which the users agree to the pursued effects and can relate them to their work and needs.

Our work on effects-driven IT development has addressed five research questions, which we consider central to working systematically with effects as an instrument for managing information systems development. Our five research questions are:

1. *How can desired effects be specified and specified effects measured?* Effects are likely to be more stable than functional requirements because effects are at a higher level of abstraction and are fewer in number than functional requirements. If a focus on effects is to provide a framework for experimenting with different designs it must, however, be possible to identify, formulate, and prioritize effects as well as to find ways of measuring them. We propose that this is done in collaboration with the users following a participatory-design approach.
2. *How can pilot implementations create the conditions for measuring the effects of using a system?* To use effects actively as an instrument for managing IT projects, the system must be subjected to periods of real-world use, and these periods must be within the timeframe of the IT project. We envisage that such pilot implementations can be conducted for systems that are based on configurable platforms and by making creative use of simulation of system modules.
3. *How can effects that are specific to the users' work processes be related to overarching strategic and political effects?* An understanding of the relationship between different effects is essential to understanding and arguing for why a set of effects is desirable and how the effects can be achieved. Such an understanding requires clarity about how overarching effects are implemented at lower levels and about the effects that are directly related to the users' work.
4. *How can the partnership that is necessary for effects-driven IT development be established between the customer and the vendor?* Effects-driven IT development involves a blurring of the distinction between technical development and organizational implementation. The customer's adoption and use of the system influence the vendor's success and the vendor will, therefore, demand influence on how the customer approaches organizational implementation. Such partnerships require trust between the customer and the vendor, for example, developed through a long-lasting, strategic collaboration.
5. *How can an effects-driven approach be incorporated in the contractual regulation of IT projects and what are the consequences of doing it?* A sustained focus on effects in the management of IT projects ultimately presupposes that the effects are not subordinate to other management instruments. The existing contract types appear to be biased toward functional specifications and a linear development process. The development of a fully or partially effects-driven type of contract will be an important strengthening of effects-driven IT development.

Effects-driven IT development builds on participatory design (PD) and user-centred design (UCD). In these research traditions, the focus is on methods and techniques for mutual learning between, on the one hand, the domain specialist (the customer) and, on the other hand, the IT and organizational-change specialist (the vendor).

3 Projects

A concrete consequence of our roots in PD and UCD is that our work with effects-driven IT development takes place in close, empirical collaboration with customers and vendors.

3.1 Clinical Process

The first project we conducted in the research program was Clinical Process (DVD documentary, 2006; Hertzum & Simonsen, 2008; Pedersen et al., 2006; Simonsen & Hertzum, 2008). This project focused on how the development and implementation of an integrated EPR solution can be organized as an experimental, participatory, and effects-driven process. The EPR solution was to support all documentation so that the clinical work could proceed without any paper records.

The research goals of the project were:

- To conduct a large-scale experiment with effects-driven IT development
- To investigate whether and how effects of IT use can be defined and measured
- To analyze the customer's and vendor's experience and accept of such effects measures
- To assess whether the EPR solution gave the clinicians the desired effects, especially with respect to better overview and coordination

The project was an action–research project and was conducted in 2005–2006 in collaboration with the EPR Unit of Roskilde Amt and CSC Scandihealth.

The EPR Unit wanted to acquire knowledge about the clinical value of a clinical-process module and about the magnitude of the effort required to introduce such a module. The EPR Unit was very aware that success with a clinical-process module required that the clinicians experienced an immediate benefit from using it. The strategy was to conduct pilot implementations to learn about the effects of the EPR module before it was "rolled out".

CSC Scandihealth wanted to evaluate the configuration process associated with their new EPR platform, CSC Clinical Suite, and to evaluate its usability in a real-life clinical situation. Their purpose was to test the system's performance, scalability, and its flexibility concerning integrations with other systems. CSC Scandihealth had an interest in documenting the usability and usefulness of the system toward Region Sjælland and other potential customers, such as Region Nordjylland, which at the time was initiating the tender and bid process for a large EPR project.

The Clinical Process project was conducted at the Stroke Unit of the Neurological Ward of a medium-size hospital (Figure 2). Five full-day workshops were conducted with clinicians from the Stroke Unit, during which their suggestions for effects from the system were specified and prioritized. The top-priority effects were improved overview of the patients

combined with support for coordination. Similarly, the specification of clinical content focused on the situations involving intense coordination: the nursing handovers, the team conferences, and the medical ward rounds. During the five workshops, the EPR system was designed through up to three iterations of mock-ups and prototypes.

The configuration of the EPR system in Clinical Suite comprised 243 screens, including overviews, standard treatment plans, laboratory results, and notes, which could run on portable as well as stationary computers, on large-screen displays during nursing handovers and team conferences, and on PDAs for the registration of, among other things, stroke in progression (SIP) scores. Interfaces were developed to existing systems (e.g., GS, Labka, OPUS Medicin), and five years of patient data were migrated to the system.

Project start up	Workshops with effects specification, specification of trajectories, design of EPR	Effects measurements (paper records)		Effects measurements (EPR)		Project evaluation
	Configuration	Integration and test	Training and test	Pilot use	Analysis	
August 2005		November 2005		Week 50		February 2006

Figure 2. Timeline for Clinical Process.

After a training and test phase, the system was used during Week 50. During this week the paper records were replaced by the EPR system, which ran 24 hours a day and covered all patients at the Stroke Unit. As a safety precaution ‘shadows’, in terms of staff from CSC Scandihealth and the EPR Unit, were continually present to support the clinicians in case of uncertainty about how to use the system. A ‘back office’ was also established and staffed round the clock. The back office monitored the use of the system and simulated transactions between the Stroke Unit and other hospital wards: Requests entered into the system by the clinicians were printed by the back office, sent manually, and when the reply arrived it was typed into the system. This way the clinicians at the Stroke Unit experienced the system as though it was implemented across the entire hospital.

Measurements were made before the use of the EPR system and during the use of the EPR system. These effects measurements comprised 15 nursing handovers, 11 team conferences, and 8 medical ward rounds. The effects measurements were subsequently analyzed, and the project as a whole was evaluated and discussed at a full-day workshop in February 2006. The clinicians, the EPR Unit, and CSC Scandihealth expressed satisfaction with the experimental, participatory, and effects-driven process, and the EPR system led – in spite of the brief period of use – to several measurable, positive effects.

3.2 Clinical Monitoring

The Clinical Monitoring (KLIMO) project (Granlien, 2010; Granlien, Pries-Heje, & Baskerville, 2009) investigated the possibilities of introducing a clinical-monitoring system promoting the Danish Healthcare Quality Programme, developed by the Danish Institute for Quality and Accreditation in Healthcare. Effects-driven IT development was to be used in the development and evaluation of a system that could replace a number of paper forms (for the

registration of, e.g., growth curves, respiration, SIP, and diabetes). The system should support real-time registration using a standardized terminology (SNOMED CT) and should present the registered data in overviews along with data from other systems (e.g., PAS and OPUS Medicin).

The research goals of the project were:

- To conduct a series of small, focused experiments with effects-driven IT development
- To define and measure effects of IT use over a longer period of time, including a focus on direct effects on patient outcomes
- To assess whether the system contributed to achieving the desired effects
- To investigate the implications of effects-driven IT development in relation to the organizational implementation of the system

The project was an action–research project, and it was conducted in 2006–2007 in collaboration with CSC Scandihealth and Region Sjælland (Figure 3).

	Six workshops with effects specification and system configuration				
Project start up	Configuration	Test and configuration	Preparations for pilot implementation	Training and pilot use	Project evaluation
August 2006	September 2006		November 2006	January 2007	February 2007

Figure 3. Timeline for the KLIMO project.

Region Sjælland wanted better knowledge about the possible benefits of – and requirements for – a large, future investment in a clinical-monitoring EPR module. In addition, they wanted to identify the derived consequences of introducing such a system with respect to, among other things, revised work procedures, possibilities for changes in the division of labour, changes in the time spent on clinical monitoring, the needs for training, and the resources and competences needed for continual re-configuration, maintenance, and operation of the system.

CSC Scandihealth wanted a reference installation for quality assessments based on the Danish Healthcare Quality Programme in order to demonstrate their system's configurability, integrability, scalability, and that it could be made part of a solution for clinical monitoring.

The project was established in August 2006, and during fall that year six full-day workshops were conducted to specify the desired effects and the system design. A total of six forms were designed in collaboration with clinicians from the departments that participated in the project: neurology, cardiology, paediatric and respiratory medicine. The system was configured and tested, and the participating departments made preparations for the pilot implementation in parallel with the workshops. The pilot implementation was initiated in January 2007 with some delay and a reduction in system scope and the project was evaluated in February 2007.

KLIMO demonstrated that clinicians find it easy to formulate, specify, and prioritize effects. The project also contributed in terms of experiences regarding the practical and organizational challenges involved in conducting pilot implementations. Due to resource scarcity, the pilot implementation became shorter and more narrowly scoped than planned and the project was discontinued after the evaluation in February 2007.

3.3 Healthcare Centre Workspace System

The Healthcare Centre Workspace System (HCWS) project (Barlach & Simonsen, 2008, 2011) concerned effects-driven IT development at the newly established municipal healthcare centres. The focus of the project was to specify and develop/configure selected patient trajectories based entirely on effects specifications. The system should support the planning, clinical consultation, and continual follow-up of the patient trajectories for diabetes, chronic obstructive pulmonary disease, obesity, smoking cessation, and certain forms of cancer.

The research goals of the project were:

- To devise a model in which effects at different levels are related (from effects close to the clinical work to overarching strategic and political effects)
- To investigate whether effects specification can be used as an alternative to use cases
- To investigate the transferability of effects measurements, including whether effects measured at one healthcare centre are representative of measures from other centres
- To design effects measurements that require a minimum of resources from the clinicians, for example, by basing the measurements on log data

This action–research project was conducted in 2007–2008 in collaboration with CSC Scandihealth and three newly established healthcare centres (Figure 4).

Project start up	Workshops with effects specification and system configuration	Design of effects measures: Integration and test	Design of effects measures: Pilot implementation	Strike among Danish healthcare staff	Pilot implementation discontinued
August 2007	October 2007		February 2008	April–June 2008	August 2008

Figure 4. Timeline for the HCWS project.

The healthcare centres were especially interested in being able to evaluate the effect of the system and relate this effect to high-level clinical and strategic/political goals concerning, for example, patient empowerment and motivation. The patient trajectories should be developed and IT supported on the basis of the principles of guided self-determination.

CSC Scandihealth wanted to develop effects-driven IT development further and to train their configurators in conducting system specifications based on effects-driven IT development. Technically, the system would become part of OPUS Healthcare Portal. The project would later be followed by projects at other healthcare centres to assess the transferability of the specified and measured effects.

Six workshops were conducted with representatives from management and healthcare-centre clinicians. The initial workshops focused on the effects the healthcare centres wanted to pursue. The effects were specified in a means–ends hierarchy with five levels (environment, strategy, process, work domain, and IT system). On the basis of these specifications, prototypes were iteratively developed and discussed at subsequent workshops.

A plan was made for measuring effects concerning aspects of the quality, efficiency, and satisfaction that resulted from using the system. This plan consisted of online questionnaires integrated in the system and of automatically recorded log data about the use of the system.

The questionnaires were based on the technology acceptance model (TAM), the task load index (TLX), and the health care empowerment questionnaire (HCEQ).

The pilot implementation of the system was initiated in February 2008. Due to technical problems the pilot implementation had to be aborted and when the technical problems had been resolved the healthcare staff in Denmark went on strike. The strike and the summer holidays following immediately after it delayed the project considerably and it was therefore decided that the effects measurements would be cancelled.

The project produced useful results with respect to effects specification and the design of effects measurements. In addition, we got valuable experiences about organizing the collaboration between the customer and the vendor, about requirements for the technical development platform, and about how to plan and carry out pilot implementations.

3.4 Electronic Medication Record

The electronic medication record (EMR) project (Granlien, Hertzum, & Gudmundsen, 2008; Granlien, 2010; Granlien & Hertzum, 2009; Hertzum & Granlien, 2007) was part of a larger project aiming to consolidate the medication module of OPUS in Region Sjælland. The focus of the EMR project was to identify target areas for achieving effective use of the EMR in the medication process and to evaluate a number of interventions with respect to their contribution to achieving a safe medication process in which the EMR is used efficiently. The purpose of the EMR is to support the clinicians in giving the right medication to the right patient at the right time.

The research goals of the project were:

- To uncover the extent to which the departments at the hospitals in the region used the facilities provided by the EMR and followed the procedures associated with the system
- To identify any barriers to the use of the EMR in accordance with its purpose and as prescribed in the procedures for the medication process
- To work in a effects-driven way with the organizational implementation of the EMR by iteratively conducting interventions and measuring their effect
- To design effects measurements that do not tax the clinicians in their daily work, by using record audits to measure the effect of the interventions

The project was conducted in 2007–2008 in collaboration with Region Sjælland (Figure 5). The vendor of the EMR was CSC Scandihealth but they did not participate in the project, which consisted of three phases:

First, a questionnaire survey about the use of the EMR was conducted at all clinical wards at the hospitals in the region. The region was especially interested in this survey because they had the impression that many wards used the EMR partially, and because the EMR might consequently have an untapped potential. The region saw the survey as the first step in increasing the benefit of their investment in the EMR.

Second, interviews were conducted at two wards that had progressed far in their adoption of the EMR. The interviews aimed to uncover how these wards had handled barriers in the use of the EMR and served, partly, as an elaboration of the survey and, partly, as a preparation for the intervention study.

Third, an intervention study was conducted at one ward to increase and improve its use of the EMR. The region's interest in the intervention study was to gain experience with taking an effects-driven approach to organizational implementation and to improve the utility value of the EMR at the selected ward. These experiences would subsequently be used at other wards.

The intervention study involved four interventions with a common focus on delegated medication orders, which enabled the nurses to order certain types of medication in order to reach the goal of recording all medication in the EMR, rather than, for example, in the nursing Kardex. The interventions and the effect they aimed to bring about were identified at a workshop with clinicians from the ward. The effects of the interventions were assessed at six record audits: two before the interventions, two during the interventions, and two after the interventions. In addition, the use of the EMR was observed before and during the interventions to get an impression of how the interventions were received by the clinicians.

Questionnaire survey		Workshops, effects, and effects measures	Intervention period				
	Interviews	Audit 1	Audit 2	Audit 3	Audit 4	Audit 5	Audit 6
August 2007		February 2008		April–May 2008			September 2008

Figure 5. Timeline for the EMR project.

We found large differences in the extent to which the wards used the EMR, but the general picture was that several system facilities and mandated work procedures were used consistently by a minority of wards. The interventions led to the desired decrease in the amount of medication information not recorded in the EMR, but the last record audit three months after the end of the interventions indicated that the effect of the interventions might not be lasting.

3.5 Maternity Ward

The Maternity Ward project (Simonsen, Hertzum, & Barlach, 2011) is the fourth effects-driven IT development project undertaken by CSC Scandihealth since 2005, and the processes and tools developed to manage and conduct these projects are gradually becoming more mature. Effects-driven IT development is used as an instrument for guiding and facilitating the partnership between CSC Scandihealth and a large hospital complex located in a European region (the Hospital for short). The Hospital's overall strategy is to use CSC Clinical Suite (CCS) as the platform for all parts of its Electronic Health Record (EHR). The EHR is developed and implemented in a step-by-step manner and the Maternity Ward project is the first project that includes the clinical-process part of the EHR. The project focuses on how effects are specified and how a relationship can be established between the customer and the vendor.

The research goals of the project are:

- To evaluate a hierarchical model for effects specification including effects at strategic, tactical, and operational levels (see Figure 8, in Section 4)
- To evaluate CSC Scandihealth's process for effects-driven IT development when it is used for configuring systems that are intended to support clinical pathways

- To try out effects measurements that require a minimum of resources from the customer and the vendor
- To explore how effects measurements can be incorporated in the contractual regulation of subsequent projects

The project has been running during the period 2010–2011 (Figure 6) and comprises two related clinical pathways and EHRs: the Midwife Record, which covers the pregnant woman's outpatient treatment during her pregnancy, and the Partogram Record, which covers the pregnancy from the time the woman is hospitalized and until the child is born. Except for a few workshops early in the project the two records have been developed jointly.

Management workshop	Lab workshop (PR)				Pilot use	
End-user workshop (PR)	End-user workshop (MR)	Lab workshop	Lab workshop	In-situ workshop	Effects assessment	Project evaluation
June-July 2010	August 2010	September 2010	November 2010	January 2011	Spring 2011	Fall 2011

Figure 6. Timeline for the Maternity Ward project (MR – Midwife Record, PR – Partogram Record).

The project follows CSC Scandihealth's process for effects-driven IT development. This process consists of a series of workshops with the customer. First, effects were specified in separate workshops with management and end-users. These effects specifications formed the starting point for iteratively developing prototypes and evaluating them at workshops with clinicians. Early prototypes were evaluated in laboratory workshops; that is, in a setting away from the users' real work. In a laboratory workshop the prototype is demonstrated using a projector and supported by process models of the clinical pathway drawn ad hoc on a whiteboard. The prototype is evaluated against the effects specification. As the prototype gets more mature, the laboratory workshops are replaced by in-situ workshops. In in-situ workshops the prototype contains either realistic test data or actual patient data from the clinic, and the users evaluate the prototype by simulating or conducting actual tasks using the prototype. The outcome of each workshop is requests for revisions of the prototype and of the measures for assessing the achievement of effects during a pilot implementation of the system.

Effects achievement will be assessed on the basis of data from event logs generated automatically by CCS and from online questionnaires triggered at predefined points in the clinicians' use of the EHR. The final evaluation of the project will include an analysis of the legal implications of using effect assessments as part of an addendum to future contracts.

CSC Scandihealth sees the process for effects-driven IT development and the hierarchical model for effects specification as operational management instruments for guiding an agile development process. The project has, however, reinforced that the users who participate in the effects-specification workshops and laboratory workshops need to have concrete insight into the customer's current work practices. Effect specifications appear to be a useful mediation tool in the communication between the different actors in the vendor's partnership with the Hospital. The high-level effects specified at the management workshop were tightly aligned with the effects formulated in the Hospital's overall business case and they have remained unchanged throughout the project. After the effects had been specified it was

decided to integrate the Midwife Record and the Partogram Record. This happened as part of an organizational merger of two types of clinic and it occasioned no changes or supplements to the high-level effects and only minor changes to lower-level effects.

3.6 Clinical Overview

The Clinical Overview (CLOVE) project (Hertzum & Simonsen, 2010a; Rasmussen, Fleron, Hertzum, & Simonsen, 2010) concerns the design, technical development, organizational implementation, and evaluation of IT systems for supporting clinicians at emergency departments (EDs) in maintaining the overview they need in their work. The project addresses clinical overview at two levels. At the ward level, overview is about keeping track of the progress of the treatment of all patients at the ED, about the clinical resources available, and about their allocation at any given time to the ever-changing number of patients. At the patient level, overview is about obtaining and maintaining knowledge regarding the individual patient's condition and about integrating patient information from a host of sources.

The research goals of the project are:

- To arrive at an understanding of the notion of clinical overview in terms of how clinicians describe their overview and in terms of the effects associated with having an overview
- To investigate the extent to which a system consisting of electronic ED whiteboards can be transferred from one ED to another with only minor changes to its configuration
- To evaluate the effects of electronic ED whiteboards on different aspects of the communication, coordination, and work in EDs
- To gain experience with automated collection of data for assessing effects, including logging of computer use and of clinicians' whereabouts

	Interviews, observation, and workshops				
Project start up	Questionnaire survey 1	Questionnaire survey 2	Effects measurements (before and after)	*Not yet planned in detail*	Project evaluation
	ED1, ED2, and Paediatric start using whiteboards		ED3 and ED4 start using whiteboards		
March 2009	Dec 2009–March 2010	Sept 2010	Nov 2010–Sept 2011		Dec 2012

Figure 7. Timeline for the CLOVE project.

The project has been running during the period 2009–2012 in collaboration with Region Sjælland and the Norwegian IT vendor Imatis (Figure 7). All four EDs in Region Sjælland take part in the CLOVE project; two of them are involved in design as well as evaluation activities, the other two in only evaluation activities. The project has three phases, each lasting about a year:

First, a pilot version of the electronic ED whiteboards was designed and developed by Imatis in collaboration with ED1 and ED2. The pilot version was taken into use at the two EDs and was gradually evolved while in use. This process provided rich feedback to the ongoing development activities and to the change process associated with the organizational implementation of the whiteboards. Research activities during this phase involved a field

study of the implementation process and a survey of the clinicians' expectations toward and experiences with the whiteboards.

Second, the electronic ED whiteboards resulting from the first phase were taken into use at ED3 and ED4. Before they started to use the whiteboards, the configuration of the whiteboards was tailored to the individual ED, and the two EDs adjusted – based on input from ED1 and ED2 – their work processes to take advantage of the whiteboards. We measured selected effects of the use of the conventional dry-erase whiteboards prior to the introduction of the electronic whiteboards and will repeat the measurements for the electronic whiteboards after they have been used for 3–4 months.

Third, the focus of the project will change from ward-level to patient-level overview. The patient-level overview will be accessible through the whiteboards so the two levels are interrelated, technically and clinically. Initial activities regarding design, development, and real-use evaluation will again be performed in collaboration with ED1 and ED2.

We have found that at the time they started to use the electronic whiteboards, the clinicians at ED1 and ED2 responded similarly to key survey questions and appeared to base their expectations toward the whiteboards largely on whether they expected the whiteboards to yield improvements for the patients. After they had used the electronic whiteboards for eight to nine months the clinicians perceive an improvement in the extent to which they have the overview they need in their work, compared to when they were using dry-erase whiteboards, but they have not yet experienced improvements for the patients. These largely positive results for ED1 and ED2 are the result of an implementation process that has attended carefully to balancing tradition and transcendence by allowing the whiteboards and the associated work practices to evolve gradually. At ED3 and ED4 the process is different because they have not been involved in the design process. We are currently investigating how this might affect the reception and adoption of the whiteboards and the extent to which the effects are attained.

In 2010, the scope of the CLOVE project was extended to also include the pre-hospital phase before patients arrive at the ED. This part of the project is a collaboration with Region Syddanmark and comprises field studies of pre-hospital work and evaluations of pilot systems installed in ambulances. We focus, in particular, on the effects concerning the collaboration and information exchange between pre-hospital staff and ED staff.

4 Results

Our work with effects-driven IT development until now has produced a number of interesting results. In the following section, we summarize the main results concerning our five research questions. The overall status is that we have many elements of answers to questions 1, 2, and 3, whereas a lot of further work is required to provide answers to questions 4 and 5.

Research question 1: How can desired effects be specified and specified effects measured?

We have specified desired effects at workshops with clinicians and management representatives. The effects concern purposes of the clinical work – as opposed to IT functionality – and the clinicians can generally specify the effects they want from new IT systems quickly and precisely. In the HCWS project, all effects were specified at one four-

hour workshop and there were subsequently few changes to the set of effects (Barlach & Simonsen, 2011). Effects may be directly related to the treatment and care of the patients. For example, the clinicians in the KLIMO project defined an effect related to a quicker regulation of diabetes patients admitted for stroke. This is a situation in which regulation is often needed but the involved clinicians are not specialists in diabetes. Other effects concern the clinicians' work, rather than patient outcomes (Hertzum & Simonsen, 2010b).

Effects specifications are instrumental to identifying the information and functions an IT system should provide. We have demonstrated how effects specifications can be a pivotal element of a development process by completely replacing use cases, and how effects specifications support the communication between different groups in the development and configuration process: management, clinical users, EPR-responsible staff, configurators, and developers (Barlach & Simonsen, 2008). A short amount of training appears to be sufficient for vendor configurators to plan and conduct effects specifications and subsequent system configuration (Barlach & Simonsen, 2011).

We have documented several positive effects of using an EPR by identifying, quantifying, and measuring planned effects of its use (Hertzum & Simonsen, 2008). Many effects can be measured with internationally recognized methods such as TAM and TLX. More specific effects can, for example, be measured with questionnaires devised specifically to gauge these effects, but it is our experience that the interpretation of such tailor-made questionnaires is more often contested. An alternative to questionnaires is record audits, which do not interrupt the clinicians in their work (Granlien & Hertzum, 2009). In the future, we will focus on methods that are internationally recognized and/or methods for which consensus about their interpretation can be achieved prior to the collection of data. Measurements must also require a minimum of resources from the participating clinicians. Here we are experimenting with, among other things, analyses of log data from the use of the systems and incorporation of short online questionnaires in the systems that are being evaluated.

Research question 2: How can pilot implementations create the conditions for measuring the effects of using a system?

Pilot implementations are an opportunity to conduct formative evaluations of effects and, thereby, inform the ongoing development and implementation of IT systems (see Figure 1). This makes it possible to measure the effects of using a system before it is fully implemented. The clinicians' experiences with the pilot system may also produce new ideas. In the Clinical Process project all design proposals from the clinicians were registered, and 38% of the proposals (183 of 482 proposals) were made during the five-day pilot implementation (Hertzum & Simonsen, 2008; Pedersen et al., 2006).

We have demonstrated how an EPR system can be designed and configured through an experimental, participatory, and effects-driven process and, then, pilot implemented at a hospital ward (Simonsen & Hertzum, 2006, 2008). A pilot implementation of an integrated EPR system at one ward must make use of creative methods to simulate full use of the final system. This can be achieved using, for example, Wizard-of-Oz techniques, which simulate online transactions with hospital wards that are not part of the pilot implementation (Hertzum & Simonsen, 2010b; Simonsen & Hertzum, 2008).

A pilot implementation evaluates a system under realistic conditions and, thereby, makes it possible to evaluate the specified effects and also to encounter unanticipated effects (positive

as well as negative), which also follow from introducing new IT-based tools. We have seen unanticipated, positive effects that emerged spontaneously after only a brief exposure to the possibilities provided by an EPR system. These effects were identified using observational, ethnographic methods and show the necessity of supplementing measurement of planned effects with the observation of selected work situations. This supports the identification of unanticipated effects and the incorporation of the novel use of a system in clinicians' work practices and in further development and implementation efforts (Simonsen, 2009).

The use of pilot implementations in effects-driven IT development presupposes that the technology is sufficiently flexible to accommodate an iterative development process and that it is sufficiently mature to be evaluated under realistic conditions. The Clinical Process project demonstrated that the configurable technological platform used in that project was sufficiently mature to enable that EPR solutions can be iteratively configured and adapted to individual clinical specialties without sacrificing existing standards, integration with other systems, or system performance (Møller-Jensen, Pedersen, & Simonsen, 2006; Møller-Jensen, Simonsen, & Iversen, 2006).

Iterative development processes that involve pilot implementations are demanding in resources. It is important to be able to predict which parts of a system will require experimentation and which parts can be developed in a predominantly linear manner. We have worked with developing techniques for identifying, characterizing, and estimating both the stable parts of an EPR system (those that do not require experimental systems development) and the parts that must be configured iteratively and experimentally to attain the desired effects (Barlach & Simonsen, 2007). Our analyses suggest that it is only a minor part of a system that needs to go through multiple iterations and intensive evaluation, including the parts that are specific to a medical specialty and those that integrate information in new ways compared to the paper records. An example of system parts that often integrate information in new ways are overview displays (Hertzum & Simonsen, 2010a; Rasmussen et al., 2010). We expect that further research in this area can produce an estimation tool that will allow customer and vendor to identify the parts of a system with which they need to experiment.

Pilot implementations are difficult to conduct successfully, and they are often discontinued before the system has been in pilot use for a longer period of time. This has, for example, happened in two of our projects. The challenges include that the learning objective of pilot implementations has difficulty "competing" with the demands of the day-to-day production. The customer may, for example, assign primacy to patient treatment and safety, and the vendor to the development and support of the existing product suite. The difficulties of pilot implementation and how they can be countered have not been systematically investigated; there is a need for further research in this area.

Research question 3: How can effects that are specific to the users' work processes be related to overarching strategic and political effects?

The benefit resulting from a large investment in an IT system can be assessed from multiple perspectives and at multiple levels of abstraction. We use a model that represents effects in a hierarchy ranging from overall strategic/political effects over effects directly addressing the clinicians' work to effects concerning the specific design of the system (Barlach & Simonsen, 2008; Granlien, 2009; Simonsen et al., 2011). The model is inspired by Cognitive Systems

Engineering, Cognitive Work Analysis, and our previous research on methods for systems analysis (the MUST method). The model specifies five hierarchical levels of effect: environmental, strategic, procedural, work-domain, and IT-system effects (see Figure 8).

Our experiences with the model indicate that management representatives tend to focus on its two upper levels, whereas clinicians typically focus on its three lower levels, which presuppose detailed knowledge of the concrete clinical work. Effects specification at the four upper levels has produced rather stable effects, which have not changed much in the course of a project (Barlach & Simonsen, 2011). At the same time effects specifications appear to provide a usable starting point for the development and configuration of IT systems (Barlach & Simonsen, 2008) as well as for working systematically with their organizational implementation (Granlien & Hertzum, 2009). It appears promising to implement a system organizationally over a period of time while its functionality is gradually extended on the basis of local experiences with the system (Hertzum & Simonsen, 2010a; Rasmussen et al., 2010).

Effects hierarchy	National Indicator Project (NIP)	Standard treatment plans
Environment (political demands, national standards, legislation etc.)	National indicators improve the quality of treatment	Coherent patient trajectories, knowledge sharing
Strategy (response to environment, abstract function)	High quality in NIP recordings	Standard treatment plans
Process (recurrent, familiar, input-output relationships)	Well-documented patient trajectories	Well-documented patient trajectories
Work domain (information-processing task with need for IT support)	Situations in which NIP data are produced	Acute admission of stroke patients
IT system (functions, information, categories, standards, user interface etc.)	Functionality capturing NIP data at their source	Template with checklist for junior physicians

Figure 8. Examples of hierarchically specified effects.

Lately, we have been investigating how to integrate the effects hierarchy into effects specifications and how to support its use with tools (Granlien, 2009; Simonsen et al., 2011). In our further research, we will focus on identifying and handling inconsistencies between effects and on managing large sets of effects. This is related to another area that warrants further attention, namely, the selection of the user and management representatives who take part in the effects-specification activities.

Research question 4: How can the partnership that is necessary for effects-driven IT development be established between the customer and the vendor?

Effect-driven IT development involves technical development and organizational implementation co-determining each other and forming one integrated process. This necessitates an innovative relationship between the customer and the vendor. Our experience is that it tends to be tacitly assumed that the vendor is responsible for developing and

delivering the system, while the customer is responsible for its organizational implementation. This conventional division of responsibility is associated with considerable inertia.

An effects-driven approach blurs the distinction between development and implementation of IT systems by, instead, making their development a more continual and integrated part of the development of the organization (Granlien, 2007). This calls for reconsidering issues such as which parts of the IT solution the vendor must develop and maintain on a continual basis and which parts of the system can best be developed and maintained by the customer, who possesses the domain expertise and the most extensive knowledge of local circumstances. We will seek answers to these issues in future work.

The need for pilot implementations and for working systematically with organizational implementation is emphasized by the not uncommon experience that desired effects fail to show, even after a system has been in use for an extended period of time (Granlien et al., 2008). We have identified a number of barriers that hamper consistent use of EPR systems in accordance with mandated procedures, for example, the clinicians experience the presence of barriers but are unable to describe the concrete nature of these barriers (Granlien et al., 2008). This makes it difficult to target efforts to address the barriers. We have gained some preliminary experience with integrating the identification of barriers in processes primarily aimed at the specification of effects (Granlien, 2009), but it is an area we need to address in more detail in future work.

In the EMR project, we have iteratively improved the organizational implementation of a system by first specifying a desired effect and subsequently conducting multiple rounds of interventions and effects measurements (Granlien & Hertzum, 2009). The EMR project showed that positive results can be obtained by working with organizational implementation only, but it would have been advantageous to work also with the technical development of the system. Technical changes to the EMR were, however, not possible within a timeframe that could be combined with monthly effects measurements. This stresses the need for a close collaboration between the customer and the vendor, in which both parties agree to prioritize quick, iterative evaluations and adjustments to the system and the associated work procedures. The potential of a gradual implementation process with multiple iterations and adjustments to the system has been observed in the CLOVE project, in which the customer has undertaken most of the configuration of the system (Rasmussen et al., 2010). Such configuration is laborious and must be tightly coupled with the organizational adaptations accompanying the system. By undertaking the configuration the customer has converted some development costs into internal person hours and ensured that the configuration has been performed by people with local knowledge. The vendor has been relieved of a laborious task and has instead been able to focus on developing generic and configurable functionality and to respond quickly to reported errors and inconveniences. Without close collaboration between the customer and the vendor there is considerable risk that the implementation process would grind to a halt and the desired effects are attained only partially or not at all (Granlien et al., 2008; Granlien et al., 2009).

Research question 5: How can an effects-driven approach be incorporated in the contractual regulation of IT projects and what are the consequences of doing it?

For effects-driven IT development to become widely used an effects-driven mindset must probably be incorporated in the contractual regulation of IT projects so as to achieve an

optimal partnership between the customer and the vendor. Until now we have not had opportunity to work very concretely with this research question.

The plan for our further research is to start out with projects in which the system is developed in an effects-driven manner and, in parallel, write a draft of an effects-driven extension to the conventional contract. The drafts will be evaluated by being used as shadow contracts for the projects; that is, without legal implications. When a suitable contract extension has been devised it will be evaluated in a subsequent proof-of-concept project, in which the contract extension is part of the legal foundation of the project. A precondition for the initiation of the proof-of-concept phase is that satisfactory results have been achieved with respect to the results of the effects measurements and the experiences with the customer–vendor partnership. In addition, there must be a mutual belief that once organizationally implemented the IT system will generate the effects specified in the contract. Until we become involved in projects that satisfy these conditions, we aim to elaborate the ways in which effects specification and assessment can be used as an instrument in projects regulated by conventional contrasts.

5 Conclusion

Effects-driven IT development is an instrument for the management of iterative, participatory, and experimental IT projects. This chapter has described the status of effects-driven IT development based on our experiences from six empirical projects, conducted during the period 2004–2011. The six projects – Clinical Process, KLIMO, HCWS, EMR, Maternity Ward, and CLOVE – are all in the healthcare domain, but we contend that effects-driven IT development is also applicable in other large and complex IT projects.

All the empirical projects indicate that desired effects can be specified. In three projects specified effects have also been measured; two of the other projects ended before measurements were made. Our mixed experiences with ensuring that measurements are made point toward a number of challenges in relation to pilot implementations. These challenges are important and somewhat surprising given the widespread practical use of pilot implementations. This suggests that the challenges involved in pilot implementations are poorly understood. To work with effects at different levels of abstraction – for example, effects specific to the users' work processes and overarching strategic effects – an effects hierarchy has been introduced. Our experiences with this effects hierarchy are promising. In contrast, the six projects have only provided us with tentative experiences concerning how a partnership between a customer and a vendor can be established. Further work on this issue requires empirical projects of considerable duration. Finally, none of the conducted projects have addressed how an effects-driven approach can be incorporated in the contractual regulation of IT projects.

Effects-driven IT development seeks to establish a sustained focus on achieving and documenting the utility value of IT systems. The means for achieving this end is the specification and assessment of effects. Apart from the assessment of whether desired effects are achieved an important result of working systematically with effects is that it provides opportunities for identifying additional desirable effects and incorporating them in the subsequent work on a system.

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