TAKING INDUSTRY SERIOUSLY IN ICT RESEARCH – THE CASE OF BUILDING AND CONSTRUCTION INDUSTRY

Completed Research Paper

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Abstract

Industry has received little attention in Information systems research as a factor explaining information and communication technology (ICT) related activities in organizations. By drawing on a case study in the building and construction industry in Sweden, the aim of this paper is to contribute to an enhanced knowledge of how industry specific features shape the adoption and use of ICT. It is concluded that the adoption and deployment of ICT is shaped by the interplay among three main dimensions of the industry. These dimensions are the market and production environment (shaped by specific interaction patterns among its features), the socio-cognitive environment, and institutional actors. The outcomes of this interplay will "fit" material features of ICT, implying certain ICT applications are preferred in a specific industry. However, the interaction patterns among which features to be included in the framework will vary among industries. The suggested framework can be used as a point of departure when ICT-related activities in an industry are analysed.

Keywords: Industry, Building and Construction, Adoption, Deployment

Introduction

Chiasson and Davidson (2005) claim that industry has received little attention in IS-research when developing theory. The authors state that (Chiasson and Davidson 2005:597):

> *"By focusing only on the organizational context, researchers may overlook elements in the industry that facilitate or constrain actors' IT-related actions".*

Arguments for including industry in the analysis of ICT related activities can however be found both from a practice perspective, as well as from a theoretical perspective. From a practice perceptive the reasons are for instance; the classification of industry made by governmental authorities and their equivalents in different countries, the wide array of industry specific products and services promoted by information technology vendors like SAP, Oracle and IBM global services (Chiasson and Davidson, 2005), common technology and marketing strategies within particular industries (Mauri and Michaels, 1998), and industry associations promoting common interests to develop shared infrastructure and to exchange information. From a more theoretical perspective it can be argued that the environment, including for example institutional actors, production technologies, uncertainty, and complexity are important features when an industry is analysed and its shared systems of meanings impose actions taken. On the organizational level there is a broad strand of studies showing how shared systems of meanings and the influences of shared normative, cognitive, and regulatory structures shape IS-related activities. Analysis's on the industry level are however rarer.

There are still a few studies which take industry into consideration. By focusing on industry type (general manufacturing, high-tech, banking/finance, and retailing service) Yeh and Chang (2007) showed how industry affects the motivation of firms to adopt security countermeasures. In a study of adoption of internet based innovations in two US industries Melville and Ramirez (2008) showed that information processing requirements in an industry determines IT-adoption and diffusion. By studying a computerized physician order entry system Davidson and Chismar (2007:756) showed that aligning social structures and technology capabilities is a significant challenge in IT-related organizational change in the health care industry – which it also is in other industries. By applying Van de Ven's (2005) industry infrastructure framework, Cho and Mathiasen (2007) showed how the influence of different components of the industry infrastructure alters over time and how there is a necessity of engaging different stakeholders in order to develop and un-mature components in the industry infrastructure. By investigating the relationships between IT capability, IT spending and market value, Muhanna and Stoel (2010) showed that IT capability appeared to be more relevant for the firm value in high tech industries. And finally, the need for taking industry products into consideration has been illustrated by Chatterjee et al (2001) who argued that firms in very dynamic industries, whose business processes and product/service offerings are highly digitizable, are likely to engage in seemingly continuous stream of IT deployments.

These studies have highlighted important aspects and together brought valuable insights to our understanding of the role of industry features in the adoption and use of ICT. However, these studies have focused on certain ICT applications, or certain features of an industry, but to lesser extent focused on how the interplay among features of an industry shapes what kind ICT applications that are adopted and how they are deployed. Based on this background the aim of this paper is to contribute to an enhanced knowledge of how industry features shape the adoption and deployment of ICT. The aim of the paper will be reached by analysing a case study in the building and construction industry in Sweden.

Understanding Industry

If industry is claimed to be an important element for the understanding of the deployment of ICT, how can industry then be understood? When defining industry a wide array of definitions can be identified depending on the perspective taken. With a focus on products, Porter's (1980) basic definition is that industry is a group of companies producing products that are close substitutes for each other. The point of departure for this perspective is similar to that of an organizational population, i.e. organizations facing similar environmental vulnerabilities that foster similarities in adaptive capabilities and structural form (Hannan and Freeman, 1977). If other organizational populations and institutional actors are included in the analysis, industry can be considered as an organizational field (Scott et al, 2000), which according to DiMaggio and Powell (1991:64-65) includes

> *"... those organizations that in aggregate, constitute a recognized area of institutional life: key suppliers, resources and product customers, regulatory agencies and other organizations that produce similar services or products."*

Regardless of the perspective chosen, it is important to understand that what is seen as industry is not static (Chiasson and Davidsson, 2005). One such example is the increasingly blurred boundaries between the telecom, computer, and entertainment industry over the last decades. When studying how industry shapes ICT related activities, it is also of crucial importance for future theorizing that authors states their view on industry (*ibid*). In this paper we take the perspective of industry as an organizational field as we will not *a priori* exclude any actors that might have an influence on ICT related activities. To aid future theorizing of the industry's role in relation to ICT related activities, it is also necessary to be specific on what is meant by ICT-related activities. Benbasat and Zmud (2003:186) state that there are four core topics in research on ICT that can be seen as ICT related activities. These are; 1) ICT uses associated with implementing and applying ICT artefacts, 2) ICT capabilities for developing and/or applying ICT, 3) ICT practices such as methods and techniques used to develop IT artefacts and manage the IT function, and 4) ICT impact, or consequences (direct and indirect, intended and unintended) of use for individuals, collectives, structures, and contexts. In this paper we will focus on the first category as our main interest will be on the adoption and deployment of ICT. However, in future studies attention can be paid to whether there are different configurations of industry features that shape the four categories of ICT related activities, or if it is the same configuration of features that shape the four categories of activities. Accordingly, the next question is how the features, or characteristics of industry, can be understood.

Industry characteristics

Chiasson and Davidson (2005), who draw on an institutional perspective, suggest that industry can be analysed with regard to two main dimensions; 1) the material-resource environment that influence the production system that transforms inputs to outputs (Scott, 2001) and, 2) the institutional environment that refers to normative, cultural, and regulatory structures that are shared widely among actors within an industry. The advantage of the framework presented by Chiasson and Davidson (2005) is that an industry can be analysed along more than one dimension. In for example Porter's (1980) five forces framework, the rivalry among firms in an industry is in focus whereas the institutional setting and production technologies are overlooked when analysing firms' behaviour in an industry. Another framework often used to analyse industries is the industry infrastructure framework for technological innovations (Van de Ven, 2005). This framework has many similarities with the framework presented by Chiasson and Davidson (2005) because of the emphasis on the institutional setting. A difference is however that in the industry infrastructure framework socio-cognitive dimensions are not included. In Chiasson and Davidson's framework the institutional logic can be seen as an important and underlying force that shapes the socio-cognitive environment, i.e. how people makes sense of for example events and innovations. Institutional logic can be understood as the organizing principles that underlie practices and belief systems within an institutional setting, playing a powerful role in shaping individual's interpretations and legitimizing their actions (Scott, 2001). Scott (2001:41) commented that:

> *"... individuals do construct and continuously negotiate social reality in everyday life, but they do so within the context of wider, pre-existing cultural systems: symbolic frameworks perceived to be both objective and external, that provide orientation and guidance."*

Socio-cognitive dimensions have previously been shown to be important for our understanding of ICT related activities in single organizations (see e.g. Orlikowski, 1992, Orlikowski and Gash, 1994) and there is therefore no reason to *a priori* believe that socio-cognitive dimensions would not be of importance for ICT related activities on an industry level.

When presenting the two dimensions along which an industry can be analysed, Chiasson and Davidson (2005) suggested (based on Scott et al 2000) that the dimensions are shaped by four, respectively three, elements which have consequences for ICT related activities. These elements are presented in table 1.

Table 1. Features of industry and its influences on ICT related activities (based on Chiasson and Davidson, 2005)

Material-resource environment		
Feature	*Expressed as…*	*Influence on ICT related activities*
Demand-side factors	Complexity, stability, or variation in demand for product/services	*(not discussed)*
Supply-side factors	Scarcity, concentration of key inputs to product/service	*(not discussed)*
Technologies	Material technologies, skills, and knowledge used to transform inputs to desired outputs	Design and functionality of ICT reflect most often an industry's core technology
Market structure	Alignment of suppliers, customers, competitors that influence flow of resources	E.g. dominant suppliers or customers drive industry standards
Institutional environment		
Feature	*Expressed as…*	*Influence on ICT activities*
Institutional logics	Organizing principles, underlying practices and belief systems	Institutional logics and actors are encoded in data structures, software and interfaces
Institutional actors	Individuals and organizations that create and enact institutional logics	
Governance systems	Systems of regulatory and normative control	Managerial controls are reflected in ICT features

This framework will be used as a point of departure for the analysis of the building and construction industry. However, already now we assume that there is an interplay among the different features that shapes the characteristics of an industry and its ICT related activities. Based on Chatterjee et al's (2001) observation that features of the product/service shape ICT related activities, we will also at the outset include the product as another element that shapes characteristics of an industry.

Features of the Building and construction industry

A central feature that distinguishes the building and construction industry from other industries is the way power is distributed (Harty, 2005). A construction project may be coordinated by one actor, for example the main contractor, but each one of the organizations involved in a project has its own influence on the project and bring its own expectations and working methods (ibid). Even if contractual obligations are the mainstay of the formal coordination in the industry, in practice these are hard to enforce, especially when the work is underway (Earl, 1996). This is for example emphasized by Love et al (1998:381) who claims that:

> *"…each discipline has become dedicated to the optimization of its own function, with little regard to, or understanding of, the construction process".*

This dedication of optimizing the own function has led to a fragmentation of the industry which implies a lack of integration between the design and production processes (Dainty et al, 2006). Varying sets of prin-

ciples, rules, and knowledge domains in professional groups implies difficulties in co-operating (Söderholm, 2006). Kadefors (1995) also claims that the increased fragmentation is a consequence of the increased complexity of buildings. Requirements for lower energy consumption in buildings have for example implied that a new category of specialists has been introduced for every new technical system, which has made the project organization even more fragmented and specialized. This has led to a great need for information processing and a corresponding need for stable coordinating and uncertainty reducing institutions (Kadefors, 1995). To deal with the fragmentation and need for co-ordination, projects are generally organized around structured role systems whose nuances are negotiated in situ (see e.g. Bechky, 2006). In building projects role systems are quite standardized and associated with strong cultures and value orientations facilitating the interaction with other professional groups and which means that managers can expect groups to behave in certain ways (Björklöf, 1986; Kodeda, 1992; Kadefors, 1995). Thus, the institutionalization of role systems can be claimed to function as a facilitator for coordination and uncertainty reduction when actors in professional groups move from one project to another and interact with actors from other professional groups who they never have meet before.

Aside from the distribution of power, fragmentation and institutionalized role systems, there are a number of other characteristic features of the building and construction industry. Based on a review of literature, Dubois and Gadde (2002) described the building and construction industry as a loosely coupled system characterized by six more or less interrelated features derived from a variety of sources. These features are presented in table 2.

Table 2. Features of the building and construction industry

Feature	**Source**
Focus on single projects	Construction is mainly about coordination of specialized and differentiated tasks at site level (Shirazi et al, 1996). This implies a decentralized decision making and financial control due to management's unfamiliarity with local resources and environment (Dubois and Gadde, 2002)
Local adjustments	Need for local adjustments at site is a consequence of three uncertainty factors: lack of complete specifications, lack of uniformity, and an unpredictable environment (Dubois and Gadde, 2002).
Utilization of standardized parts	Due to the uncertainties above, materials are not tailored for specific contractors or sites. (Dubois and Gadde, 2002). The industry relies on standardized parts, contrary to other industries where standardized activities are the norm (see Stichcombe, 1959).
Competitive tendering	Strong reliance on competitive tendering that is supposed to promote efficiency (Cox and Thompson, 1977), which explains the use of standardized parts and sets the condition for relationship among parties (Dubois and Gadde, 2002).
Market-based exchange	Competitive tendering shape market based, short term interactions between independents businesses (Gann, 1996).
Multiple roles	A broad activity scope of the including design, production and distribution in various combinations that varying greatly between different projects

Compared to other industries the building and construction industry also relies on far-reaching market based solutions when a project team is composed. More than one specialist competence is never available in-house and the mobilization of specialist competences from different firms can be seen as one way the industry manage risks and uncertainties in order to avoid excess capacity.

If these features of the building and construction industry are related to the framework proposed by Chiasson and Davidson (2005), the features of the industry can be sorted under the general industry features

suggest. However, in this stage we will not do this. Instead this analysis will be performed in the analysis section where the original framework is modified in relations to the findings in the analysis of the industry.

The role of materiality

As claimed in the introduction section, limited attentions has been paid to how industry features shape the types ICT-applications adopted and used in an industry. Against the background of the on-going debate on the role of materiality (see e.g. Orlikowski, 2007; Leonardi and Barley, 2008) and earlier writings on the need of being specific about technology (see e.g. Monteiro and Hanseth, 1995; Orlikowski and Iacono, 2001), it can be assumed the ICT itself is needed to be taken into consideration when analysing the adoption and deployment in an industry. Leonardi and Barley (2008) states that:

> *"…it seems reasonably clear that technologies do not dictate general practices and or forms of organizing, it is nevertheless the case that a technology's materiality does set constraints and offer affordances for use. It is worth entertaining the idea that key constraints and affordances push practice in one direction rather than another, if for no other reason that an alternative practice is too difficult or costly."* (Leonardi and Barley 2008:171)

Jacobsson and Linderoth (2010) have for example showed how the interplay among ICT's material features, actors' frames of reference, and contextual elements shapes the types of ICT that is adopted by the project organization and the line organization in a building and construction company. Thus, when analysing the role industry in the adoption and deployment ICT, it may not be a bold assumption that characteristics of an industry will imply that ICT applications with certain features are preferred.

Data Collection and Case Description

The reasons for choosing the building and construction industry is that it is, to our knowledge, under examined in the IS-community. For example, in their review of studies reporting a specific industry studied in two top tier IS journals (MIS Quarterly and Information Systems Research) Chiasson and Davidson (2005) identified that manufacturing, high tech/IT-consulting/telecom, and banking/finance comprised 56% of the studied industries and only one paper out of 115 was on real estate.

In order to reach 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 for a study of this purpose. As a part of the case study an ethnographically inspired study of a single partnering project was undertaken. The project, worth approximately €50 million over a period of two years, was a re-building 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 contains 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. Coffey and Atkinson (1996:80) stress that*"…the analysis of narratives can provide a critical way of examining not only key actors and events but also cultural conventions and social norms"* which consequently means that narratives collected with semi-structured interviews with open-ended questions can be a suitable way of understanding contextual aspects of an industry. The combined data collection also 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.

A total of 17 interviews were conducted with actors on different hierarchical levels within the permanent and temporary (project) parts of the organisation. Interviewees were 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 was collected by following a deputy site manager during one day at the construction site, as well as from the project's document database and the provided access to 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 company and its ICT-systems

The 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 8 000 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 four thousand. The most important link between the permanent line organization and the temporary project organization is the so called operation system that consists of five subsystems: 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 studied project, 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.

The influence of the market and production environment, institutional actors, and the socio-cognitive environment

According to Harty (2005) there are five central aspects which construction work is characterized by. These are: 1) the collaboration upon which construction work is based, 2) the organization around particular projects, 3) the centrality of communication to the performance, 4) the importance of inter-organizational relations, 5) and the way power is distributed (Harty 2005:513). Against this background we could have expected to find an industry with deeply integrated and encompassing deployment of collaborative ICT. However, based on our analysis we have found an industry where the deployment of ICT can be characterized as self-centric among actors and with a focus on control and calculation. The question to pose is why this situation has emerged, where certain kind of ICT applications have been rapidly adopted, whereas other ICT applications (supporting collaboration) have not been adopted rapidly? The reason for this deployment trajectory can be seen as a result of the interplay among a set of features characterizing the industry.

Drawing on the analysis of our empirical data from the industry and earlier writings on the industry we have chosen to modify the original framework suggested by Chiasson and Davidson (2005). The two di-

mensions – material-resource environment and institutional environment – suggested as analytical perspectives in the original framework, have been divided into three main dimensions: market and production environment, socio-cognitive environment, and institutional actors (see figure 1). The main reason for this division is that we have discovered that it is the interplay among different industry features that shapes the industry's characteristics and by that ICT related activities. The reason for re-naming the material-resource environment to market and production environment is that we found that demand side factors and the production system (technology) have an important influence on the market structure. When starting to analyse the interplay among elements in the original material-resource environment, we soon realized that both the governance structures and the product needed to be included in the market and production environment. It was revealed that governance structures is an outcome of demand side factors and technology, and the product has an influence on the technology: organizing by projects. The interactions among these elements shape the market structure which is one important element that influences ICT-related activities. Moreover, the institutional environment was separated into two dimensions: socio-cognitive environment, and institutional actors. The line of reasoning behind this division is that the socio-cognitive environment can be seen as an outcome of the market and production system. When Scott (2001) discuss institutional logics he describes it as the organizing principles that underlie practices and belief systems within an institutional setting that play a powerful role in shaping individual's interpretations and legitimizing their actions. Thus, the institutional logics play a crucial role in the socio-cognitive environment when norms are established for legitimate actions. However, if an industry in an international context is analysed it is also necessary to include the role of national culture in the analysis in order to explain eventual differences in norms in an industry among countries. We also argue that the socio-cognitive environment reinforces elements in the market and production environment, and that differences among countries may be explained by norms shaped by national culture.

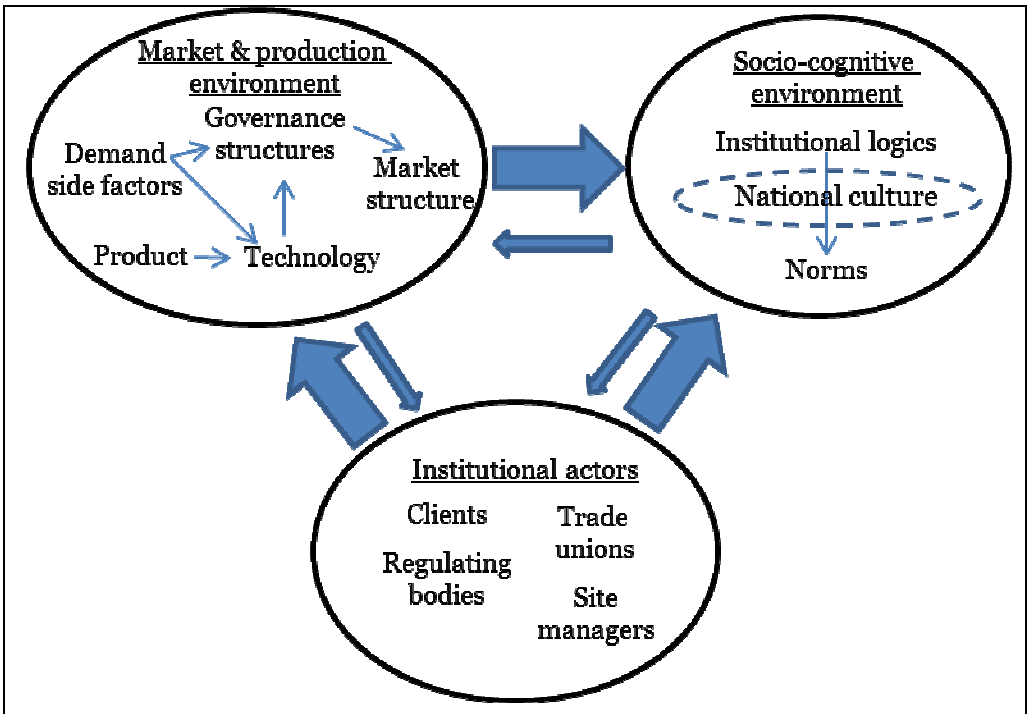

Figure 1. The interplay among industry's generic dimensions.

The institutional actors do in turn shape the market and production environment when recreating the institutional logics. In this study we have however not uncovered any clear evidences that institutional actors have imposed any dramatic changes on the market and production environment. They have instead enacted prevailing institutional logics on the market and production system. It is, however, outside the

scope of this paper to analyse how institutional actors re-shape the market and production environment. Moreover, we argue that it is the market and production environment, and the interaction among elements in the environment, that pave the ground for the understanding of an industry's characteristics and how they shape ICT-related activities, especially if these features have remained stable for a period of time.

The market and production environment

The technology in terms of the organizing of production activities by projects has been found as one explanation shaping ICT deployment in building and construction companies (see e.g. Croker and Rowlinson, 2007; Jacobsson and Linderoth, 2010). The technology has also been one explanation for different problems in the industry, e.g. innovation, knowledge transfer, and the adoption of the kinds of ICT (DeFilippi and Arthur 1998; Gann and Salter 2000; Jacobsson and Linderoth, 2010). In this paper we however claim that it is the interplay between technology and other features of the market and production environment that shape the adoption and deployment of ICT. That is, technology is not a cause *per se*, instead it is the interplay among demand side factors, the product, technology, and governance structures that has shaped a market structure promoting market based short term relation among actors (see figure 2).

In this section we will describe the interactions among the elements in the market and production environment, the consequence of the interactions, and the influence on ICT-related activities. The relations in the interactions among these elements are showed in figure 2 and the outcomes of the interactions as well as the consequences for ICT related activities are summarized in table 3.

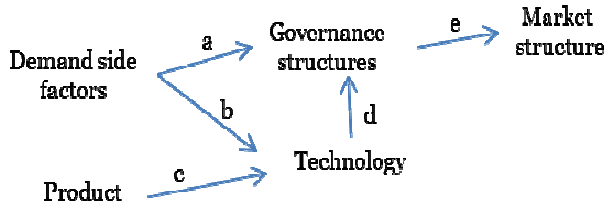

Figure 2. Interplay among features of the market and production environment.

The interplay among the elements in the industry's market and production environment has shaped an institutional logic where short term objectives are in focus in order to save time and money in the project. The implications for ICT adoption and deployment is that project actors do not have any incentives for investing in ICT that should be used for supporting what is best for the project, unless short term gains are obvious for an actor (see also Jacobsson and Linderoth, 2010). Instead, ICT investments have been done in applications that can help the single firm to make its own work more efficient, or that can help them to monitor and control consumption of resources in the project (*ibid*). For example, in the project studied, some subcontractors have for a long time used 3D-CAD for preparing drawings, but when drawings were delivered to the project they were converted into 2D. At the same time the advantages for the project to use 3D-CAD, or BIM (Building Information Models), have been recognized in many years. Despite these advantages it is only during the last few years a slow take off of the adoption and deployment of BIM can be identified. Thus, how has this situation with a self-centric deployment of ICT emerged?

Table 3. Interplay among elements in the market and production environment

Arrow	Influence of elements	Outcome	Consequences for adoption and deployment of ICT
a	Demand side factors → Governance structures *Clients demand for lowest price tender policy*	Creates the demand among actors to control the consumption of their own resources in the project.	Promotes the adoption and deployment of ICT that aids monitoring and control of a firm's consumption of resources in a project.
b	Demand side factors → Technology *Clients demands for customized buildings and constructions*	Organizing by projects: 1) ease the management of clients' demands for varying features of the product, 2) spread the risks of excess capacity among actors when demand decreases.	Even if components are standardized and activities not are standardized, management try to standardize activities in the management process of projects by prescribing activities to perform and support with document templates in ICT-systems.
c	Product → Technology *Immobility of product*	Implies that organizing by projects becomes the most appropriate mode of organizing production. All actors involved in a project have to be mobilized at a specific site during a "bracket in time". Causes a decentralization of power in larger firms, and a balancing of power among project actors.	Historically it has been troublesome to provide sites with bandwidth. ICT has reached the office of the site manager. Immobility of product implies mobility of actors, implying that applications like mobile phones were rapidly adopted. Unlike other industries no actor has had power enough to enforce others using certain ICT.
d	Technology → Governance structures *Organizing operations by projects*	Implies a focus on the balance among time, cost and quality as central components in governance structures. Theoretically quality can be increased by increasing time and cost as along as a client perceives higher value vs. increases in costs.	Adoption and deployment of ICT in a project organization requires that resources are set aside for investments. If the client does not demand certain ICT applications, investments in ICT will create avoidable harm for the project actors' profits.
e	Governance structures → Market structure *Mutually reinforcing governance structures*	Governance structures shaped by technology (time, cost and quality) and demand side factors (lowest tender policy) have created market based short term relations among actors in the industry.	No one feels the responsibility for long term investments in ICT facilitating what is best for the projects. Because in the next project there will be a new constellation of actors with (maybe) new versions of ICT applications. But powerful actors, e.g. large building and construction companies can in projects under own management demand use of certain ICT.

A direct reason for the appropriateness of the technology in the industry (organizing the production by projects) is the demand side factors (arrow b in figure 2). Whatever the client wants to build is built by the

project network. This implies that the product has a high degree of customization, but the customization is normally delimited by the way standardized components can be assembled. Thus, it is doubtful if clients (and also architects) would accept a limited number of product models, as for example in the automotive industry. The organizing by projects and the composition of the project team with occupational groups from a wide variety of firms can also be seen as a mode of dealing with a very varying demand and by that reducing risk. In one of the interviews, a business area manager state that the industry is either in an economic boom, or in a recession, and the equilibrium is quickly passed on the way up or down. The up-side of this organizational arrangement is that risks for having excess capacity in an economic downturn is shared among companies engaged in a project based work. The down-side is that the project is just a bracket in time with neither a history nor a future, implying that projects do not have an organizational memory, nor a future allowing evolutionary processes where performance is improved (Kreiner, 1995; Björkegren, 1998).

Another reason for the appropriateness of the technology is the immobility of products (buildings and constructions) (arrow c in figure 2). The production and consumption of end products is bounded to a certain location. This implies that all resources for the production of the product have to be allocated to this location during a certain period of time. When a project is finished, resources are allocated to a new location. Thus compared to other manufacturing industries, in the building and construction industry there is a reverse relationship between the product and productions resources mobility: production resources are mobile whereas the product is immobile. The immobility of products can be claimed to be an underlying reason for the way power is distributed. Due to the management's unfamiliarity with local resources and environment, decision making and financial control is delegated to the site level (see also Dubois and Gadde, 2002), i.e. site managers. Combined with the organizing by projects this has implied that the power of larger firms' decreases, and a balancing of power among actors emerge especially when the work is underway (see also Earl, 1996). The project as a separate entity decoupled from the firm is emphasized in interviews. A chief financial officer at a major contractor states that the company often acts like hundreds of small companies, each defined by single projects. The balancing of power among project actors also imply that smaller firms like architects or technical consultants do not risk immediate reprimands if they do not deliver on time. In the project under study the architectural firm was for example delayed with the delivery of drawings due to its engagements in other projects, and even if it was obvious who was to blame there were no measures taken. This distribution of power combined with short term relations has implied that even powerful actors have problems to put demands on other project actors to use certain ICT-applications in a project.

The technology, shaped by demand side factors (e.g. customization) and the product, has together with other demand side factors (e.g. lowest price tender policy) shaped the governance structures (arrow a and d in figure 2). This has resulted in a market structure with market based short term relations among actors (arrow e in figure 2). On the demand side it has historically been a strong reliance on competitive tendering that is supposed to promote efficiency (Cox and Thompson, 1977) and clients have demanded a lowest price tender policy making it to a corner stone in the governance structures. It can be claimed that all actors regard the lowest price tender policy as more or less institutionalized in the industry. When new contractual forms are introduced, they are often initiated by larger construction firms who have a hard work in convincing the clients. In one interview a higher level manager in the company stated that they have a hard time to convince clients about benefits with so called partnering contracts where the client and the contractors shares "the pains and gains". However, the lowest price tender policy has not on its own created the market structure. The combination of demand side factors (the lowest price tender policy) and technology (organizing by projects) has created a governance system that reinforces the market structure. The organizing by projects brings in another governance structure that in the interplay with the lowest price tender policy has created the market structure. In project organizing there is always tradeoffs to be made among time, cost, and quality, which has led to a focus on budgets and deadlines in the project organization. In order to promote the accomplishment of projects on time and budget, incentives in the project organization are time based. For example, piece wages are predominate among blue collar workers, 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. Site managers are also evaluated on their ability to accomplish a project on time and budget. However, the quality of the product could (theoretically) be increased by increasing costs and time consumption as long as the client perceives a higher value in relations to the increased time consumption and costs. But this arrangement is incompati-

ble with the lowest price tender policy. If these forces are combined with the fact that the project is only a bracket in time with neither a history nor a future (see Kreiner, 1995; Björkegren, 1998), a governance system emerge that promotes a market structure where market based interactions is the norm for behaviour, and firms will pay very little attention to relational elements in business transactions (see also Tompsson et al, 1998).

Thus, these circumstances will effectively prevent that long term relations are built between actors in the project network, opposed to other industries. Instead the focus is on the own firm which also can be explained by the fact that contractors, sub-contractors, consultants, and architects are often involved in several parallel independent projects networks. This also implies that firms in the industry try to coordinate themselves among the project networks they are involved in. This can be seen as an explanation to a low adoption of ICT aimed for coordinating the project organization. Instead ICT has mainly been used to controlling and calculating purposes (see Jacobsson and Linderoth, 2010). ICT applications supporting collaboration among project actors has been adopted relatively late, like systems for document management in a project. In the project studied a document management systems was used, but representatives for the contractor who managed the project had to constantly remind other project actors to use the system and keep to the routines agreed upon. Other, more advanced collaborative ICT, like building information models, BIM, has been a hot topic in the industry during the last two decades, but the adoption rate has been slow.

The role of institutional actors

When the market and production environment was described, a few institutional actors could be identified. One of the most important institutional actors is the client who has played a central role in shaping governance structures. First directly via demands for lowest price tender policy, and second, indirectly via demands for more or less unique designs of products reinforcing the organizing by projects as the most appropriate technology. However, in other situations, like putting demand on the use of BIM in a project, clients have not used their power even if it is claimed that the client is the greatest beneficiary (Olofsson et al, 2008). One reason for this is that the client enacts the socio-cognitive environment where it is supposed that the lowest price tender policy will imply efficiency and it is up to other actors in the project network to create this efficiency. This might explain why it is the major construction firms who promote a more integrated use of BIM in Sweden, whereas major clients have been hesitant in demanding BIM.

Other important institutional actors are governmental and other regulating authorities, industry associations, trade unions, and site managers. In Sweden, the features of the end-product have been an object for more or less detailed regulations during the years. In recent years rather detailed prescriptions about accessibility for disabled groups to public buildings have been developed, whereas detailed regulations for private houses have decreased somewhat. Other regulations concern for example labour safety and energy consumption. Industry association reinforce for example governance structures by providing templates for clients on their homepages for the most common contractual forms. Except for labour safety issues, trade unions have been an important institutional actor in maintaining governance structures by constantly promoting piece wages, and that is even if these have been questioned for their impact on quality. The site managers position as institutional actors can be explained by the delegation of power to the project organization originating from the need for local adjustments, e.g. due to lack of complete specifications (see also Dubois and Gadde, 2002). Lack of complete specifications for a buildings and construction is an institutionalized expectation in the industry. A business district manager states in an interview that there is even an abbreviation for tasks that have to be solved at the work site. Thus, the site manager can be seen as "Mr. Wolf", the problem solver in the movie Pulp Fiction, arriving in his Ferrari and solving problems wherever they might emerge. This picture is confirmed by a CIO interviewed who states, "... *we start with the heroes in the company – the site managers*", when he describes the initiation of an IT related project. Moreover, the power of site managers is illustrated again when a manager in the line organization describes computer supported administrative routines by project start-ups. The company's routines prescribe that some procedures have to be followed before the site managers can get an account number. The manager states that this routine is not always followed and one opportunity could be to *"make it compulsory in the systems"*, but then it might be too much complaints from site managers and some might find ways to by-pass the prescriptions. However, the role of site managers as the problem solver is slightly changing. In interviews, more experienced site managers state that they have got less time *"to build"*, while they have to spend more time on administrative tasks. This is a consequence of the

larger construction firms' attempts to control projects and site managers by providing them with ICT systems that should standardize quality and cost control in projects.

None of the institutional actors have tried to exercise influence over ICT related activities in the industry. Instead they are acting after their own agendas, as the rest of the actors in the industry. For example in the case of BIM that gives opportunities for a more integrated collaboration among actors, issues of liabilities and intellectual property rights have been considered as obstacles among some actors (Sebastian, 2011), whereas the client still seems to rely on the lowest tender policy as guarantee for cost effectiveness. Moreover, the use of collaborative ICT like BIM would put architects, consulting firms, contractors, subcontractors, and suppliers on the supply side in the building process and the client alone on the demand side. This would in turn be a very different position affecting roles, responsibilities, tasks, and communication channels (*ibid).* It would also imply a re-configuration of the market and production environment, a change of the relations among institutional actors, and a change of the socio-cognitive environment. The challenge for the institutional actors in the industry constitutes of how such a process would be managed and if it lies in the interests of actors to promote such a change.

Concluding Discussion

The aim of this paper has been to contribute to an enhanced knowledge on how industry specific features shape the adoption and use of ICT and by that gain knowledge about how we can theorize on how industry shape ICT related activities. By taking the point of departure in the framework presented by Chiasson and Davidson (2005) it has been revealed that it is the interaction among industry specific elements that shapes the adoption and deployment of ICT. Chiasson and Davidson (2011) argued that when studying the role of industry's impact on ICT related activities, a question should be raised if industry has an impact. However, in order to answer this question we argue that we initially needed to address and analyse the concept of industry. Accordingly, the first step was to gain a deeper knowledge about industry characteristics, in order to be able to answer the question whether industry shape ICT related activities or not. To gain knowledge about industry, Chiasson and Davidson (2005) suggested, by drawing on Scott et al (2000), that industry could be analysed by the dimensions: material-resource environment, and the institutional environment. This framework has provided us with a valuable set of generic elements which shape the characteristics of an industry. In the initial step of our analysis we however identified three generic intertwined dimensions of industry: the market and production environment, the socio-cognitive environment, and institutional actors. A main reason that these three dimensions were identified in the analysis is that the governance structures cannot be regarded as a separate element in the institutional environment. Instead, the governance system can be regarded as an outcome of the interplay among demand side factors, technology and product in the production and market environment. In our analysis the supply side factors did not appear to have an impact on the governance structures on its own, but it will probably have in other industries. The governance structures can in turn be regarded as an element of industry that shapes the market structure by providing actors in the markets with incentives for how to behave. Moreover, the outcome of the interplay among the elements in the market and production environment shapes the socio-cognitive environment, i.e. how actors make sense of for example events and innovations, and the norms for a legitimate behaviour. As an example, the lowest price tender policy implied that actors do not add investments that might give the client a long term value because this damage the bid for a contract, i.e. reducing the chances of getting a contract.

By staring the analysis in the market and production environment it will be possible to get an understanding of the present characteristics of an industry and explain the socio-cognitive environment. If this analysis is conducted over time, it can be claimed that it is possible to uncover the role of institutional actors if elements in the market and production environment are transformed. Institutional actors play a central role in establishing and maintaining characteristics of an industry, but we claim this influence will vary among industries. In the building and construction industry institutional actors like clients, trade unions, site managers, and others have enacted features of the market and production environment and by that maintained the socio-cognitive environment. Thus, the behaviour of institutional actors will shape ICT related activities. How this behaviour emerges will however depend on the specific market and production environment in the industry. In the building and construction industry institutional actors have not had the will, or the ability, to transform ICT related activities. Whereas in other industries, like banking, institutional actors like large banking corporations promoted the introduction of ATM and Internet banks that

changed the technology and delivery of services. Probably depending on that, interaction patterns among elements in the market and production environment is different in the banking industry.

Thus, the interplay between the market and production environment, shaped by interaction patterns among its elements, and institutional actors, shape the socio-cognitive environment. In this way ICT applications are given a meaning and made sense of in the socio-cognitive environment that in turns shape the deployment in certain directions (figure 3). This also implies that some ICT-applications material features "fit better" when they are interpreted in the socio-cognitive environment. This can be illustrated with BIM (Building Information Models), which for two reasons mainly has been used for detecting clashes in field installations. First, governance structures in the market and production environment promote short term gains, implying that obvious and immediate benefits from an innovation are crucial in the sense making of innovations (see also Jacobsson and Linderoth, 2010). Second, also by drawing on governance structures in the sense making of BIM, actors perceive BIM as a mean to avoid costs these not can be transferred to the client.

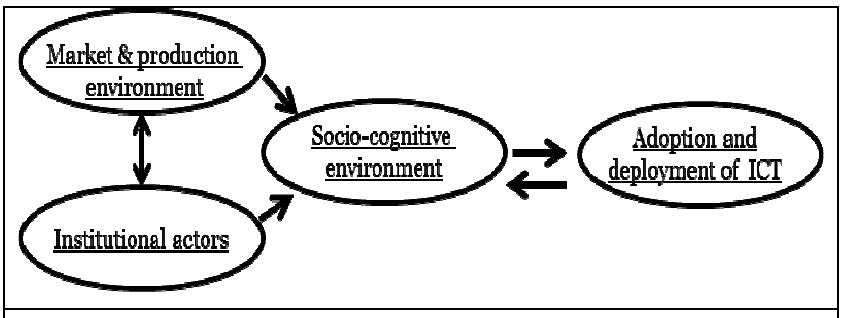

Figure 3. Industry characteristics interactions with adoption and deployment of ICT

With regard to the theorizing on how industry shapes the deployment and adoption of ICT, we claim that the overall framework can be used as a point of departure when the adoption and use of ICT in an industry is analysed. But interaction patterns among elements, as well as elements to be included in the framework, will vary among industries. In the building and construction industry demand side factors play a central role in shaping the technology, and indirectly together with feature of the product, when governance structures are shaped. On the other hand, we did not find that suppliers alone played a central role in the market and production environment. In other industries there will probably be other configurations of the elements in the market and production environment and some other features may play a more dominant roles, as well as other not having any significant influences. It can also be assumed that institutional actors may have bigger influences on the inclusion of certain kinds of ICT in the market and production system, but on the overall level the interplay among the three dimensions of industry will determine adoption and deployment of ICT.

By analysing the impacts industry characteristics have on ICT related activities some practical implications can also be drawn. First, by understanding the socio-cognitive environment and its institutional logics and norms, practitioners can get a brief understanding of how an ICT application fits into the industry if they also have a general understanding of the application's material features and how these are made sense of. Second, from a strategic perspective, by gaining an understanding of how the different elements shapes the characteristics of an industry and the material features of a technology, practitioners who want to promote an ICT-induced change can analyse which elements that has to be changed, or what alliances should be built if a change would be promoted. For example, practitioners in the building and construction industry, who wants to promote BIM as a mean for cooperation among actors already in the early stages of a project, would realize rather soon that they have to start to build alliances with clients and persuade them to do modifications in the governance structures.

References

Bechky, B. A. 2006a. "Gaffers, Gofers, and Grips - Role-Based Coordination in Temporary Organizations," *Organization Science*, (17:1), pp. 3–21.

Benbasat, I., and Zmud, R. W. 2003. "The Identity Crisis within the IS Discipline: Defining and Communicating the Discipline's Core Properties," *MIS Quarterly* (27:2), pp. 183-194.

Björklöf, S. 1986. Byggbranschens innovationsbenägenhet (The Building Sector's Propensity for Innovation). Linköping, Sweden: Linköping University.

Chatterjee, D., Richardson, V. J. and Zmud, R. W. 2001. "Examining the shareholder wealth effects of announcements of newly created CIO positions", MIS Quarterly, (25:1), pp. 43-70.

Chiasson, M., and Davidson, E. 2005. "Taking industry seriously in IS research," *MIS Quarterly*, (29:1), 2-16.

Cho, S. and Mathiasen, L. 2007. "The role of industry infrastructure in telehealth innovations: a multilevel analysis of a telestroke program." *European Journal of Information Systems,* (16:6), pp. 738-750.

Coffey, A. & Atkinson, P. 1996. *Making sense of qualitative data*, London: Sage.

Cox, A. and Thompson, I. 1997. "Fit for purpose, contractual relations: determining a theoretical framework for construction projects." *European Journal of Purchasing and Supply Chain Management*, (3:3), pp. 127-135.

Croker, N. and Rowlinson, S. 2007. "The temporal nature of forces acting on innovative IT in major construction projects", *Construction Management & Economics*, (25:3), pp. 227-238.

Danity, A., Moore, D., and Murray, M. 2006. *Communication in construction: Theory and practice*, Oxon, Taylor and Francis.

Davidson, E. and Chismar, W. G. 2007. "The Interaction of Institutionally Triggered and Technology-Triggered Social Structure Change: An Investigation of Computerized Physician Order Entry", *MIS Quarterly*, (31:4), pp.739-758.

DeFillippi, R.J. and Arthur, M.1998. "Paradox in project-based enterprises: the case of filmmaking", *California Management Review*, (40:2), pp. 125–140.

DiMaggio, P. J. and Powell, W. W. 1983. "The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields," *American sociological review*, (48:2), pp. 147-160.

Dubois, A. and Gadde, L. E. 2002. "The construction industry as loosely coupled system: implication for productivity and innovation." *Construction Management and Economics*, (20:7), pp. 621-631.

Earl, P. 1996. "Contracts, coordination, and the construction industry", in *Management, marketing and the competitive process,* P. Earl, Cheltenham: Edward Elgar.

Eisenhardt, M. K. 1989. "Building Theories from Case Study Research", *The Academy of Management Review*, (14:4) pp. 532-550.

Gann, D. M. 1996. "Construction as a manufacturing process? Similarities and differences between industrialized housing and car production in Japan", *Construction Management and Economics*, (14:5), pp. 437-445.

Gann, D.M. and Salter, A. 2000. "Innovation in project-based, service-enhanced firms: the construction of complex products and systems", *Research Policy*, (29:7/8), pp. 955–972.

Hannan, M. T. and Freeman, J. 1977. "The population ecology of organizations," *American Journal of Sociology*, (82:5), pp. 929-964.

Harty, C. 2005. "Innovation in construction: a sociology of technology approach", *Building research & Information*, (33:6), pp. 512-522.

Jacobsson, M. and Linderoth, C.J. H. 2010. "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", *Construction Management and Economics*, (28:1), pp. 13-23.

Kadefors, A. 1995. "Institutions in building projects: Implications for flexibility and change," *Scandinavian Journal of Management*, (11:4), pp. 395-408.

Kodeda, F. 1992. Byggherrens val av genomförandeform för byggnadsprojekt (The client's choice of contract form of building projects). Gothenburg: Chalmers University of Technology, Gothenburg Department of Building Economics and Construction Management.

Leonardi, P. M. and Barley, S. R. 2008. "Materiality and change: Challenges to building better theory about technology and organizing." *Information and Organization,* (18:3), pp. 159-176.

Love, P., Gunasekaran, A. and Li, H. 1998. "Concurrent engineering: a strategy for procuring construction projects", *International Journal of Project Management*, (16:6), pp. 375-383.

Mauri, A. and Michaels, M. 1998. "Firm and industry effect within strategic management: An empirical examination," *Strategic management journal*, (19:3), pp. 211-219.

Melwille, N. and Ramirez, R. 2008. "Information technology innovation diffusion: an information requirements paradigm," *Information Systems Journal*, (18:3), pp. 247–273.

Monteiro, E. & Hanseth, O. 1995. "Social shaping of information infrastructure: On being specific about technology. "In *Information technology and changes in organizational work,* W. J. Orlikowski, G. Walsham, M. R. Jones, and J. I. DeGross (Eds.), London: Chapman & Hall, pp.325-343.

Muhanna, W. A. and Stoel, M. D. 2010. "How Do Investors Value IT? An Empirical Investigation of the Value Relevance of IT Capability and IT Spending Across Industries", *Journal of Information Systems*, (24:1), pp. 43-66.

Olofsson, T., Lee, G., and Eastman, C. 2008. "Editorial - Case studies of BIM in use", *ITcon* 13 (2008) pp. 244-245, (http://www.itcon.org/2008/17 (Retrieved September 6, 2011).

Orlikowski, W. 2007. "Sociomaterial practices: Exploring technology at work." Organization Studies, (28:9), pp. 135-1448.

Orlikowski, W. J. 1992. "The duality of technology: Rethinking the concept of technology in organizations", *Organization Science*, (3:3), pp. 398-427.

Orlikowski, W. J. & Iacono, S. 2001. "Research commentry: Desperately seeking the "IT" in IT research - A call to theorizing the IT artifact", *Information Systems Research*, (12:2), pp. 121-134.

Orlikowski, W. J. and Gash, D. C. 1994. "Technological frames: Making sense of information technology in organizations", *ACM Transactions on information systems*, (12:2), pp. 174-207.

Porter, M. 1980. Competitive strategy, New York: The Free Press.

Scott, W. R. 2001. *Institutions and organizations, 2.nd ed.,* Sage: Thousand Oaks, CA.

Scott, W. R., Ruef, M., Mendel, P. and Caronna, C. 2000. *Institutional change and healthcare organizations: From professional dominance to managed care*, Chicago: Chicago University Press.

Sebastian, R. 2011. "Changing roles of the clients, architects and contractors through BIM", *Engineering, Construction and Architectural Management*, (18:2), pp. 176-187.

Shirazi, B., Langford, D. and Rowlinson, S. 1996. "Organizational structures in the construction industry", *Construction Management and Economics*, (14:3), pp. 199-212.

Stichcombe, A. 1959. "Bureaucratic and craft administration of production. "*Administrative Science Quarterly*, (4:2), pp. 199-212.

Söderholm, A. 2006. Kampen om kommunikationen (The fight for communication), in Wikforss, Ö. (ed) *Kampen om kommunikationen, om projektledningens informationsteknologi (The fight for communication, on the project management's information technology)*, Royal institute of technology, Stockholm, Sweden, pp.27-38.

Thompson, I., Cox, A. and Anderson, L. 1998. "Contracting strategies for the project environment", *European Journal of Purchasing and Supply Management*,(4:1), pp. 31-41.

Van de Ven, A. H. 2005. "Running in packs to develop knowledge-intensive technologies," *MIS Quarterly*, (29:2), pp. 365-377.

Yeh, Quey-Jen; Chang, Arthur Jung-Ting. 2007. "Threats and countermeasures for information system security: A cross-industry study," Information & Management, (44:5), pp. 480-491.

Yin, K. R. 1994. *Case study research: Design and methods [Second Edition]*, Beverly Hills, CA:Sage Publishing.