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User perceptions of ICT impacts in Swedish construction companies: 'it's fine, just as it is'

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The use of information and communication technologies (ICT) in construction companies has been growing steadily during the last decade. However, few studies inquire into either perceptions of the impact of actual ICT use or perceptions among different occupational groups in construction companies. The aim of the paper is to explore users' general perceptions of ICT impacts in the post-adoption stage and analyse the implications for construction management practice. A mixed methods approach was used. Quantitative data were collected using a web-based survey both in a major construction company and among medium-sized companies in Sweden. Data from 294 returned completed questionnaires were analysed with t-tests and multiple regression analysis. In addition, participant observations and semi-structured interviews were conducted within the major construction company in order to strengthen the analysis. It can be concluded that respondents are generally fairly satisfied with the ICT. Differences in perceptions among occupational groups can be explained by the nature of work tasks and the original intentions for using ICT as a means of control and calculation. Even if respondents perceive that a further development of ICT could improve competitiveness, they do not want to increase their use of it in their workplaces. They basically think that 'it is fine, just as it is'. This indicates that a challenge in construction management is to investigate how prevailing and new ICT applications can be used to develop the industry.

Keywords: Information systems, occupational groups, post-adoption, surveys, user satisfaction.

Introduction

Studies of ICT in the construction industry have until now mainly focused on topics such as diffusion of ICT (see e.g. Samuelson, 2002, 2008); the development of general frameworks for understanding the diffusion and adoption of ICT (see e.g. Peansupap and Walker, 2006); contextual influences on its adoption and use (see e.g. Croker and Rowlinson, 2007; Jacobsson and Linderoth, 2010); or prescriptive advice on how different ICT applications should be implemented (see e.g. Succar, 2009; Adriaanse *et al.*, 2010). However, despite extensive research and a high degree of workplace computerization (see e.g. El-Mashaleh, 2007; Samuelson, 2008), there are only a few studies that examine users' general perceptions of the impact of the ICT they are using and the implications for construction management practice. Impact is here defined as tangible and intangible effects (consequences) of ICT use, at both the individual and organizational levels. In the construction industry, such studies have mainly reported the collective perceptions of different professions such as architects, engineers and constructors. Even so, these studies have indeed contributed valuable knowledge about perceptions of ICT impacts in the industry as a whole. However, for the industry to take advantage of ICT's transformative capacity, more fine-grained knowledge would be needed regarding perceptions of ICT impacts and whether those perceptions vary among different occupational groups within construction companies.

One overall reason for studying users' perceptions of how ICT impacts on their work is that it helps to tie together factors and processes that intervene between ICT investments and the realization of their

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economic value (Wixom and Todd, 2005). The importance of understanding users' perceptions is however not unique for the construction industry and it is therefore necessary to take advantage of similar prior research on information systems (IS) and draw conclusions from these studies. Our main goal, however, is not to contribute to the IS literature. Instead the contribution firmly lies within the field of construction management by providing a more detailed knowledge of users' perceptions of ICT impacts and the implications for construction management practice. Such contribution has not been made before. Moreover, in the field of IS research, previous work has examined factors that have an impact on users' intentions to adopt ICT. It is claimed that by contrast, users' perceptions of ICT impacts in the post-adoption stage have been under-examined (see e.g. Jasperson *et al.*, 2005; Saeed and Abidinnor-Helm, 2008).

The main reason for studying differences in perceptions of ICT impact among occupational groups in the construction industry is that perceptions will shape the future inter- and intra-organizational deployment of ICT (see e.g. Orlikowski, 1992; Linderoth, 2010). As previous research has illustrated that the work environment within the construction industry is characterized by strong cohesiveness within different occupational groups (Dainty *et al.*, 2006), the understanding of perceptions of ICT impact among occupational groups could also potentially aid collaboration and create more well-functioning projects. In addition it has been shown that existing ICT solutions have problems in incorporating the interests of these groups (Wikforss and Löfgren, 2007). As ICT is an important part of everyday activities and a potential facilitator for well-functioning collaboration, the understanding of differences in perceptions among occupational groups is therefore important to overcome impending problems related to cross-functional (and cross-occupational) collaboration.

By studying users' perceptions of ICT impacts and differences in perceptions among occupational groups, at least three ICT-related subjects contributing to construction management practice can be identified. First, from a managerial perspective, it is important to understand whether there is an alignment between *intended* impacts of ICT and *perceived* impacts among users, which has previously been claimed not to be the case (see e.g. Ciborra, 1996). Secondly, knowledge about perceived impacts can enhance understanding of the future deployment of ICT, while interactions with ICT can change or reinforce initial user perceptions (see e.g. Orlikowski, 1992; Orlikowski and Gash, 1994; Linderoth and Pellegrino, 2005). Thirdly, uncovering discrepancies among end-users' perceptions of ICT impacts could potentially aid the development of better adapted ICT and as a result, both improve the general benefits flowing from the use of ICT, as well as increase its effectiveness in the construction industry (see also Wixom and Todd, 2005).

Given this background, the overall aim of the paper is to explore users' general perceptions of ICT impacts in the post-adoption stage and analyse the implications for construction management practice. A specific emphasis is put on potential differences among various occupational groups and the underlying reasons for these differences. In order to achieve this aim a mixed methods approach, analysing data from a survey of Swedish construction companies and contextualizing the results with data from a case study in a major Swedish construction company, was used.

The rest of the paper is structured as follows. An overview and discussion of previous studies on perceptions of ICT impacts is given first. The starting point of this discussion is taken in the field of IS research and it is followed by the more contextual aspects of the construction industry. Thereafter, the exploratory mixed methods approach is described and discussed in relation to its benefits and limitations. After the methodology, the results of the analyses are presented in three steps. First, general attitudes towards ICT are analysed; then predictors for perceptions of ICT impacts are considered; and finally the identified differences among occupational groups are scrutinized. The paper ends with a discussion of the results and conclusions.

Perceptions of ICT impact

In the field of IS research, the impacts or consequences of ICT use (direct and indirect, intended and unintended) for individuals, collectives, structures and contexts, are considered to be one of four core research topics (Benbasat and Zmud, 2003, p. 186). Impacts on the individual and organizational levels have been a core topic in the broad strand of literature trying to develop models explaining ICT success and end-user satisfaction (see e.g. DeLone and McLean, 1992; Seddon, 1997; Torkzadeh and Doll, 1999; Rai *et al.*, 2002; Petter *et al.*, 2008). In this literature, impacts on the individual level have been regarded as antecedents to organizational impacts (see e.g. DeLone and McLean, 1992; Torkzadeh and Doll, 1999) In the IS success literature on the other hand, individual and organizational impacts have recently been re-labelled as net benefits based on the argument that impacts can be on levels other than the organizational and the individual. For example,

impacts might be on workgroups, industries and even societies (DeLone and McLean, 2003). However, it is important to bear in mind that ICT impacts imply not only positive outcomes such as for example benefits for individual users, work groups or organizations. ICT impacts can also appear as disadvantages for individuals, collectives and organizations. Impacts from an ICT application that are perceived as benefits for one work group can also be perceived as disadvantageous for other groups (see e.g. Zuboff, 1988; Orlikowski, 1992).

Whether net benefits are being measured at the individual, group, organizational, industry or national level, Petter *et al.* (2008) state that there is an abundance of methods. At the organizational level, profitability measures have been preferred but Petter *et al.* (2008) claim that there are insufficient data from the research to support any model that can be used to predict success. On the individual level, past research has demonstrated that the perceived usefulness, or job impact, of ICT is an important user perception that influences both pre- and post-adoption phases (Venkatesh and Davis, 2000). In order to understand attitudes held by individuals and to predict the adoption and use of ICT, the construct of perceived usefulness of ICT has been widely applied (Petter *et al.*, 2008). The construct of perceived usefulness originates from the so-called Technology Acceptance Model (TAM) (see e.g. Davis, 1989). When users assess perceived usefulness of an ICT application, a construct with a six-item scale has been used (Davis, 1989; Rai *et al.*, 2002). These six items are:

- accomplishing tasks more quickly;
- improving job performance;
- increased job productivity;
- enhancing job effectiveness;
- making the job easier;
- being useful on the job.

However, occasionally and for several reasons, the original construct of perceived usefulness (see Davis, 1989), has been recognized as problematic or insufficient. Adams *et al.* (1992) found that the items 'accomplishing tasks more quickly', 'improving job performance' and 'enhancing job effectiveness' did not fit well with perceived usefulness. Other authors have found that 'task productivity', 'task innovation', 'customer satisfaction' and 'management control' are central items to include in a construct describing net benefits (see Torkzadeh and Doll, 1999). Thus, despite rich empirical research on relationships among constructs related to IS success, as well as determinants for IS success, findings have often been inconsistent (Sabherwal *et al.*, 2006). Reasons behind this inconsistency include whether the use is voluntary or compulsory (Seddon, 1997); that exclusion of factors affects the constructs (DeLone and McLean, 1992; Rai *et al.*, 2002); and that the role of re-invention and learning in the traditional model measuring perceived usefulness of ICT has been overlooked (Saeed and Abdinnour-Helm, 2008). Moreover, it is important to stress that perceived usefulness of ICT should not be regarded as static or stable over time as it has been shown that user perceptions of ICT do vary over time and space, as well as among social groups (Orlikowski and Gash, 1994). Apart from the recognized problem with the construct, Benbasat and Barki (2007) also claim that TAM has diverted researchers' attention away from other important research issues by the attempts to expand the model in order to adapt it to constantly changing ICT environments. With this development, which is described as a theoretical chaos, it is today unclear which version of TAM is the commonly accepted one (ibid.).

TAM is however only one of two primary research streams investigating perceived impacts of ICT. In the other stream—user satisfaction—object-based perceptions about the ICT are investigated, whereas TAM investigates behavioural perceptions about using the ICT (Wixom and Todd, 2005). In a comprehensive literature review of the so-called DeLone and McLean construct for IS success, Petter *et al.* (2008) state that empirical results show a strong association between user satisfaction and net benefits (perceived impacts). User satisfaction has been found to have a positive influence on net benefits (perceived impacts) expressed as for example: performance effectiveness (Rai *et al.*, 2002); decision-making (Vlahos and Ferratt, 1995; Vlahos *et al.*, 2004); and job satisfaction (Ang and Soh, 1997; Morris *et al.*, 2002). In the user satisfaction literature, information and system quality are major antecedents to user satisfaction and their relation to user satisfaction is strongly supported (see Iivari, 2005). Information quality is described as a desirable characteristic of the ICT system's output incorporating for example, relevance, accuracy, comprehensibility and usability (Petter *et al.*, 2008). Regarding net benefits (perceived impacts), information quality has been related to decision-making efficiency (Gatian, 1994); quality of work and time savings (D'Ambra and Rice, 2001; Shih, 2004); and decision-making satisfaction (Bharati and Chaudhury, 2006). System quality is described as a desirable characteristic of an ICT system incorporating for example, ease of use, system reliability, sophistication and flexibility (Petter *et al.*, 2008). In their overview of studies investigating the relation between system quality and net benefits (perceived impacts), Petter *et al.* (2008) identified mixed results in studies investigating the relation between system quality, measured as ease

of use, and net benefits, measured as perceived usefulness. Similar results were shown by McGill and Klobas (2005) who did not find a relationship between system quality and net benefits, measured as decision-making quality and productivity on the individual level. The mixed findings when the relationship between system quality and net benefits (perceived impacts) is studied might not be surprising as it can be claimed that system quality needs to be accompanied by information quality for the user to perceive any net benefits. This claim is supported by Wixom and Todd (2005) who found that system quality, mediated by system satisfaction, was a significant predictor for information quality, mediated by information satisfaction that in turn predicted perceived usefulness. This finding will serve as an important point of departure when exploring and operationalizing users' general perceptions of ICT impacts in the post-adoption stage in construction companies. Thus, based on Wixom and Todd's finding, we argue that studying information quality and its impacts will also implicitly incorporate system quality since a system with a perceived low quality will have difficulties in providing users with information of high quality and that would shape perceived ICT impacts. When continuing to develop an instrument for measuring perceived impacts of ICT we draw on the five central dimensions mentioned above: decision-making, information quality, system quality, performance effectiveness and job satisfaction. However, we will not test the relations among these dimensions in light of the fact that previous research has showed the difficulties in identifying relations among these variables and their consistency over time.

Perceptions of ICT impacts in the construction industry

In the context of the construction industry, perceived impacts of ICT use on the individual and organizational levels have been studied in different national contexts. In contrast to studies in the IS field, where specific ICT applications have most commonly been investigated, studies of the perceived impact of ICT in the construction industry tend to examine perceived impacts of ICT in general, without distinguishing between different types of ICT.

In a study of the Canadian architectural/engineering/construction (AEC) industry, the three highest ranked perceived benefits from ICT use were: 'better quality of work', 'work done more quickly' and 'better financial control' (Rivard, 2000). In Goh's (2005) study in Singapore, the top three advantages provided by ICT were: 'work done more quickly', 'better quality of work' and 'faster access to information'. In a study of Nigerian construction companies, Oladapo (2007) found that 'improved quality of work', 'making complex tasks easier to perform' and 'time saving' were the top three benefits from use of ICT. In a study among Malaysian companies, Lim *et al.* (2002) found that 'time savings', 'improved efficiency' and 'cost saving' were the top three perceived benefits of using the Internet. In a Swedish context, Howard *et al.* (1998) and Samuelson (2002, 2008) have studied the experienced advantages of ICT use on three occasions: 1998, 2000 and 2007. The top three advantages experienced are shown in Table 1.

If these studies in different national contexts are summarized, 'quality of work', different aspects of 'time savings' and 'better financial control' are the top ranked perceived benefits. However, these studies have not operationalized what the perceived impacts mean in practice by identifying predictors for the perceived impacts. For example, which variables predict perceived quality of work?

On the one hand, these rankings can be claimed to be more or less aligned with the items in the construct of perceived usefulness. On the other hand, the rankings show implicitly the underlying problems with the construct—for example, changed ranking of items over time and the inclusion or exclusion of items.

In the studies reported, the focus on different dimensions of time saving can be seen as a logical consequence of the project-based way of working in the industry, implying that actors are constantly facing approaching deadlines. What is also striking in the rankings of benefits experienced from ICT in Swedish

Table 1 Top three experienced advantages of IT use in Swedish AEC companies in 1998, 2000 and 2007 (Howard *et al.*, 1998; Samuelson, 2002, 2008)

1998	2000	2007
[1] Simpler/faster access to common information	[1] Better financial control	[1] Simpler/faster access to common information
[2] Better quality of work	[2] Simpler/faster access to common information	[2] Better financial control
[3] Work done more quickly	[3] Better communications	[3] Possibility of sharing information

companies is that the ranking of 'better quality of work' has dropped compared to the other countries (Samuelson, 2008). In Sweden 'better quality of work' was ranked as 7th. It was ranked 6th in both the two latest surveys 2002 and 2007 (ibid.). An explanation might be that better quality of work is taken for granted and the focus has moved to other features of ICT systems. Another explanation might be that other variables also measure better quality of work—simpler/faster access to common information and possibility of sharing information could, for example, be variables connected to quality of work. Moreover, the perception of better financial control is well aligned with the overall idea reinforcing the use of information systems: to increase control (see e.g. Torkzadeh and Doll, 1999), which in turn is closely linked to the main concern of higher level management in construction companies: to control projects (see e.g. Jacobsson and Linderoth, 2010). Therefore it is of interest to inquire into individuals' perceptions of the impact of ICT on profitability at the organizational level, even if it has been problematic to assess ICT impacts in terms of profitability measures at the organizational level (see Petter *et al.*, 2008).

It can be concluded that the above-mentioned studies of perceptions of ICT impact in the construction industry have provided researchers and practitioners with important knowledge of users' perceptions of ICT. However, the understanding is still limited to perceptions in the post-adoption stage with regard to variables that predict perceived impacts on the individual and organizational levels, as well as the perceptions of ICT impact held by different occupational groups in the companies.

Methods

The study on which this paper is based used an explorative mixed methods approach. The quantitative data collection tool was a self-completed web-based questionnaire. The primary goal with the survey was to capture individuals' perceptions of ICT impacts, both for themselves and for the company, as well as general attitudes to ICT. The process of questionnaire development and administration involved a number of steps. First, a draft questionnaire was developed, tested and revised through interviews with decision-makers in the construction sector. This was done in order to ensure that the questions in the survey were perceived as both clear and relevant. In the development of the questionnaire a forced-choice scale of six steps was chosen. A forced-choice scale does not include a neutral response category and is therefore appropriate if the respondents have knowledge and experience of the topic, which was the case in this study (Shiu *et al.*, 2009). When developing the questionnaire we started with the five dimensions addressed in the theory section: decision-making, information quality, system quality, performance effectiveness and job satisfaction. When the dimensions were operationalized into questions, inspiration was drawn from both Howard *et al.* (1998) and Samuelson (2002, 2008), as well as concepts identified during the interviews. Aspects such as costs, quality of product and processes, working environment and environmental impacts were found to be important when decision making was to be operationalized. Secondly, permission to conduct the survey was granted from one of the top three Swedish construction companies in terms of both turnover and employees. The selection of this company was based on the possibility of undertaking complementary qualitative data collection and thereby strengthening the analyses. As this study took an explorative approach, it was of great importance to facilitate this possibility—that is, combining quantitative and qualitative methods. The company chosen is a branch of one of the top three leading construction and property development groups in the Nordic region. In 2010 the company had a turnover of 2 billion and approximately 7500 employees. The company builds everything from schools, hospitals, sports facilities and housing, to roads, bridges, railways and power plants.

The target population of the survey in the major construction company was de-limited to 'white collar workers', for example, offsite managers, site managers, foremen, purchasers, estimators and project managers. In the major company, the process of sending out a link to the survey was handled by the company itself. In this way we ensured that all white collar workers in the targeted regions received the link to the survey. After the initial distribution of the web-based survey, two reminders were sent out. As a complement to the survey in the major construction company 300 e-mails with a link to the survey were sent to managers in the 100 largest construction companies in Sweden (except for the three largest companies). Companies in this group are labelled mid-sized companies because only four of them have more than 500 employees in Sweden. No reminders were sent to these companies. Responses were received from respondents in at least 20 of the mid-sized companies. The exact numbers are not known as it was not mandatory to indicate employer in the survey. Even if we do not have any ambitions to generalize the findings of this study, we consider the mid-sized companies as a control group in order to get a first impression of the reliability of the results from the total survey. A summary is provided in Table 2 of the numbers of

Table 2 Response rates

Companies	Total surveys sent out	Responses	Wholly completed questionnaires	Response rate(%)
Major company	600	530	263	44
Mid-sized companies	300	82	31	10
Total	900	612	294	33

questionnaires sent out, responses received and response rates for the different company groups.

As there was a slight over-representation of 'offsite managers' and 'site managers' in the total sample—and among the medium-sized companies 50% of respondents were either 'offsite managers' or 'site managers'—it is not possible to draw on potential differences between company groups. The exact numbers of respondents in the different occupational groups are presented in Table 3. Even if the slightly uneven representation prevents a comparison between the major and the mid-sized companies it does not constitute a problem insofar as our aim was to inquire into potential differences in perceptions among occupational groups. When mean values of the 12 statements in the survey were compared, significant and mildly significant differences were found for three statements that can be explained by differences in company size (see results section). This may indicate that results would be similar in a larger sample.

Finally, a test of the instrument's reliability and validity was conducted by exploratory factor analysis. Exploratory factor analysis (EFA) is considered useful when searching a structure among a set of variables, or as a data reduction method. In that way EFA makes it easier to examine the validity of a construct when an instrument is developed (Hair *et al.*, 1998; Kline, 2000). In the first EFA the reliability—Cronbach's alpha—was 0.846 which is above the lowest recommended level of 0.7 (see Hair *et al.*, 1998, p. 88). However, the validity was initially troublesome. Three components were extracted from the 12 items, explaining 63.7% of the variances (see Appendix A).

Another EFA was conducted where the last three items in Table 5 had been excluded from the instrument. In the second EFA the Cronbach's alpha was 0.903. One component was extracted from the nine items, explaining 56.9% of the variances (see Appendix B). Almost 57% can be considered on the brink of being too low. However, in social science it is not uncommon to consider a solution that accounts for 60% of the total variance, and in some instances even less, as satisfactory (Hair *et al.*, 1998, p. 104).

Analysis of data

The analysis of data was conducted in the following three steps. First, in order to scrutinize differences among occupational groups, t-tests were initially conducted. Second, the analysis of predictors for perceptions of ICT impacts was conducted with a multiple regression analysis via a so-called stepwise method, meaning that each variable was entered in sequence and its value assessed (Brace *et al.*, 2006). Brace *et al.* (2006, p. 210) describe the procedure as follows:

> If adding the variable contributes to the model then it is retained, but all other variables in the model are then retested to see if they still are contributing to the

Table 3 Number of respondents in occupational groups

	Number of respondents starting to fill in the questionnaire		Completed questionnaires	
Position	Number	Percentage (%)	Number	Percentage (%)
Manager off site	85	14	42	14
Site manager	170	28	95	32
Foremen	144	24	64	22
Estimator/Planner	71	12	43	15
Purchaser	40	7	20	7
Design	20	3	13	4
Accounting/Finance	12	2	3	1
Other	70	11	14	5
Total	612	100	294	100

Table 4 Occupational groups' use of ICT systems

System/Occ. group	Manager off site	Site manager	Foremen	Estimator/ Planner	Purchaser
Accounting system	+	+	–	–	0
Quality system	0	0	0	0	0
System for making and handling of drawings	0	0	0	0	+
Project management system	+	+	0	+	+
Enterprise resource planning (e.g. SAP)	–	–	–	–	–
System for establishing and managing project-related documents	0	0	–	0	0
Purchase system	0	0	0	0	+
Costing system	0	0	–	+	0
Environmental management system	0	–	–	–	–
Budget/cost monitoring system	+	+	–	–	0

success of the model. If they no longer contribute significantly they are removed. Thus, this method should ensure that you end up with the smallest possible set of predictor variables included in your model.

Third, in order to create a deeper understanding of the survey results, selected qualitative data from a case study in the major Swedish construction company have been used in order to contextualize and discuss the survey results. The qualitative data consist of a total of 17 interviews with actors chosen from all different hierarchical levels within the permanent as well as the temporary (project) parts of the organization. Interviewees, for example, were 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 candidates selected for the interviews agreed to be interviewed. All conducted interviews varied in length from one to two hours. Further empirical material was collected through participant observation in a building project—consisting of attendance at 45 meetings, encompassing a total of 80 hours. The interviews mainly focused on getting an understanding of the development of ICT use in the company—for example with regard to systems used, perceived benefits and problems with ICT use, as well as future development of ICT use in the industry. Moreover, interviews were focused on capturing the viewpoint of different actors' daily practice and their use of ICT. The observations (participation in meetings) were conducted in order to further deepen the knowledge about the wider context and by that enhance the understanding of the context for the everyday ICT use.

The mixed methods approach described this paper provided extensive insights into possible reasons behind differences in perception of ICT impacts among occupational groups. However, it should be noted that the paper does not claim that any generalizations are possible as the study is limited by the selection and number of companies included in the survey. The results will, however, serve as a valuable input for further studies interested in users' perceptions.

Results

In this section the results from the study will be presented. First, a descriptive overview of the different kinds of ICT the occupational groups are using is presented (see Table 4). Then the mean values for the users' perceptions regarding ICT impacts and general attitudes towards ICT use will be given. Thereafter a multiple regression analysis is conducted in order to identify variables predicting 'higher quality of work', 'IT as a means of reducing the company's costs', and 'IT as a means of improving competitiveness'. Finally, identified differences in attitudes

Table 5 Significant differences between the major company and mid-sized companies

Variable	Major company	Mid-sized companies	p-value
There is too much communication and information via computers at my workplace	2.76	2.27	0.016
In my workplace, we should use IT more	3.08	2.69	0.055
A further development of the company's IT systems would increase our competitiveness	4.44	4.08	0.062

among different occupational groups are presented and discussed.

Although the study did not inquire into perceptions of individual ICT systems, a summary of the range of ICT systems used by different occupational groups is presented in Table 4. This overview serves as a starting point for the rest of the analysis. The respondents were asked to indicate their frequency of use for 10 different systems on a five-grade scale where: 1 = never used; 2 = used very rarely; 5 = used daily. The frequency of use has been divided into three categories: + = high frequency (mean value > 3.5); 0 = medium frequency (mean value > 2.5 < 3.5; – = low frequency of use (mean value < 2.5). As illustrated in Table 4 the offsite managers are the primary ICT users with regard to the variety of systems used while the foremen are the occupational group using ICT the least.

General attitudes towards IT

In the questionnaire consisting of 12 statements on impacts of ICT use, respondents were asked to rank each statement on a six-grade scale, ranging from 'totally disagree' (1) to 'totally agree' (6). In Figure 1 the mean values for each statement are presented. From the results it can be concluded that respondents are fairly satisfied with the ICT, with regard to its impact both on the organizational as well as on the individual level. It can be claimed that the major impact is that ICT is considered a necessity when performing the daily work tasks. Users are also fairly satisfied with the information they get and the ICT is perceived as a means of improving the quality of the respondents' work. The ICT is also perceived as being fairly well adapted to the conditions of the construction industry. Interviewed respondents also claim to have witnessed a great improvement over the last decade regarding adaptations to the industry. What is remarkable is that respondents on the one hand agree with the statement: 'A further development of the company's IT systems would increase our competitiveness', but on the other hand they slightly disagree with the statement: 'In my workplace, we should use IT more'. The correlation between two statements was further analysed in a bi-variate analysis. A significant negative Pearson correlation coefficient (–0.148, p = 0.005) was found between the statements:

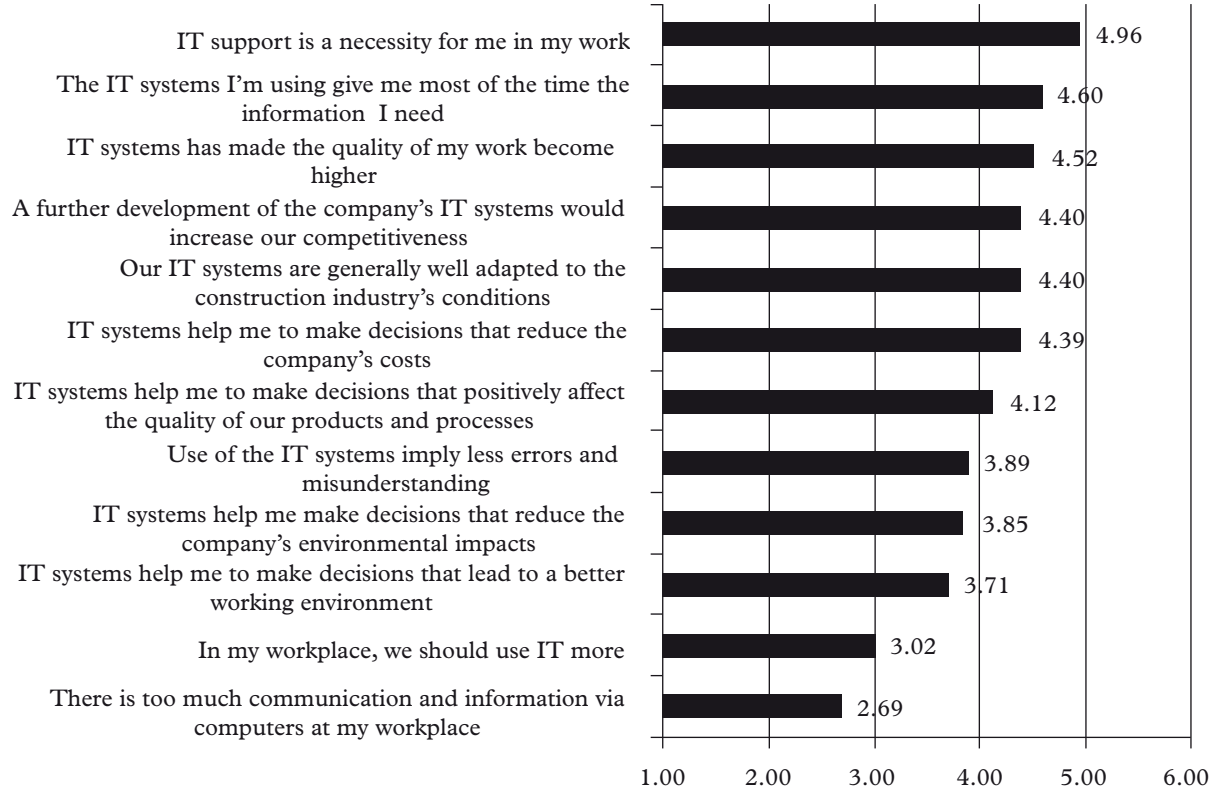

Figure 1 General attitudes towards ICT

Note: The term IT is used in the questionnaire instead of the term ICT, because respondents are more familiar with the term IT, compared to the term ICT. The term IT will be used when referring to the questionnaire.

- 'In my workplace, we should use IT more'; and
- 'Our IT systems are generally well adapted to the construction industry's conditions'.

And a significant positive correlation (0.496, p = 0.000) was found between the statements:

- 'Our IT systems are generally well adapted to the construction industry's conditions'; and
- 'The IT systems I'm using give me most of time the information I need'.

These correlations can be interpreted as indicating that some respondents think that more use of ICT would improve competitiveness but the prevailing ICT systems are not adapted to the industry's conditions. This opinion has also been expressed during interviews. Respondents have for example expressed frustration that it is difficult to move data between systems and that systems are not adapted to the project-based mode of organizing operations. We think that an important topic for further studies is to inquire more deeply into the group with concerns about prevailing ICT but who express the opinion that ICT can be used more in order to improve competitiveness.

Moreover, it should be noted that the scores for 'IT systems help me to make decisions that reduce the company's costs' and 'A further development of the company's IT systems would increase our competiveness' are more or less the same. A question that can be raised is whether the perception that 'A further development of the company's IT systems would increase our competitiveness' is just a substitute for 'The IT systems help me to make decisions that reduce the company's costs'. This question will be elaborated upon in the next section when predictors for these variables are analysed.

Owing to the differences in representation of respondents in occupational groups, as previously mentioned we do not have any ambitions to draw any conclusions about differences between large and mid-sized companies. When the results were compared, significant and mildly significant differences were found for three statements (see Table 5). The reasons for these differences are attributable to company size and an increasing need for coordinating information (see. e.g. Mintzberg, 1980, 1983).

If perceived impacts of ICT on the individual level are taken into consideration, improved quality of work can be claimed to be the variable with the highest perceived impact. If the individuals' use of ICT and its impact on the company are taken into consideration, the two most important perceptions of impacts are a reduction of the company's costs and an increased competiveness of the company by a further development the ICT systems. These three variables were further analysed in a multiple regression analysis in order to identify their predictors.

Analysing predictors

In Tables 6–8 the dependent variable, the independent variables, their beta-value, and significance are shown. First the predictors for 'IT systems have made the quality of my work become higher' were analysed. Using the stepwise method, a significant model was obtained ($F_{5.314}$ = 127.705, $p < 0.000$, adjusted R square = 0.665) (Table 6). That is, the model explains 67% of variations in respondents' scores.

The next step in the analysis was to identify predictors for 'IT systems help me to make decisions that reduce the company's costs'. Using the stepwise method, a significant model was obtained ($F_{4.315}$ = 127.194, $p <$ 0.000, adjusted R square = 0.613) (Table 7).

The final step in the analysis was to identify predictors for 'a further development of the company's IT systems would increase our competitiveness'. Using the stepwise method, a significant model was obtained ($F_{2.317}$ = 97.399, $p < 0.000$, adjusted R square = 0.377) (Table 8).

The predictor 'IT systems help me to make decisions that positively affect the quality of our products and processes' had the highest impact on quality of work and cost reduction. This can be regarded as a perception that better decisions are made, or the right decisions are made, either of

Table 6 Predictors for IT systems have made the quality of my work becoming higher

Predictors for higher quality of work	Beta	p-value
IT systems help me to make decisions that positively affect the quality of our products and processes	0.330	p < 0.000
IT support is a necessity for me in my work	0.235	p < 0.000
Use of the IT systems imply less errors and misunderstanding	0.192	p < 0.000
A further development of the company's IT systems would increase our competitiveness	0.221	p < 0.000
The IT systems I'm using give me most of the time the information I need	0.097	p = 0.019

Table 7 Predictors for IT systems help me to make decisions that reduce the company's costs

Predictors for IT systems help me to make decisions that reduce the company's costs	Beta	p-value
IT systems help me to make decisions that positively affect the quality of our products and processes	0.376	$p < 0.000$
IT systems help me make decisions that reduce the company's environmental impacts	0.296	$p < 0.000$
IT support is a necessity for me in my work	0.151	$p = 0.001$
IT systems has made the quality of my work become higher	0.112	$P = 0.043$

Table 8 Predictors for a further development of the company's IT systems would increase our competitiveness

Predictors for a further development of the company's IT systems would increase our competitiveness	Beta	p-value
IT systems has made the quality of my work become higher	0.422	$p < 0.000$
IT systems help me to make decisions that positively affect the quality of our products and processes	0.241	$p < 0.000$

which improves quality of work and saves money for the company. Regarding the predictor 'IT support is a necessity for me in my work' there is a question as to whether the necessity of using ICT led to a real impact on the quality of end products and costs, or if respondents just perceive that the quality of their work has been higher by using ICT. What might be a surprising predictor for cost reductions is the relatively high impact predictor 'IT systems help me make decisions that reduce the company's environmental impacts'. One interpretation is that information can be retrieved in order to avoid using hazardous substances that cause environmental damage and demands on the company for financial compensation. However, this finding needs closer investigation. In the case of improved competitiveness, quality-related predictors have had a high impact. Arguably then, quality is regarded as an important competitive measure and the ICT support is contributing to its development. The importance of quality has also been stressed in interviews when respondents claim that consciousness about quality issues has increased during the last decades. However, it can be claimed that the quality dimension ultimately concerns 'doing things right' in the production process, i.e. that work instructions and blueprints are followed. This become obvious when the work of the quality group in the project studied was followed. The group's major concern in the initial stages was to verify that all actors in the project had established routines in order to avoid deviations in their production processes. In later stages of the project the group's major concern was to ensure that deviations in the production process were reported and managed. Against this background it can be claimed that quality-related predictors first and foremost are related to 'doing things in the right way'.

Differences among occupational groups

When analysing differences in attitudes among the occupational groups it should initially be stressed that attitudes are not polarized even if there are significant differences. Among the 12 items presented, significant differences between two or more occupational groups were found in seven variables. In another variable the difference was mildly significant. Table 9 presents the significant differences between the groups and comments on them. When an occupational group is listed in the table, it means that the mean score is significantly lower compared to the occupational group listed in the heading (mean values are presented in Appendix C). P values smaller than 0.05 are given in bold. The variables are grouped after identified themes that seem to explain differences among the professional groups. That is, there can be differences among the same groups along more variables.

Discussion

The overall aim of this paper has been to explore users' general perceptions of ICT impacts in the post-adoption stage in Swedish construction companies and analyse the implications for construction management practice. By studying users' perceptions of ICT impacts and differences in perceptions among occupational groups, three ICT-related subjects contributing to construction management practice could be identified. First, from a managerial perspective it is important to understand whether there is an alignment between *intended* impacts of ICT and *perceived* impacts among users. Secondly, knowledge about perceived impacts can enhance understanding of the future deployment of ICT. Thirdly, uncovering discrepancies among end-users' perceptions of ICT impacts could potentially aid the development of bet-

Table 9 Differences among occupational groups

Variable/occupational position	Offsite manager	Site manager	Foremen	Estimator/ planner	Purchaser	Comments
Our IT systems are generally well adapted to the construction industry's conditions				Site man p = 0.032		These differences can mainly be explained by the nature of work tasks and how the use of IT systems supports these tasks. Estimators and planners were among the first professional groups to use IT systems adapted for their daily work tasks. This has led to fewer errors and less misunderstanding. The increased use of IT has also given offsite managers better possibilities of controlling projects. With regard to site managers and foremen, the question can be raised as to whether prevailing systems fully provide them with accurate information, or whether there are central aspects in their work that are not captured by IT.
Use of the IT systems implies fewer errors and less misunderstanding	Site man p = 0.048			Site man p = 0.012		
IT systems have made the quality of my work become higher				Site man p = 0.005 Foremen p = 0.004	Site man p = 0.077 Foremen p = 0.064	
The IT systems I'm using give me the information I need most of the time				Site man p = 0.08 Foremen p = 0.049	Foremen p = 0.093	
IT support is a necessity for me in my work	Foremen p = 0.071	Foremen p =0.049		Foremen p = 0.060	Foremen p = 0.014	Foremen and site managers are the occupational groups closest to the operations. However, in contrast to site managers, foremen's work tasks have a lower degree of computerization.
In my workplace, we should use IT more				Man off site p = 0.078 Site man p = 0.025		Managers off site have used IT for controlling projects (site managers). Estimators/planners encompassing use of IT might have implied recognition of the potential of a more encompassing use of IT and by that an increased competitiveness.
A further development of the company's IT systems would increase our competitiveness				Site man p = 0.060 Foremen p = 0.063		
There is too much communication and information via computers at my workplace	Purch p = 0.052		Purch p = 0.066	Purch p = 0.019		It can be claimed that the purchaser role traditionally has been rather relation-oriented. Today, however, more and more purchase activities tend to be managed electronically.

ter-adapted ICT that would improve both the general benefits as well as the effectiveness of ICT in the construction industry.

The results of the studies warrant a claim that there is an alignment between intended impacts of ICT and perceived impacts among users. In interviews, top managers state that controlling projects is a major managerial task as it is projects that generate the majority of costs and revenues. Moreover, top managers state that there is a need to respond to increasing costs over recent years by decreasing costs in the industry. Another managerial concern during the last decade has been to improve quality in all stages of the production process. Thus, a crucial issue is how well aligned users' perceptions of ICT impacts are with these managerial concerns. The managers interviewed stated that the development of ICT has made it much easier for them to control projects and portfolios of projects. The benefit of ICT as a means of 'better cost control' is also confirmed in previous studies (see e.g. Samuelson, 2008). If ICT is considered as a means of management control (see Trokzadeh and Doll, 1999), it can be claimed that management has been successful, because the major perceived impact of ICT is that it is perceived as a necessity in the respondents' work. That is, users cannot perform daily work tasks without using ICT applications designed to control work. Moreover, two important control dimensions are cost and quality. As previous research showed, this study has confirmed individuals' perceptions indicating that improved quality of work is a major impact of ICT. What have been added to previous knowledge are the predictors for ICT as a means of improving quality of work and for reducing the company's costs. ICT is perceived as a support that improves quality of products and processes when decisions are made. This variable is a significant predictor for the perceptions that ICT has increased the quality of work and that ICT aids decisions that reduce the company's costs. This result is interesting as it shows an explicit or implicit awareness of the cost dimension in situations where quality is lacking. The quality dimensions are also shown to be important predictors for development of ICT as a means of improving competitiveness. What might be surprising is that the results do not show any relation between ICT as a means of reducing cost and ICT as a means of increasing competitiveness. The variable consequently does not significantly predict attitudes towards ICT as a means of increasing competitiveness. However, an alignment between management's intended impacts of ICT and users' perceived impacts of ICT does not mean that there is not a potential for development in the future deployment of ICT.

Enhancing the understanding of future deployment of ICT by developing knowledge about perceived ICT impacts was the second ICT-related subject that concerns construction management. ICT as a means of increasing competitiveness is linked to its future deployment. However, based on the claim that ICT is used as a means of doing things right, it seems that ICT is primarily used for better control, for example better calculation (see also Jacobsson and Linderoth, 2010). The fact that ICT has had a tendency to be used more for control than as a means of innovating and developing organizational processes is thus a classical problem (see also Zuboff, 1988). However, an innovative use of ICT is not uncomplicated to implement. Samuelson (2008) reports that the third biggest obstacle towards an increased use of ICT is a 'general attitude that old ways of doing things have worked well throughout the years and changes are unnecessary' (p. 16). It is possible to relate this observation to the results from the present study. First, it can be related to the perception that respondents do not want to use more ICT in their workplaces. Secondly, respondents are fairly satisfied with the prevailing ICT and perceive that it is well adapted to the industry's conditions and they are mostly satisfied with the information from the systems. This could be seen as evidence that respondents have become accustomed to a certain level of ICT use and are satisfied with that, but they are hesitant to use it further as a means of change and development. However, it seems there are groups of respondents who consider ICT could be used to improve competiveness but they perceive that it is not possible with prevailing ICT, or perhaps with the way ICT is used today. From a managerial point of view this is a delicate issue. Should top management rely on the overall results showing that users are fairly satisfied with the way ICT is used and take the results as testimony that they do not have to worry about ICT issues? Or, should top management worry about how prevailing ICT is used since it is perceived that a development of ICT could improve competiveness, even though the prevailing use of ICT is an obstacle for this development? Or, is management itself the problem? In Samuelson's (2008) study, 'Insufficient interest/commitment from the management' and 'Decision-makers have no time for IT efforts because of heavy workload' were ranked respectively as number seven and number nine as perceived obstacles for an increased use of ICT. Thus, based on the results from this study and previous studies it can be claimed that management in construction companies needs more information regarding options for a more innovative use of ICT as well as a window of opportunity to reflect on such a use.

These reasons for lacking management involvement could be seen as an expression of the differences in perceptions of ICT impacts among occupational groups, which was the third ICT-related subject that concerns construction management. Uncovering discrepancies among end-users' perceptions of ICT impacts could potentially aid the development of better adapted ICT thereby improving both the general benefits of ICT use as well as its effectiveness in the construction industry. The differences in perceived impacts among occupational groups could be interpreted as originating from the types of systems different occupational groups are using and how well they perceive that the systems are supporting their work tasks. When differences among the occupational groups are scrutinized, variations in perceived impacts can be explained by distance from operations. Occupational groups not directly involved in daily operations have a slightly more positive attitude to ICT than occupational groups directly involved in operations, that is, foremen and site managers. Closer scrutiny of what people actually do and the nature of work tasks—that is, the context of the ICT use—could potentially further help to explain differences among occupational groups and how they make sense of ICT. For example, one primary task for offsite managers is to keep track of project performance in order to control the use of resources and the profitability of a portfolio of projects (see Jacobsson and Linderoth, 2010). The benefit of ICT as a means of better cost control is also confirmed in previous studies (see e.g. Samuelson, 2008). Thus, it can be claimed that offsite managers perceive ICT as a means of improving management control which is expressed in the high frequency of their use of systems for monitoring budgets and costs (see Table 4). If offsite managers use ICT for controlling outputs from operations, estimators/planners and purchasers use ICT for generating input to operations (see Table 4). It can thus be claimed that the introduction of ICT in the work practices of estimators/planners has been an attempt to control work from a distance, or reduce the risk of errors in calculation. However, despite the control dimension in the computerization of the work practices of estimators/planners, this group is most positive about the impacts of ICT. They are more positive than other groups about using more ICT in the workplace and they have a stronger belief than other groups that a developed use of ICT can improve the company's competiveness. Especially interesting is the difference between offsite managers and estimators/planners towards using more ICT in the workplace. One reason for this difference might be the way the two groups are using ICT. For example, when estimators and planners use ICT support for generating input to a tender, or carrying out the planning of a project, an understanding of the positive impacts at the individual and organizational levels might have been developed. Offsite managers have in contrast used ICT for control. Such a usage might not trigger innovative thinking on how ICT can be used more to increase the company's competiveness.

Compared with the other occupational groups, site managers and foremen appreciate the impact of ICT to a somewhat lesser extent. It can be claimed that two major functions of ICT, as a means of control and a means for computing, do not support the work tasks of site managers and foremen to the same extent as they do for the other groups. Site managers and foremen have to manage a sometimes messy situation that does not follow the practice inscribed in the systems. In a study of operations managers' use of accounting information Jönsson and Grönlund (1988) claimed that they must be able to connect the information from ICT systems with other sources of information as they have a need to see things with their own eyes and talk to people closest to the events. Moreover, one of the interviewed site managers stated that over the last decades they have had to spend more and more time in front of the computer, compared with time spent out at the construction site. Accordingly, site managers' high frequency of use of certain systems (see Table 4) can also be seen as evidence that site managers are the targets of increased control via ICT. This increased use of ICT for control purposes has been described by Styhre (2006) as the bureaucratization of the site manager's role. This picture was further confirmed in an interview with a chief information officer (CIO) who claimed that ICT systems have not been developed for the needs of the site managers. The CIO further stated that historically, ICT issues have belonged to the accounting and finance department and for site managers the development of ICT systems has just resulted in a few more points on a checklist. Thus, even if managers closest to the operations perceive a positive impact of ICT, further efforts are needed to adapt and develop prevailing ICT systems so they, to a higher degree, can support the work of site managers and foremen. Accordingly, a subject for future studies is to delve into how site managers' and foremen's perceptions of ICT impact will develop with an increased use of Building Information Models (BIM) that have the potential to be used as a support in the production process.

Conclusions

Based on a sample of 294 respondents, working both in line and project organizations, it can first and foremost be concluded that respondents are fairly satisfied

with the ICT with regard to its perceived impact on both the organizational as well as the individual level. The major perceived impact is that ICT is considered to be a necessity when performing daily work tasks. In practice, this has meant that ICT is perceived as a means of contributing to higher quality of work since ICT supports decisions that improve the quality of products and processes, which in turn reduces the company's costs and improves the company's competiveness. However, whether these perceptions are matched by an actual reduction in costs and increased competitiveness is difficult to determine as the realization of the potential benefits of IT use must go hand in hand with changes in the company's processes and structures (see e.g. Marcus, 2004). It is also interesting to note that on the one hand the respondents perceive that a further development of IT systems would increase the company's competitiveness, but on the other hand, they do not want to increase their use of ICT in their workplace. This observation raises the question of how contemporary ICT is used. A concern from a managerial perspective is that apparently there are groups of people who think that ICT can be used to increase the competiveness of the company, but at the same time, they do not think that current ICT is well adapted to the industry's conditions. A future challenge in construction management is therefore to investigate these opinions more deeply to find out the deficiencies of the prevailing ICT and how it can be developed in order to increase the competitiveness of the company.

Differences among occupational groups could be explained in relation to contextual aspects relating to the nature of their work tasks. One example is that use of ICT by higher level managers focuses on control of project performance, whereas planners and estimators use ICT as an indispensable computing and planning tool in their daily work. Moreover, the nature of site managers' and foremen's work is not always aligned with the intentions inscribed in the ICT. This can be seen as a consequence of the fact that ICT historically has been developed for control and computing purposes. Accordingly, a challenge in construction management is to develop and adapt prevailing ICT systems so they to a higher degree can support the work of site managers and foremen. Moreover, the emergence of BIM in the production process might have the potential to change site managers' and foremen's perceptions of ICT impact.

This study has a couple of limitations that need to be recognized and addressed in future studies. First, the results gained come from a limited sample of construction companies in one national context. As the approach was both mixed methods and explorative—analysing both quantitative and qualitative data—there was an inevitable trade-off between sample size and depth. Future research should therefore extend into larger samples of construction companies and other actors in the industry in order to test to what extent the results are generalizable to the construction industry as a whole. Secondly, future studies could also recognize differences in an international context as well as scrutinize the perception of impacts of different ICT systems among different occupational groups.

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Appendix A

Table A1 Total variance explained (extraction method: principal component analysis)

	Initial eigenvalues			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.361	45	45	5.361	45	45
2	1.372	11	56	1.372	11	56
3	1.103	9	65	1.103	9	65
4	0.891	7	73			
5	0.772	6	79			
6	0.600	5	84			
7	0.473	4	88			
8	0.398	3	91			
9	0.356	3	94			
10	0.288	2	97			
11	0.240	3	99			
12	0.145	1	100			

Table A2 Component matrix (extraction method: principal component analysis)

	Component		
	1	2	3
IT systems help me to make decisions that positively affect the quality of our products and processes	0.865		
IT systems has made the quality of my work become higher	0.846		
IT systems help me to make decisions that reduce the company's costs	0.825		
IT systems help me to make decisions that lead to a better working environment	0.770		
IT systems help me to make decisions that reduce the company's environmental impacts	0.767		
IT is a necessity for me in my work	0.696		
The IT systems I'm using give me most of the time the information I need	0.653	−0.491	
Use of the IT systems imply less errors and misunderstanding	0.647		
A further development of the company's IT systems would increase our competitiveness	0.631		
In my workplace we should use IT more		0.726	
Our IT systems are generally well adapted to the construction industry's conditions	0.515	−0.552	
There is too much communication and information via computers at my workplace			0.868

Appendix B

Table B1 Total variance explained (extraction method: principal component analysis)

	Initial eigenvalues			Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5.124	57	57	5.124	57	57
2	0.993	11	68			
3	0.772	9	77			
4	0.646	7	84			
5	0.409	5	88			
6	0.372	4	92			
7	0.294	3	96			
8	0.244	2	98			
9	0.146	2	100			

Table B2 Component matrix (extraction method: principal component analysis)

	Component 1
IT systems help me to make decisions that positively affect the quality of our products and processes	0.873
IT systems has made the quality of my work becoming higher	0.851
IT systems help me to make decisions that reduce the company's costs	0.829
IT systems help me to make decisions that lead to a better working environment	0.787
IT systems help me to make decisions that reduce the company's environmental impacts	0.784
IT is a necessity for me in my work	0.691
The IT systems I'm using give me most of the time the information I need	0.651
Use of the IT systems imply less errors and misunderstanding	0.639
A further development of the company's IT systems would increase our competitiveness	0.636

Appendix C

Table C1 Mean values for occupational groups

Statement/Occupational group	Manager off site	Site manager	Foremen	Estimator/ planner	Purchaser
Our IT systems are generally well adapted to the construction industry's conditions	4.51	4.27	4.37	4.63	4.62
There is too much communication and information via computers at my workplace	2.57	2.76	2.66	2.42	3.17
In my workplace, we should use IT more	2.90	2.92	3.09	3.40	3.18
Use of the IT systems imply less errors and misunderstanding	4.08	3.67	3.84	4.19	4.00
The IT systems I'm using give me most of the time the information I need	4.65	4.50	4.47	4.8	4.82
IT support is a necessity for me in my work	5.04	5.00	4.67	5.08	5.29
A further development of the company's IT systems would increase our competitiveness	4.37	4.30	4.28	4.71	4.19
IT systems has made the quality of my work becoming higher	4.61	4.32	4.29	4.89	4.78
IT systems help me to make decisions that positively affect the quality of our products and processes	4.29	3.97	3.99	4.33	4.19
IT systems help me to make decisions that lead to a better working environment	3.73	3.72	3.78	3.62	3.54
IT systems help me to make decisions that reduce the company's costs	4.43	4.40	4.27	4.45	4.50
IT systems help me to make decisions that reduce the company's environmental impacts	3.94	3.92	3.77	3.63	3.92