Evidence-Based Development: A Viable Approach?

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ABSTRACT

Systems development is replete with projects that represent substantial resource investments but result in systems that fail to meet users' needs. Evidence-based development is an emerging idea intended to provide means for managing customer-vendor relationships and working systematically toward meeting customer needs. We are suggesting that the effects of the use of a system should play a prominent role in the contractual definition of IT projects and that contract fulfilment should be determined on the basis of evidence of these effects. Based on two ongoing studies of home-care management and electronic patient records for diabetes patients, this paper reports research in progress regarding the prospects and pitfalls of evidence-based development.

Author Keywords

Evidence-based development, effects, user-centred design

ACM Classification Keywords

D2.1. Software engineering: Requirements/specifications
D2.9. Software engineering: Management

INTRODUCTION

Most IT projects regulate the relationship between customer and vendor by means of specifying requirements in terms of system functionality. This entails that the overall purpose of implementing a system in an organization is transformed into a requirements specification, defining the system functionality. The requirements specification subsequently constitutes the key contractual element that guides the development process and the ongoing negotiations between customer and vendor. The limitations of this approach are evident from the large numbers of systems that are rejected by users or produce a merely marginal gain over former systems and work practices [e.g., 2, 5].

It is a central assumption in our research that this type of contractual element severely constrains the possibilities of evaluating whether the introduction and use of a system produce the effects intrinsic to the overall purpose of the IT project. It is our hypothesis that by substituting system functionality with measurable, agreed-upon effects of using the system, the contract will provide more appropriate means for managing the customer-vendor relationship and working systematically toward meeting customer goals. We term this evidence-based development and we further suggest that it may be used in managing vendor commitment in projects involving multiple vendors.

Evidence-based development entails a shift from focusing on the product, through focusing on the process, to focusing on the effects obtained as a result of the organizational implementation and use of a system. It has previously been argued that systems development should move from a product focus to a process focus [3]. The shift toward a focus on effects accentuates that user participation, prototyping, and the other activities in the systems-development process are merely means to an end. The overall purpose of IT projects is neither the system as a product nor the process involved in developing it but the effects of the system on its users and their work.

EVIDENCE-BASED DEVELOPMENT: A SKETCH

Evidence-based development is an emerging idea. We are suggesting that the intended effects of the use of a system should play a prominent role in the contractual definition of IT projects and that contract fulfilment should be determined on the basis of evidence of these effects. However, we have neither a method specifying how this can be accomplished, nor proof that the envisaged advantages are attainable. Rather, we are putting forth the idea of evidence-based development as a working hypothesis that may provide inspiration for new ways of organizing and managing IT projects.

Evidence-based development is rooted in the following preferences:

- *Effects* over products and processes.

- *Measurement* over expectations and estimates.

- *Evidence-based contracts* over functionality contracts.

That is, while there is value in the items on the right, we value the items on the left more and thus focus on planned and valued outputs (increased service levels, higher efficiency, etc.). Two major sources of inspiration in our work

on evidence-based development are performance-based procurement and objectives-based usability engineering.

Performance-Based Procurement
Performance-based procurement has primarily been reported on within the construction industry [4], though one IT related case has attracted considerable interest: In an effort to improve their ability to manage large, high-risk IT projects effectively, the California Franchise Tax Board has developed and used performance-based procurement [1, 6]. In this case, performance-based procurement has been deployed by a large IT customer to manage relations with vendors. The key objective of performance-based procurement is risk sharing, which is accomplished through performance-based payments. Vendors only get paid if and when the benefits stated in the contract (in terms of increased income, operational savings, and cost avoidance) are realized after implementation of the systems. This is assumed to increase vendor commitment to success through their assumption of up-front project costs, and it limits the customer's expenses and liability for unworkable systems.

The benefits to be achieved by a system are defined through an extensive pre-project phase, during which the customer and a group of qualified vendors collaboratively identify and describe the business problem and outline alternative solutions. On this basis, the customer selects the preferred solution and negotiates a contract with the vendor offering this solution. This is akin to the conventional contract model of systems development but emphasizes the substantial resources expended by the group of vendors to identify and define the benefits to be achieved by the system. The vendors are not paid for this work, and the vendor getting the contract is only paid if and when they deliver the benefits stated in the contract. In this way, performance-based procurement may make it possible to fund IT projects within the customer's operational budget because project costs are not to be paid until the operational savings are attained.

Objectives-Based Usability Engineering
Performance-based procurement can be seen as an extension with more radical means of the usability-engineering approaches that emphasize quantification and iterative measurement of usability goals [e.g., 9]. These approaches represent usability specialists' efforts to establish usability as an important concern within vendor organizations. A principal artefact in accomplishing this has been usability specifications giving the worst, planned, best, and present level of user performance for a specified set of tasks. In specifying the set of tasks, the performance measure used for each task, and the values defining the different levels of performance (worst, planned, and best), usability specialists define a set of effects to be achieved by the system. Usability specifications provide for an iterative process alternating between design and evaluation until all effects have been achieved. This implies, however, that they are at the same time restricted to effects for which it is possible to devise

performance measures that can be established fairly quickly, inexpensively, and precisely. Consequently, objectives-based usability engineering tends to point toward more restricted effects than those targeted by performance-based procurement.

RESEARCH APPROACH
We investigate our overall hypotheses through an exploratory and empirical approach and address three overall research questions:

- How can methods for measuring effects be developed?
- How can projects be based on evidence-based contracts?
- What does evidence-based contracting entail with regard to organizational consequences, practices for cooperation, tools and techniques, and so forth?

These questions are investigated in two ongoing studies of IT projects in the public healthcare domain: home-care management and electronic patient records for diabetics. IT projects in this domain are often initiated and influenced by government politics, adding an interest in investigating how effects can be linked to political objectives.

Our planned research approach includes three phases (each lasting about one year), during which the systems from both empirical settings are continuously developed, implemented, and integrated with a range of other systems:

- Phase 1, *Analysing*: Descriptive analyses of current development conditions and challenges, as well as identification, specification, and analyses of potential measurable effects in the two empirical settings.
- Phase 2, *Experimenting*: Conducting and evaluating experiments in which selected parts of customer-vendor contracts are based on specified effects.
- Phase 3, *Proof-of-concept*: Conducting and evaluating complete development cycles by means of evidence-based contracts.

Below we present in more detail our preliminary findings which, due to the limited space in this paper, are restricted to the project about home-care management.

HOME-CARE MANAGEMENT: PRELIMINARY FINDINGS
Home-care providers deliver care to patients in their homes and generally spend little time in office settings together with other home-care providers. This reduces the possibilities for face-to-face communication and informal coordination of activities such as collaborative care for common patients. In the greater Copenhagen area in Denmark, the overall coordination of the home-care providers' daily work is sorted out by an information system. This system produces the schedules detailing the patients to be visited by each home-care provider and the care to be administered. Recently, the system was extended with a mobile front end running on personal digital assistants (PDAs), and within a year 4500 home-care providers will access their daily schedules by means of such PDAs. The further develop-

ment and organizational implementation of the PDA system is planned as a gradual process envisaged to yield the following benefits:

- Continuity in the service provided to patients (in extreme cases patients have been treated by 200+ home-care providers during the course of one year).

- Compliance with legislation and procedures (this aspect has lately received considerable political attention).

- Better communication and coordination (home-care providers work alone most of the time).

- Improved documentation.

- Higher levels of efficiency.

Currently, these benefits have not been expressed in terms of measurable effects and planned performance levels such as "a patient must be treated by at most X different home-care providers during the course of a year". Devising and reaching agreement on a set of measurable effects is by no means trivial. Some aspects of a system may lend themselves more readily to quantification than others, and vendors may be reluctant to commit to effects because effects are dependent on the entire organizational implementation and use situation, not just the IT system. Further, individual vendors may be responsible for only parts of a system and reluctant to commit to effects that also involve parts for which other vendors are responsible.

In relation to the latter issue, it is a core characteristic of the home-care project that its success depends on contributions from multiple actors under multiple managements. The home-care system must get data from and feed data to a host of systems used by general practitioners, nursing homes, hospitals, local-government institutions, and the National Board of Health. Such system integration requires common ways of classifying activities, objects, and events; negotiation of mappings between different terminologies; agreement on schedules, responsibilities, and deadlines; development of interfaces, data pumps, and other integration components; and a general willingness to make efforts, concessions, and adjustments for the benefit of other actors in the project. Thus, a considerable part of the actors on which the home-care project is dependent are primarily working on and responsible toward other projects in other organizations.

With a traditional contract, the individual vendors can focus on providing the system components for which they are responsible, whereas the customer bears the risks relating to cross-component integration. As the home-care project involves multiple vendors and a dynamically changing context of use, there are numerous situations that require adjustments of previously negotiated agreements concerning component interfaces, deadlines, and so forth. Evidence-based development promotes a more even distribution of the risks associated with these cross-component issues. In addition, the nature of the customer's task is changed from one concerning technicalities and project-internal negotia-

tions to one directly related to the customer's prime interest in how the system will affect their ways of working.

Our preliminary studies of home-care management suggest that measurable effects can be formulated. Examples of measurable effects could include:

- Coordination and rescheduling of patient visits consume 20% less of home-care providers' time, providing additional time for care, treatment, and other patient-oriented activities.

- Up-to-date, individual treatment plans (a legislative requirement) are available for 95% of patients and provide a basis for both home-care management and the actual treatment of patients.

- Compliance with a specific procedure, X, is documented in 95% of all cases where the procedure was performed.

- Phone calls to inquire about patients' medication are reduced by X%, indicating better coordination between home-care providers and general practitioners and less uncertainty experienced by home-care providers.

- Home-care providers rate "satisfied" or "very satisfied" with the information they receive from hospitals when patients are discharged and home care is resumed.

- Two home-care providers can in no more than two minutes schedule an ad-hoc meeting about a patient.

These example effects are in accord with the collaboration needs in home care identified by Pinelle and Gutwin [7]. Further, Schultz-Larsen et al. [8] find that an attempt to standardize work procedures in home care incurred an administrative overhead for the home-care providers and failed to improve efficiency. This suggests that effects aiming at increasing home-care providers' control over their work and collaboration with their colleagues may stand a better chance of improving home-care practices.

DISCUSSION

The idea of evidence-based development is akin to the concept of evidence-based medicine in healthcare. The two contexts differ, however. In healthcare there is an established tradition of measurement, often conducted through controlled, comparative studies in which statistical analysis relates effects with causes. In systems development, effects are rarely measured. Further, it might not be of great importance to link causes and effects because the prime interest is simply to obtain the effects. The example effects in the previous section illustrate that a number of effects can be stated rather simply and need not be difficult to measure.

Prospects of Evidence-Based Development

Evidence-based development seems promising especially for complex projects that require establishment of long-term, mutually beneficial relationships characterized by trust, cooperation, and mutual learning [6]. It suggests an overall organization of public/private partnerships pursuing the same goal, sharing risks, and coordinating interrelated

projects based on intended measurable outcomes. Because everyone needs the system to be successful there is an incentive for pursuing realistic approaches. Potential prospects for the customer and vendor, respectively, include:

- The customer can focus on conceptual proposals (not detailed technological specifications) defining the problem and desired outcomes in terms of specified effects that might be linked to overall political demands. The projects are easier to fund as (part of) the vendors' payment is postponed until the effects have been attained.

- Vendors are motivated to develop IT solutions that quickly and feasibly deliver the effects. A broader range of the vendor's expertise (than delivering IT) is appreciated and valued, including system adoption, organizational change, and training. Payment may be relative to the value of obtained effects and may potentially yield a much higher profit than from IT systems alone.

Pitfalls and Limitations

Evidence-based development is not a panacea. While we believe the idea holds promise, there are also pitfalls and limitations that call for further investigation. These include:

- Effects must be adequately defined, controlled, obtained, and measured within a reasonable period of time. This is not always possible. Within the healthcare domain, aspects like care and nursing might be hard to quantify in measurable terms.

- Measurable effects are a result of multiple factors including a broad range of organizational factors. If vendors' payments are made dependent on effects of system use, then vendors must be granted influence on the pace, extent, and managerial enforcement of customer participation in the development process as well as on the organizational implementation of the system. Customers may, however, be unable and unwilling to work intensively with all involved vendors.

- Small vendors may be excluded (or forced to engage in strategic partnerships with other vendors) because they lack the resources to enter into projects in which they are not (fully) paid until after the system has been delivered and the stated effects attained.

- If measurable effects are fixed prematurely, the result may be that projects are confined to known solutions for known needs. Openness toward problems and needs that emerge during the project is a requirement.

- Many systems are developed in an incremental manner with each increment organized as an individual project. It may be difficult to devise relevant effects for individual projects, especially early projects that primarily provide the infrastructural foundation for subsequent, more application-oriented projects.

CONCLUSION

Many, if not most, IT projects do not produce the effects customers are aiming to achieve. From the customer's point of view such projects are full or partial failures, but the vendors may have successfully fulfilled their contract by delivering the specified system functionality. Evidence-based development is an emerging approach to contractual development. It is based on the idea that contracts should specify the effects to be achieved by the developed system when used by intended users. By linking contract fulfilment to evidence of the actual effects of system use, vendors get a direct interest in producing systems that lead to measurable improvements in users' ways of working. Our initial analyses illustrate that measurable effects are not necessarily difficult to specify. In our future work, we will look further into the complex and dynamic process of defining such effects and investigate the possibilities and conditions for getting vendors to commit to evidence-based development.

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