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The influence of contextual elements, actors' frames of reference, and technology on the adoption and use of ICT in construction projects: a Swedish case study

MATTIAS JACOBSSON¹ and HENRIK C.J. LINDEROTH^{1 2*}

¹Umeå School of Business, Umeå University, Umeå, Sweden

²School of Technology and Society, University of Skövde, Skövde, Sweden

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In contemporary research on construction-related ICT (information communication technologies), little distinction is made between the use of ICT in permanent line organizations and its use in temporary organizations (for example, in building and construction projects). This paper makes that distinction. The aim is to understand how the interplay among contextual elements, actors' frames of reference, and the ICT itself, influences the adoption and use of ICT in a building and construction project. This will be done through a description and analysis of a case study of ICT use in a major Swedish construction company. It is concluded that the well-defined duration of the temporary organization (the construction project) stands in sharp contrast to the generally indefinite duration of ICT-mediated change processes. However, by analysing the ICT application to be implemented, it can be revealed whether it can be 'ready packed' for, or delimited to, certain processes in order to achieve immediate benefits. When implementing more encompassing ICT applications, the challenge for the company is to find alternative ways of implementation in the project-based organization and of creating alternative spaces for innovation and renewal where new ICT can be tested and experimented with.

Keywords: Organizational change, temporary organizations, project-based organizations.

Introduction

Within large building and construction companies the use of ICT to coordinate and manage internal information flows, is at present, at the same level as companies in other industries (see e.g. Molnár *et al.*, 2007). However, in construction projects, the use of ICT for intra- and inter-organizational coordination and information exchange in the planning, design and production processes is still limited, even if it is claimed to have a recognized potential (see e.g. Wikforss and Löfgren, 2007). Explanations for the limited adoption and use of ICT in construction projects include:

- fragmentation of the industry and lack of integration between the design and production processes (Dainty *et al.*, 2006);
- a focus on solving technical problems, at the same time as the organizational context is over-

looked, as well as problems of existing ICT solutions in incorporating the interests of varying professional groups (Wikforss and Löfgren, 2007);

- varying sets of principles, rules, knowledge domains, etc. in professional groups leading to difficulties in cooperating (Söderholm, 2006).

Moreover, Rowlinson and Croker (2006) and Croker and Rowlinson (2007) have criticized earlier research on adoption and use of ICT in the industry for not distinguishing between the permanent organization and the project-based one. This paper makes that distinction. When analysing the adoption and use of ICT, we separate the project-based organization from the permanent one so that one important stream in the literature on organizational and managerial aspects of ICT can be followed. The point of departure in this stream is to understand adoption and use of ICT as an

* Author for correspondence. E-mail: henrik.linderoth@his.se

emergent change process embedded in an organizational and societal context (Kling, 1980; Markus and Robey, 1988; Orlikowski, 1992), where contextual elements are shaping actors' frames of reference as these give meaning to interactions with new ICT. Accordingly, it is possible to raise the question of how the separation between the temporary and the permanent part of the organization shapes the adoption and use of ICT in a building and construction company. However, in order to fully understand the adoption and use of ICT, it is of crucial importance to include ICT in the analysis and not take it for granted or see it as unproblematic (Monteiro and Hanseth, 1995; Orlikowski and Iacono, 2001). Given this background, the aim of the paper is to investigate how the interplay among contextual elements, actors' frames of reference, and the ICT itself, influences the adoption and use of ICT in a building and construction project. This aim will be pursued by a description and analysis of a case study of ICT use in a major Swedish construction company, based on semi-structured interviews and an ethnographically inspired study of a partnering project worth 50 million over two years.

The processual and emergent nature of ICT adoption and use

The importance of taking the organization and its context into consideration when ICT adoption and use is studied is well recognized within information systems (IS) research (see e.g. Lucas, 1975). Lucas (1975) stated that one reason for failure of ICT implementations was too strong a focus on the technology, coupled with a neglect of its impacts on people affected by it. This opinion was further developed in the seminal articles by Kling (1980) and Markus and Robey (1988) who challenged those views which tended to overemphasize the rationality of managers directing change and the capability of ICT to create predictable changes in organizational processes. The authors suggested that research should instead analyse the processual and emergent nature of ICT-mediated change. The process of ICT adoption and use can be described as a social one involving a wide array of actors (see e.g. Newman and Robey, 1992; Robey and Boudreau, 1999). This process is linked to intra-organizational and broader situations—so-called multi-layered contexts—emerging from a series of historical, organizational and economic circumstances (Walsham, 1992). The context in which the adoption and use of ICT unfolds can be understood as a broader socio-political structure that includes elements like industry characteristics, political agendas and power relations (Pettigrew, 1985). However, it is possible to be more specific about the

context and its elements by applying Orlikowski's (1992) concept of institutional properties that is arguably similar to contextual elements. She includes more concepts when describing institutional properties of organizations, among which are: organizational dimensions such as structural arrangements, business strategies, ideology, culture, control mechanisms, standard operating procedures, division of labour, expertise, communication patterns, as well as environmental pressures such as government regulations, competitive forces, vendor strategies, professional norms, states of knowledge about technology and socio-economic conditions (Orlikowski, 1992, p. 409). Hence, when changes are triggered by the adoption and use of a new ICT, it is likely that actions triggered by the new ICT challenge for example, existing cultures, structures and power relations in the organization (see e.g. Orlikowski, 1992, 2000).

The contextual elements can be seen as entities reinforcing actors' frames of reference. By drawing on stocks of knowledge, norms, formal and informal rules, etc. constituted by the contextual elements, humans interpret and give meanings to events and behaviours to achieve meaningful interaction (see also Giddens, 1984). In this vein, new ICT is interpreted and given a meaning. Actors' frames of reference regarding a specific technology can be understood as (Orlikowski and Gash, 1994, p. 178):

... the understanding that members of a social group come to have of particular technological artifacts, and they include not only knowledge about the particular technology but also local understanding of specific uses in a given setting.

Even if the technology may appear to have objective forms and functions at one point in time, these can and do vary over time due to there being different contexts and different users assigning varying meanings to technology (see e.g. Pinch and Bijker, 1987; Orlikowski, 1992; Linderoth and Pellegrino, 2005). Actors' frames of reference are continuously constructed and refined in practice through inferences of past experience, as well as the obtainment of new knowledge emerging from, for example, added features or a redefined use of a technology (Linderoth and Pellegrino, 2005).

The ICT as shaper of the process

When studying adoption and use of ICT in organizational contexts, it is important to include the ICT in the analysis of outcomes of the interaction between the technology and that context (see e.g. Monteiro and Hanseth, 1995; Orlikowski and Iacono, 2001). One way of taking ICT into consideration is to recognize

programmes of actions, inscribed in technological artefacts, which originate from technology designers' assumptions about the potential user and the context for use (Akrich, 1992; Latour, 1992). These inscribed programmes of action delegate roles and competencies to the components of a socio-technical network, including human and non-human entities of the system (*ibid.*). When a programme of action is inscribed into a piece of technology, the technology could become an actor imposing its inscribed programmes of action on its user (Monteiro, 2000, p. 77). However, the concept of inscriptions should not be viewed from a technologically determinist perspective. Instead, inscriptions in technological artefacts can govern programmes of action in strong or weak modes (Hanseth and Monteiro, 1997). Inscriptions are strengthened in a process of translation where different actor groups, indispensable for the change, need to be enrolled into a network carrying out the change (see e.g. Latour, 1991).

Depending on roles and relationships delegated to the socio-technical entities in the network carrying out the change, different challenges arise for a permanent organization when outcomes from ICT-mediated change processes are managed and transferred (Linderoth, 2007). For example, challenges depend on whether an ICT system is designed *a priori* for intervening in a large number of interconnected processes, or if the organization can choose a process to change and by that choose to delimit the complexity of the change process (*ibid.*). By taking the technology into consideration when ICT-mediated change processes are analysed, it can be concluded that the process is ambiguous and fluid. Long-term consequences are hard to predict, due to learning and knowledge development that emerge during technology deployment (see e.g. Rosenberg, 1982; Ciborra, 1996, 2000; Orlikowski, 1996; Orlikowski and Hofman, 1997). Taking these conditions into consideration, the management of an ICT-mediated change process in a project with set boundaries will imply a number of challenges for the permanent organization due to conflicting logics in project management—and change processes (see e.g. Bresnen, 2006; Linderoth, 2007).

Method

The overall intention for the collection of the empirical material has been twofold. First, we wanted to get an overview of the use of ICT within the studied company. Secondly, we wanted to understand the actors, the interplay with the context, and the use of the technology. Hence, in all research on the adoption and use of technology in an organizational context, it is of

crucial importance to understand the context in which the technology is deployed (see e.g. Barley, 1986).

In order to achieve the aim of the paper, and through that deepen the understanding of the context of building and construction projects, a case study was conducted. Case study research allows for obtaining rich insights (Eisenhardt, 1989; Yin, 1994), and is thus a suitable and established strategy in order to reach the aim of the paper. As a part of the case study an ethnographically inspired study of a single partnering project was undertaken in the studied company. The project, worth approximately 50 million over a period of two years, is a rebuilding and expansion of a public multi-activity arena. The existing building contained indoor swimming pools and an arena for indoor sports such as basketball and handball. The expanded arena will contain an adventure pool, new swimming pool, a gym and a bowling ground.

Case study research is moreover a research strategy that is strengthened by the possibility of combining data collection methods which focus on understanding the dynamics present within a single setting (Eisenhardt, 1989). In line with recommendations from Yin (1994) and Eisenhardt (1989) the empirical material was therefore collected from a variety of sources, including semi-structured interviews, participant observations, meeting participation and document analysis. The combined data collection focused on gaining an in-depth understanding of the building and construction company and in particular what kind of ICT is selected by the company and how it is used. At issue has been whether interviews with open-ended, semi-structured questions could allow the interpretive-oriented researcher to understand contextual elements, something that is stressed by Coffey and Atkinson (1996, p. 80):

... the analysis of narratives can provide a critical way of examining not only key actors and events but also cultural conventions and social norms.

A total of 17 interviews were conducted with actors on different hierarchical levels within the permanent and temporary (project) parts of the organization. Interviewees are for example, the CEO of the company, the head of a regional unit, the head of a business district, site managers, ICT managers, project managers and managers in an R&D department. All conducted interviews varied in length from one to two hours. The empirical material, collected through participant observation in the project, necessitated attending 45 meetings, encompassing a total of 80 hours. The meetings were:

- production meetings at the main contractor's production site involving the site manager,

deputy site managers, foremen and representatives of construction workers;

- project/design meetings with representatives of the main contractor, the subcontractors and their consultants, and the client representatives;
- meetings of the quality group with responsibility for internal quality audits;
- internal 'check meetings' by the main contractor including the site manager, deputy site managers, purchaser, cost accountant, project manager, planning manager.

Additional data were collected by following a deputy site manager during one day at the construction site, as well as from the project's document database, and minutes from all internal meetings. The information and understanding gained from the participant observations have mainly been used in relation to the analysis of contextual elements and their reinforcement of actors' frames of reference. This analysis has then been used as input for a further analysis of the characteristics an ICT would have in order to be adopted.

The chosen methodological approach also implies that more than a straight account of the respondents' answers to questions, or observations made, would be needed in order to elicit deeper knowledge about the dynamics of the process. The interpretive approach taken in this study is expected to enable an organizational member and/or a researcher to see his or her world with new eyes (see also DiMaggio, 1995). Therefore, the results should be organized in a manner that is based on the researcher's interpretations supported by the theoretical concepts presented. Interpretative case studies are a recommended method when the researcher is seeking to understand an emerging process of organizational transformation through ICT, and they have previously been shown to give compelling and transferable results (see e.g. Markus and Robey, 1988; Orlikowski and Baroudi, 1991; Orlikowski, 1992; Walsham, 1992; Robey and Azavedo, 1994).

The collected empirical material was analysed and interpreted against the theoretical frame of reference and could be described as a theoretical thematic analysis on a latent level (Braun and Clarke, 2006). With a starting point in the theoretical frame of reference and the concepts presented, a latent level theoretical coding was conducted, one that analysed the interplay between contextual elements, actors' frames of reference, and the ICT itself. A latent level theoretical coding seeks to go beyond the semantic surface meaning, trying to identify or examine underlying ideas, assumptions or conceptualizations (Braun and Clarke, 2006). In line with recommendations from Nylén (2005) the results of the coding were thereafter

organized according to the theme structure and presented partly as short narratives (episodes) strengthened by quotations.

The company and its ICT systems

The Swedish company studied is a branch of one of the leading construction and property development corporations in the Nordic region. The Group had sales of 5 billion in 2008, with approximately 20 000 employees; in the same year the company itself had sales of €2.5 billion, with approximately 8000 employees. The company builds everything from schools, hospitals, sports facilities and housing, to roads, bridges, railways and power plants.

Within the company there are a total of approximately 60 different ICT systems with the number of users ranging from one user to 4000 users. The most important link between the permanent line organization and the temporary project organization is the so-called operation system that consists of five sub-systems: a customer relation management (CRM) system; two different systems for the planning of projects (one for larger and one for smaller projects); a system for the calculation of project costs, containing standard costs and so-called recipes; and an e-commerce system linked to major suppliers.

In the project studied the most common ICT applications supporting information and communication flows in the production process were a database for sharing documents among contractor, subcontractors and client; a digitized survey; the e-commerce system linked to major suppliers; and of course e-mail and mobile phones. Additionally, within the project studied, 3D-based building and information model (BIM) was adopted half a year after the project started, and their use of BIM in the company is rapidly growing.

Results

The project-based mode of organizing operations in the industry has been identified as one of the most distinguishable industry characteristics. It is a contextual element that has also given rise to others, such as a lack of standardization and it reinforces actors' frames of reference. However, the building and construction industry is also often mentioned as one of the industries with the longest tradition of organizing activities by projects. It is a form of organizing that is recognized as being the most appropriate because of the often individual and unique character of the outcomes of the production processes. Nevertheless, Croker and Rowlinson (2007) have recognized the problem of organizing by projects, because of the short-term

existence of these project-based organizations. The following section will therefore—in line with the aim of the paper—address the contextual setting, followed by the consequences of the project-based mode of organizing, and how this shapes the actors' frames of reference and in turn shapes the adoption and use of ICT.

Characteristics of the contextual setting

One argument regularly put forward in favour of adopting ICT is that a company can remain in business or be more competitive (see also Mitropoulos and Tatum, 2000), but Croker and Rowlinson (2007) observed that there was no geographical pressure to adopt the technology and this lack operated as a constraining external force on innovative ICT implementation. Thus, it is relevant to raise the question of whether the characteristics of the 'competitive landscape' in the industry have reinforced the use of ICT in order to improve competitiveness. Even if the major Swedish building and construction companies are active in an international market, small and medium sized projects are nevertheless executed in local markets, where the large companies compete with locally based competitors. This picture is supported by an interview with the CEO of the studied company. He referred to an internal survey of 85 managers in local business districts. When asked to point out the strongest competitor, a total of 54% of them chose a locally based company. The conclusion is that a locally based company can compete successfully with the three major Swedish companies when it comes to small and medium sized projects.

One reason for this is the immobility of end products. Buildings and constructions are themselves the products of local production processes. This state of affairs, it can be argued, is intertwined with the project-based mode of organizing operations that has reinforced competition within certain boundaries. Even large building and construction companies often act as if they were hundreds of small companies defined by the projects. Hence, in relation to subcontractors, differences in company size do not always seem to matter. For example, in the project studied, the architecture company's two months' delay in producing the drawings had flow-on effects beyond the design stage. The hypothetical question, therefore, is what would happen if a subcontractor in the automotive industry caused a similar delay? In other situations, for example, purchases of materials, the large company tries to take advantage of its size in order to raise the volume of purchases from suppliers. Thus, it can be claimed that competition that is often limited to local markets has held back competitive pressure. The effect is that innovation in organizing production

processes has not been reinforced. This also implies that adoption and use of ICT as a means of renewal and development of production processes has not been fully considered.

Furthermore, the project-based mode of organizing is a factor that reinforces the lack of standardization. A comparison can be made between the building and construction industry and the manufacturing industry with its automated production lines in manufacturing, or a travel agent on the internet. When ICT is used as a support in these production processes, there is an unconditional need for varying degrees of prescribed components and activities. By contrast, in project-based companies and in projects in general, time pressure has impeded learning from and through projects (Keegan and Turner, 2001) and reduced the possibilities for creating standardized routines in operations. The autonomous nature of projects along with significant discontinuities in the movement of personnel, material and information, has made it difficult to develop routines supporting the flow of knowledge between projects or to the permanent organization (see e.g. DeFilippi and Arthur, 1998; Gann and Salter, 2000). Interviews with a number of managers confirm those same characteristics—autonomy and discontinuity—in project-based operations. For example, a site manager stated that there might be hundreds of examples where standardized building components and working procedures were lacking. The problem was further highlighted in an interview with the head of a business district, who explained that the expression 'to be solved at construction site' is commonly used in the industry. Problem solving is thus routinely delegated to the local construction site.

Hence, the lack of standardized procedures in the industry is arguably another contextual element restricting the potential use of ICT in the production process. However, a gradual change might evolve since the need for standards is highly visible as 3D-based building information models are launched. According to the managers concerned with the development and use of these models, there is a heavy workload of inscribing standardized components and work methods for them.

The project-based mode of organizing and actors' frames of reference

When onsite observations were made at a construction site two related factors characterizing operations soon emerged: the focus on time and the focus on action. This is not surprising since operations are organized as projects with set budgets and timelines, implying that monitoring and control of time and costs is the ultimate task for managers on different levels.

The focus on time and action is deeply embedded on all levels in the company and even clients require immediate action. A development manager illustrates a managerial example of this by the following generic example:

Because a client has not seen an excavator at the construction site he calls the business area manager and asks why the production has not yet started. The business area manager calls the site manager and asks why they have not yet started to excavate. The site manager then takes action for 'action's sake', by ordering an excavator to dig a hole, even if the hole will not be correctly excavated.

Moreover, even at the construction site there is a focus on immediate actions. In a meeting with external consultants a design manager explained the essence of life at a construction site:

If three or four construction workers and an excavator working together run into a problem, they want an immediate solution to it. The managers concerned try to solve the problem immediately, even if on many occasions it would have been better to stop the activity and communicate the problem with other disciplines and even actors involved in that stage of the project.

This focus on time and action can be seen as an expression of the actors' frames of reference. These frames of reference, in which actors make sense of events and phenomena, are reinforced by wage structures, which in turn are reinforced by the organizing by projects, leading to certain behaviours. In the Swedish construction sector, piece wages predominate, with the consequence that all occurrences and activities not included in the piecework can be regarded as real or potential threats to the achievement of higher wages.

Against the background of the examples in this section, it can be claimed that the project-based mode of organizing operations in the construction company has reinforced actors' frames of reference, in which time and action are prioritized in any effort to make sense of events and new phenomena. Thus, what are the consequences of this for the adoption and use of ICT?

Aligned and misaligned ICT

One conclusion from the interviews with IT managers and other managers in the permanent organization is that the large majority of ICT can be seen as a means whereby the permanent organization can control and monitor its projects. A regional head stated that controlling the projects is one of the most important tasks for managers in the industry because it is the projects that generate the revenues and the majority of costs in the company. This is mainly done by providing the project teams with ICT to facilitate those activities

in the project context. That is, as a means for planning and control, ICT has reached the office at the building and construction site, which is a big change over the last one or two decades, as the site managers witness. By contrast, ICT applications supporting the production process in a project are less common.

Furthermore, the corporate Chief Information Officer (CIO) claims that it is not a coincidence that organizationally, ICT belongs to the economics department since ICT traditionally has been considered as a means of controlling a company's financial performance. Accordingly, the large majority of systems are used in accordance with the common idea reinforcing IS implementation initiatives: that is, they integrate all information in order to reduce fragmentation and increase efficiency (see e.g. Monteiro, 2003).

In the project-based organization, attitudes towards ICT use in the project are shaped by actors' frames of reference, in which the achievement of immediate benefits (that is, saving time) is central. For example, site managers interviewed were at the outset sceptical of the web-based purchasing system since it was hard to find the right items and information. According to managers in the permanent organization interviewed, site managers' scepticism towards new ICT applications is also a result of their experience of bad functionality in previous applications. However, when it comes to the voluntary adoption and use of ICT, applications that are perceived as cutting lead times are adopted. For example, digital cameras are used for taking pictures of building components and attached to e-mails when a quick answer on a question is needed from a subcontractor. Similarly, when some information is needed about an assembly instruction, for example, the internet and Google are often used in order to find the information quickly. However, even if the use of an ICT application leads to immediate benefits for some groups, it can get a bad reputation in other groups indirectly involved in the use, due to actors' frames of reference.

One such example is the introduction of digitized survey. Early in the project it was decided that there would be no measures on the drawings. Instead, all measures for the components in the building should be surveyed by the digitized system, where the surveyor downloads the measures from the subcontractors' computerized models into his digital device and then surveys them at the right places on the site. The advantage of this system, as stated by the site manager and the design managers, is that all measures are surveyed correctly from the beginning and are more accurate than if they were done with a folding rule or measuring tape. However, not all parties affected agreed on the benefits. The construction workers' representative complained at a number of production meetings that

the workers needed the survey measures for the progress of the work. On one occasion the digitized survey was even blamed for the workers not getting enough drawings, even though the architect's firm was responsible for the heavy delays in their delivery.

Nevertheless, digitized survey is a good example of the characteristics that an ICT application should have if it is to be accepted in the project organization. That is, it should be possible to delimit the ICT application to certain processes or tasks, in order to achieve immediate benefits. Another example is BIM that was primarily used for detecting clashes in field installations. The benefits were immediate. In a meeting with design managers and installation consultants, it was observed that the first hour was spent detecting clashes in field installations by examining 2D drawings. No clashes were detected in the sections investigated. Thereafter the newly developed 3D model was used for detecting clashes in other sections of the building. In one hour, nine clashes were detected and the design manager stated that €40 000 had been saved. Design managers and site managers who have used BIM from the outset stated that they have mainly used it for detecting clashes in field installations. They used print-outs to illustrate clashes that have to be solved. A site manager explained that he uses the BIM more actively, for example as a tool for planning and scheduling the production process and for generating purchase plans. However, he also stated that he is probably one of the more advanced users and he feels that the company is a bit ambivalent about how it should continue with the more advanced use, beyond controlling clashes in field installations.

Analysis

The project as an organizational form for planning and managing activities is one of the most important contextual elements constraining or facilitating the adoption and use of ICT in the temporary organized part of the building and construction industry. Project teams are short-term alliances and they experience unavailability of resources for tasks not belonging directly to the project. For example, there is no budget for innovative ICT implementation (Croker and Rowlinson, 2007). This condition has in turn shaped actors' frames of reference in which actions and immediate benefits are in focus. In regard to ICT-mediated change processes this can be directly counterproductive, especially if positive outcomes from ICT implementations emerge through processes of knowledge development and learning requiring a time span that often goes far beyond the termination of a project. In other words, the indefinite duration of ICT-mediated

change processes stands in sharp contrast to the well-defined duration of a construction project. However, the features of the ICT can be aligned with actors' frames of reference, implying that adoption and use of an ICT application is facilitated. This interplay among contextual elements, actors' frames of reference, and the ICT is illustrated in Figure 1 and the outcomes are listed in Table 1.

Accordingly, the features of implemented ICT will play an important role in the alignment between the

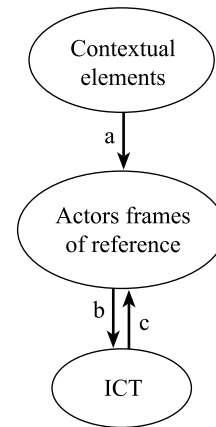


Figure 1 Interplay among contextual elements, actors' frames of reference and ICT

Table 1 Outcomes of the interplay among contextual elements, actors' frames of reference and ICT

Arrow	Influence	Outcomes
a	Contextual elements shaping actors' frames of reference	Project-based mode of organizing: <ul style="list-style-type: none"> • focus on time and action in the project based organization. • focus on controlling projects in the permanent organization.
b	Actors' frames of reference shape attitudes towards ICT	<ul style="list-style-type: none"> • Project organization: ICT might be a tool for saving time. • Permanent organization: ICT is a tool for controlling projects.
c	Features of ICT are aligned or misaligned with actors' frames of reference	<ul style="list-style-type: none"> • Project organization: Probability for acceptance increase if ICT can be delimited, or 'ready packet' for certain processes or tasks. • Permanent organization: ICT with features perceived as increasing control get accepted.

conditions shaped by the project-based mode of organizing and the acceptance and use of ICT. For example, an ICT application intervening in a large number of interconnected project processes (see Figure 2) will unfold in an ambiguous mode and require a process of knowledge development and learning with an indefinite duration. This characteristic of an ICT application, combined with the project members' focus on immediate benefits and action, will make it difficult, even almost impossible, for the project organization to realize immediate benefits from it.

However, if an ICT application has characteristics that create a possibility of delimiting its intervention to one or a few processes, or tasks (Figure 3) conditions exist for controlling the process and achieving immediate benefits. The project studied shows that digitized survey or clash controls in the 3D-based BIM were applications that were delimited to a certain process or task. At the outset BIM can be regarded as rather complex, with regard to its potential intervention in organizational processes. But the advantage of this ICT is that it consists of 'ready packed' applications for predefined processes, or tasks, implying that immediate benefits from the ICT use can be demonstrated.

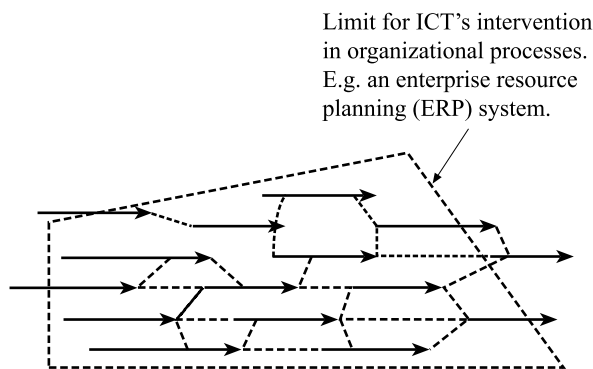


Figure 2 ICT application intervening in a majority of interconnected organizational processes and tasks

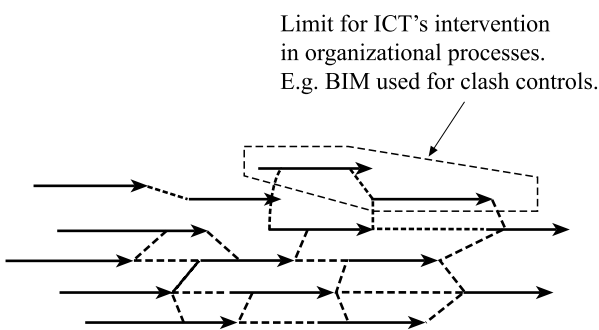


Figure 3 ICT application affecting one organizational process or task

To summarize the analysis: the project-based mode of organizing operations has reinforced actors' mode of making sense of events and new ICT with regard to immediate benefits and saving time. As far as generic types of ICT are concerned, such as those shown in Figures 2 and 3, an ICT application that can be delimited to one or a few processes and can also be 'ready packed', has a high chance of being accepted if immediate benefits can be shown. In contrast, an ICT application that intervenes in a large number of interconnected processes and requires learning and knowledge development, is unlikely to be accepted.

Discussion

With regard to Croker and Rowlinson's (2007) seminal study on the 'temporal nature of forces acting on innovative IT in major construction projects', this study has further added knowledge regarding the impact of ICT features on the adoption and use of ICT in a project setting. As shown in the analysis, conflicting logics between the mode of organizing operations and the features of ICT-mediated change is of central importance to understand. The organizing of operations by projects implies a prime focus on time, reinforced for example, by contractual regulations and incentives encouraging a reduction of time consumption. These contextual elements reinforce actors' frames of reference when an event, or a new phenomenon, is interpreted and made sense of. The implication is that events and new phenomena that lead to immediate actions and benefits are desirable among actors. Such a focus on time makes it hard to find the time space necessary for experimenting with new ICT, unless the ICT application brings immediate benefits for the actors concerned. Usually a project is used as an organizational form when ICT-mediated changes are implemented in organizations. The project is an occasion for reflecting over how the ICT and the organization can be adapted to each other and to develop knowledge on how organizational processes can be renewed. At the same time, the defined duration of the project makes it necessary to find organizational arrangements that facilitate the transfer of ideas from the project to the permanent organization (Linderöth, 2007). However, when the operations themselves are organized by projects, it will be a challenge to find the time space necessary for developing ICT-mediated change and renewal, unless resources are set aside (see also Croker and Rowlinson, 2007). In the permanent organization, ICT use is well developed, but it is applied mainly as a means of governing, monitoring and controlling projects, a fact which is further emphasized in the

studied company where ICT issues belong to the economics department.

Despite the problems caused by organizing operations by project, ICT applications are indeed adopted and used in building and construction projects. One way to reinforce ICT use in the project-based organization, especially when it can be delimited to one or a few processes (see Figure 3), is to 'package' the ICT into a single application and make it into an obligatory passage point (OPP) (Callon, 1986; Linderoth, 2007). That is, actors concerned by the change should not have any option but to use the ICT application on their way to their goals. An example is the digitized survey in the project studied. Removing measures from the drawings was an attempt by the management to force actors to await the digitized survey. It is also important to bear in mind that organizational routines affected by the change need to be adapted in order to facilitate the use of the new technology (see e.g. Linde and Linderoth, 2000; Linderoth, 2002), that is if concerned actors will perceive immediate benefits. Therefore, two requirements arise. First, actors developing applications need to possess a deep knowledge regarding context-specific conditions in projects and how the use of the new ICT will affect roles and relationships, in order to ensure that adaptations are made for reaching benefits perceived by actor groups concerned. Secondly, the permanent organization needs to develop routines that facilitate the transfer of use of the ICT application to other projects in the company.

Conclusions

By taking the context, actors' frames of reference, and especially the ICT itself into consideration when adoption and use of ICT in the building and construction sectors are analysed, it can be concluded that the project-based mode of organizing conflicts with the process of introduction and development of ICT. The focus on time in projects, reinforced by aspects such as contractual agreements, including fees for delays, and the structure of wages, creates a fundamental conflict with the ambiguous and indefinite duration of ICT-mediated change processes. Unless immediate benefits are perceived from the adoption and use of an ICT application, it will not be used. This conflict can probably not be wholly solved; a building and construction company has to learn to live with the disadvantages and obstacles of organizing by projects, because of the character of products produced. But depending on the features of the ICT, the permanent organization faces different challenges. It must either package ICT applications in a manner that is aligned with actors' frames of reference—where immediate actions and benefits

play a central role in making sense of a new ICT—or it must create spaces for innovation of ICT-mediated change in the project-based organization in order to move beyond the role of ICT as simply a means of planning, monitoring and control. When an ICT application intervenes in a large number of interconnected organizational processes (see Figure 2), the challenge is to create spaces for innovation and renewal where new ICT can be tested and experimented with. Projects under own management can be an appropriate forum for testing new technologies and organizational arrangements. In this environment, the contractor has power enough to force other actors indispensable for accomplishing a task to adopt and use an ICT application. The contractors themselves take the whole risk. On the other hand, this implies that they are freer to innovate. The use of 3D-based building information models in projects under own management is an example. In this situation the contractor has full control over which actors should be included or excluded from a project. However, it is important to bear in mind that actors engaged in these projects should not draw on their old frames of reference with regard to how projects are organized and managed.

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