

THE DEVELOPMENT OF ONLINE TRUST AMONG CONSTRUCTION TEAMS IN FINLAND

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SUMMARY: *Construction is a complex process involving many different stakeholders. It is important that information among these stakeholders flows smoothly. A crucial aspect of the success of a project depends on the effective sharing of knowledge among the different people. Trust is important for knowledge transfer especially for online applications. There are different types of trust that have implications for knowledge sharing among the construction teams. This paper describes the importance of trust that we have identified during knowledge sharing among four construction projects in Finland. It begins with identification of the needs of online technology among construction teams. It is followed by a brief review of the different types of online trust. Section Three describes the case study methodology. In Section Four the implications of the online trust among construction teams are then discussed. Section Five concludes with suggestions for promoting trust among construction teams for knowledge sharing.*

KEYWORDS: *trust, online, team, construction.*

1. INTRODUCTION

Construction projects are complex, involving numerous heterogeneous actors over relatively short periods. Construction projects vary tremendously between projects. The building as a product has to face many constraints such as functional, economical, and technical as well as aesthetical (Kubicki et al., 2006). Because of the short time period each of the teams are operating, these project teams are independent, yet they do have strong hierarchical relations. Most relationships are constructional, based on negotiation between actors. Decisions are typically decentralised with each actor responsible for his own tasks. However, time development is sequential. Succession of stages is characterised by irreversible decisions and the preservation of uncertainties. The interaction rules between actors are often informal and evolve from one project to another (Kubicki et al., 2006). The success of a project depends heavily on the quality of cooperation between the different actors involved during the project. Thus communication and interaction are essential.

Stages of building in construction projects are characterised by relations between different actors such as architect, owner, engineer and contractors. Each of these actors do not generally have a global version of the project context. Each has a very limited vision according to his contract, tasks and works to build.

Construction projects are among the most complicated of human enterprises. There is a high level of skill and knowledge required to translate a client's version or list of requirements into plans and specifications and then into a real building that functions well for the people who will live or work there. Besides technical skills required in construction projects, it is also important to have people skills in order to coordinate the diverse efforts of the many people involved.

The people involved in public construction projects typically range from 10 to a few hundreds. Time is a crucial part of the project due to the tight schedule imposed by firms. Because of this, there are many problems facing the construction industry.

The construction industry in Finland is facing numerous problems including projects often running late, being over budget and failing to meet the needs of the end users. This concern has prompted an investigation by a Prolab research project as to the causes of these problems. The second author was commissioned to investigate the reasons for the failures and to propose possible solutions. Surveys were conducted by various groups using structured interviews and focus groups in workshops. The consensus from the surveys shows that the main reasons for the failures within the construction industry were:

- Lack of information
- Lack of communication
- Lack of decision making process
- Lack of assessment
- Lack of time for planning
- Lack of trust.

Various groups in the project were set up to analyse these findings and provide possible solutions, among which were:

- Learning perspectives
- Human organisational networks
- Improvement process development
- The use of ICT.

This paper is concerned purely with the use of ICT for the construction industry.

The results from this study show that all participants agreed that ICT is a key aspect for improving communication between the numerous stakeholders within the construction industry. Some, however, were distrustful that it would address the entire problem.

ICT is increasingly being used by many industries, including construction firms, to improve their performance. All information for projects are nowadays entered into software tools or generated by computer programs. Software tools typically used in construction include text documents, 2D and 3D drawings, schedules in bar chart and other formats, various diagrams and charts, tables etc. A typical construction project meeting involves the sharing of information between different people such as designer, project manager, scheduler, cost estimator, architect, users, electrical engineers, contractors, users and etc. Because many of these people involved also come from different disciplines, it is paramount that these information are coordinated and communicated effectively. One effective means of ensuring the success of information flow between various partners is the use of knowledge management. One of the main reasons given for the failure of many construction projects was that there was a lack of management in them (Naaranoja and Uden, 2006).

Knowledge is now perceived by most organisations in the construction industry as a vital organisational resource and source of competitiveness. Knowledge is increasingly recognized as the most important resource in organizations and a key differentiating factor in business today. It is increasingly being acknowledged that KM can bring about the much needed innovation and improved business performance in the construction industry (Egbu et al, 1999). In Finland there is a national level strategy to improve knowledge management in construction by using new ICT and improving human collaboration (Visio 2005).

According to Brelade and Harman (2001), Knowledge management (KM) is obtaining and using resources to create an environment in which individuals have access to information and in which individuals obtain, share and use this information to raise the level of their knowledge.

Knowledge management systems (KMS) are tools to effect the management of knowledge and are manifested in a variety of implementations (Davenport et al, 1998) including document repositories, expertise databases, discussion lists and context-specific retrieval systems incorporating collaborative filtering technologies. The purpose of knowledge management systems (KMS) is to provide the technical support to enable knowledge capture and exchange between different users in organisations. It provides each user with a means to acquire, create, document, transfer and apply knowledge to meet an organisation's needs. A KMS is a complete system because it comprises a number of sub-systems. Knowledge management is supported by a range of technologies, broadly grouped into four areas of activity: business process management, content management, web content management and knowledge application management.

Construction companies tend to be fragmented and project-based; they have plenty of knowledge, but it is distributed and held in separate systems of participating companies. To develop successful projects requires that the different stakeholders share their knowledge.

There are three reasons for lack of collaboration in construction projects: product (the information of the building); organisation (who is doing what and which resources are needed); process (how the project will be made, e.g. the schedule) (Fischer and Kunz, 2004). The use of ICT in construction is relatively limited and ineffective compared to other sectors such as the automotive or the aerospace industry (Adriaanse et al. 2004). The obstacles of the use of new ICT can be divided into three main categories:

- **Technical:** Continual demand for upgrading hardware and software is the greatest obstacle according to Samuelson (2002). According Rees (2006), current classification and specification systems are widely accepted in the market, but do not offer enough information richness to adequately support information sharing in the construction sector. The security issues like the security of transactions or the legal position of e-tools (the acceptance of e-signature).
- **Human:** The construction professionals assessed that the “Greater knowhow is required from staff” and overabundance of information are among the main obstacles to ICT use (Samuelson 2002, p17 and Eadie et al. 2007). Cynicism and defeatism are unintended consequences of technochange failure preventing the success of the new change efforts (Markus 2003). The company culture and upper management support are also important issues (Eadie et al. 2007).
- **Economical:** Strategic objectives are not clear (Love 2004). Investment costs are too high (Samuelson 2002). Network effects on the utilization of ICT (Bansler & Havn 2004, pp 271, 272). The key challenge is to obtain a “critical mass” of users. Many new technologies fail to obtain critical mass and simply flop. The problem is the “chicken and the egg” paradox: many users are not interested in adopting the technology because the installed base is too small, and an insufficiently small number of users have adopted the technology (Bansler and Havn 2004, p 271, 272).

Technology plays a crucial role in knowledge sharing. In many ways it is technology that has made knowledge sharing a possibility – in the past it was impossible to share knowledge or work collaboratively with co-workers around the globe. According to Cutting-Decelle and others (2007) there are available flexible and inexpensive information and communication technologies such as the Internet, Intranets and Extranets, intelligent-agents, global positioning systems, open-EDI standards, electronic markets, e-procurements, and broad bandwidth. These are creating new possibilities for radical redesign of the supply chain. According to Turk and Cerovšek (2003) the core research themes in the construction informatics have been communication; information processing; and infrastructures. The supporting themes have been need specification (e.g. technology roadmaps); transferring knowledge (like education, best practices and standards); deployment (experience, lesson, learned) and what are the impacts of use. The research has approached trust in the virtual collaboration environments mainly by comparing face-to-face and virtual team settings (e.g. Holton 2001) or how the new settings are being accepted (e.g. Ren et al. 2005) or how trust will affect on the use of eCommerce (e.g. Ren et al. 2006). Also there is research of the role and nature of trust in construction project management performance (e.g. Wong et al 2000). The literature has found that trust is a key issue in the use of ICT in construction projects. However, there is lack of studies on the role of different types of trust in online communication in construction projects. Fig. 1 describes one approach how trust might be built in online environments.

Creating and maintaining an environment in which construction employees are willing and able to share knowledge is the key success in any knowledge management programme. There are many tools that construction workers use to share knowledge in Finland. Typically tools used by construction firms include the following online tools:

- Document exchange via project intranet or email is used in order to aid the efficiency of the design process and change management. The interoperability of tools used by different actors is the basis of many research works.
- Project management tools to organize and manage different activities such as requests between actors, tasks etc.
- Other collaborative tools include video conferencing that is used for planning and information exchange.

- Digital photography has become more common because of its context representation and understanding qualities. The photos are saved on the Internet for everybody to observe the construction progress and to document how the building is actually constructed.

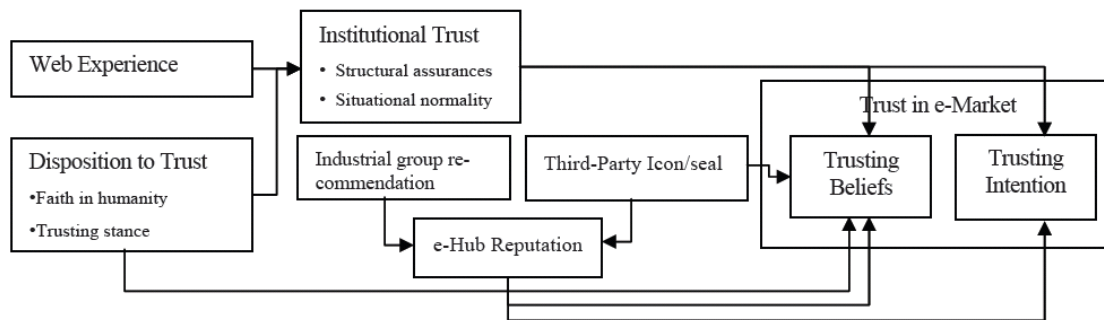


FIG. 1: Conceptual trust building model for exploration stage (adapted from McKnight et al., 1998)

Among the most commonly used online tools is e-mail. Whilst the authors appreciate the benefits of ICT for the construction industry, they strongly believe that ICT alone is not the answer to the problem. ICT is merely a tool to enable communication and understanding. Unless the users accept and adopt the technology, the tool is of little value. It is the authors' belief that the underlying problem is a lack of trust among stakeholders, including the use of ICT itself, as shown in this paper. This paper describes four public construction case studies that have used online technologies in Finland. The structure of the paper is as follows. Section Two gives an overview of trust followed by description of the case studies. This is followed by discussions of the different types of trust that have implications for knowledge sharing among the construction teams using online tools. Section Five concludes by giving recommendations how trust can be promoted to help overcome some of the barriers.

2. AN OVERVIEW OF TRUST

To help the collaboration among different teams and the sharing of knowledge among construction teams, computer mediated communication is used for communication. However, in reality, these tools were often ignored by the users, who had a preference for face to face communication. This is because there was a lack of trust in the use of online tools by the construction workers.

Although there are different definitions given to trust, it has several common characteristics such as risk, willingness to place oneself at risk with the assumption and expectation that no harm will come to oneself and one's expectations or beliefs (Rosseau et al, 1998). A common definition given to trust is that of Mayer and others (1995, p 712). According to these authors, trust is the willingness of a party to be vulnerable to the action of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party. Trust is also discussed on the basis of how it is derived (Shapiro et al, 1992; Williamson, 1993).

There are different types of trust, depending on the length of time that the team members have known each other. These are (Jarvenpaa and Shaw, 1998):

- Identification-based trust – the individuals are convinced that they have similar intentions and goals.
- Deterrence-based trust or calculus-based trust results from a fear of the consequences of behaving in an untrustworthy matter. Calculus process is where a trustor calculates the costs and/or rewards for another party to be opportunistic. In the prediction process, the trustor forecasts another party's behaviour from historical data. The individual recognises the consequences for not doing what they said they would do.
- Swift trust – the time available does not allow trust to be built up in the normal way and team members simply assume that the other team members embrace similar values to their own.
- Knowledge-based trust – the individuals trust each other as they know each other sufficiently well to be able to predict each other's behaviour and have shared experiences. The trustor uses information about how the trustee has carried out tasks in the past to predict future action.
- Transferred trust may occur when the trustor knows and trusts a person or institution that recommends the trustee. This is a form of swift trust.

- Psychological or behavioural trust - a pre-disposition towards having confidence that others will carry through on their obligations (Warrington et al, 2000).
- Technological trust – a belief that technologies will perform reliably and will not be used for untoward purposes (Chiravuri and Nazareth, 2001).
- Organizational trust – the belief that an organisation will carry through on its obligations (Cummings and Bromiley, 1996).
- Situational trust – dependence on cues and clues in the immediate social environment when deciding whether to trust another group, organisation, or institution (Karake-Shalhoub, 2002).
- Interpersonal trust – an expectation that others will behave in a predictable way and a willingness to be vulnerable during the trust relation (Dibben, 2000).
- Institutional-based trust is when an individual is willing to trust another because there are rules and regulations (i.e., external protections) that will reprimand the trustee if s/he should harm the trustor (Ford, 2002).
- Personality- based trust is when an individual trusts the trustee because it is the trustor's nature to trust others – it is not based on an evaluation of the trustee's worthiness of trust (Ford, 2002).

The level of trust between individuals, organizations and within society as a whole influences the nature of trust in online sharing, both in terms of the contributions made by individuals and the productivity of knowledge sharing. People do not share knowledge when there is no trust. People are afraid to share because they do not trust others (Standing and Benson, 2000, p.343). Trust can be an enabler or disabler of knowledge management, depending on how individuals interact. It facilitates knowledge exchange, leading to more extensively shared knowledge, which in turn facilitates the development of trust. It is also multifaceted, with rational, affective, instrumental and moral components. Trust has cognitive, affective, or behavioural dimensions with the strength of the particular dimension being dependent upon the type of relationship involved between the trustor and the trustee (Jarvenpaa and Shaw, 1998, p.36).

It is perceived by many researchers that trust and knowledge exchange are positively related (Standing and Benson, 2000; Edwards and Kidd, 2003). It is our belief that successful transfer of knowledge depends on the direct participation of both the giver and the recipient of knowledge. Since trust is so important a factor to knowledge management, it is important to understand how we can help to promote trust in knowledge sharing or transfer. Trust is a complex construct with different bases, multiple levels and determinants (Rosseau et al, 1998).

Trust also has a behavioural dimension to it. It can only develop from the right thing done (Rosseau et al, 1998, p 396). Trust is purposive. Thus the sharing of knowledge should be purposive. The goal is not knowledge transfer per se, but effective action (Connell et al, 2003, p 143). There are many intervening elements embedded in social action that are useful to explain the link between trust and knowledge transfer. These include the type, amount and level of knowledge being transferred, in what context (the goal orientation) and how it is shared or transferred (the quality of interaction) all affect the level of trust and vice versa (Ashleigh et al, 2003). To add value to an organisation, both trust and knowledge should be shared. This means participating in activities. Knowledge transfer and the development of trust can only be achieved by encompassing all elements that are relevant to the context at any particular time. This means organisations embracing the value of knowledge transfer and building of trust as an intrinsic part of their culture (Connell et al, 2003).

Trust facilitates cooperative behaviour (Shneiderman, 2000). Fukuyama (1995) defines trust as the expectations that arise within a community of regular, honest and cooperative behaviour, based on commonly shared norms, on the part of the members of the community. Concerning electronic environments, trust indicates a positive belief about the perceived reliability of, dependability of, and confidence in a person, object, or process (Fogg and Tseng, 1999).

There are different types of trusts that are important in knowledge sharing. There is institutional-based trust, knowledge-based trust or personality-based trust. Institutional-based trust is when an individual can trust another person because there are rules and regulations that will reprimand the trustee if he/she should harm the trustor. Knowledge-based trust is when an individual is willing to be vulnerable to the actions of another individual, because the trustor knows and understands the trustee and feels that he/she can predict the likelihood of harm. Personality-based trust is when an individual trusts the trustee because it is the trustors nature to trust others – it is not based on evaluation of the trustee's worthiness of trust. There is a distinction made by Morris and Moberg (1994) between personal and interpersonal trust. Personal trust is based on person to person interactions.

Interpersonal trust is based on positions and not the actual person. Determinants of trust are also crucial for knowledge transfer. Mishra and Morrisey (1990) proposed that the most pertinent determinants for knowledge management are open communication, inclusion in decision-making, sharing crucial information and sharing of feelings and perceptions.

According to Sharratt & Usoro (2003), trust can also be conceptualised across three dimensions: integrity, benevolence and competence. Integrity-based trust is the perception that another party is honest and reliable. Benevolence-based trust is related to the perception that another party would keep the best interests of the trustor at heart. Competence-based trust is rooted in the perception that another party is knowledgeable or possesses a certain level of competence.

3. METHODOLOGY

The objective of the present study was to describe the role of trust in online communication and knowledge sharing in construction projects. The study adopted a systematic approach that builds on the refinement of existing theories, rather than attempting to invent new theories. The aim is to find out what are the real challenges of building online trust in construction projects.

The empirical aspect of this research was a comparative cross-case analysis of the online communication in four construction projects in Finland. The data for the study were collected mainly through interviews. However, we have also collected artefacts of the projects like drawings and memos, and observed the meetings in two projects. The amount of interviews is written down in every case study. We wanted to gather different kinds of public projects: typical town projects and a large scale public-private project. The second author was herself partly involved in interview process and was responsible of all the interviews and empirical data gathering. In all the interviews the same themes were discussed. The theme questions were:

1. Phases of the project? How do you participate in each phase?
2. How do you participate in this process?
 - What kind of forms of participation existed?
 - How were the design meetings organised?
 - How were the site meetings organised?
 - What kind of other meetings did you have?
3. Who are the main information brokers in each phase?
 - The most important person who delivers information?
4. What kind of successes and challenges have you experienced?
 - What kind of information reaches you best?
 - What kind of information does not reach you?
 - With whom is it easiest to exchange knowledge?
 - What kind of challenges are greatest?
5. Information and knowledge in a construction project
 - Channels of information (meetings, phones, emails, drawings)
 - Why do you use the information channels you utilize?
 - What kind of IT tools do you use or not use?
 - Do you have problems with IT tools?
 - How should IT tools be improved so that you would start to utilize them?
6. Other:
 - How has construction changed during time?
 - How has the flow of information changed?
 - What kind of problem is typical today?

In the interviews we did not ask separately about trust, but trust was however often talked about and the analysis of the empirical material made it very clear that trust had an important role in the case projects. Therefore the empirical material was carefully scanned and one additional interview was made in order to get the reference of a large project that used best available technology. The studied events were selected by calculating first which online communication events were most often talked about in the interviews of the case project. The events were then described in order to explain the event. The findings were analysed through qualitative content analysis and compared with extant theory in the literature. Having defined the research focus, the empirical data were reanalysed, which allowed the conclusions to be drawn.

4. CASE STUDIES

Four case studies are used in the paper to show the use of ICT for construction projects in Finland. The four case studies concern public construction projects in in three different Finnish towns. The numbers of people involved in the projects varying between 168 to over 3000. In all cases e-mails were the main means for online communication. CASE 3 and CASE 4 involved the use of an integrated project intranet.

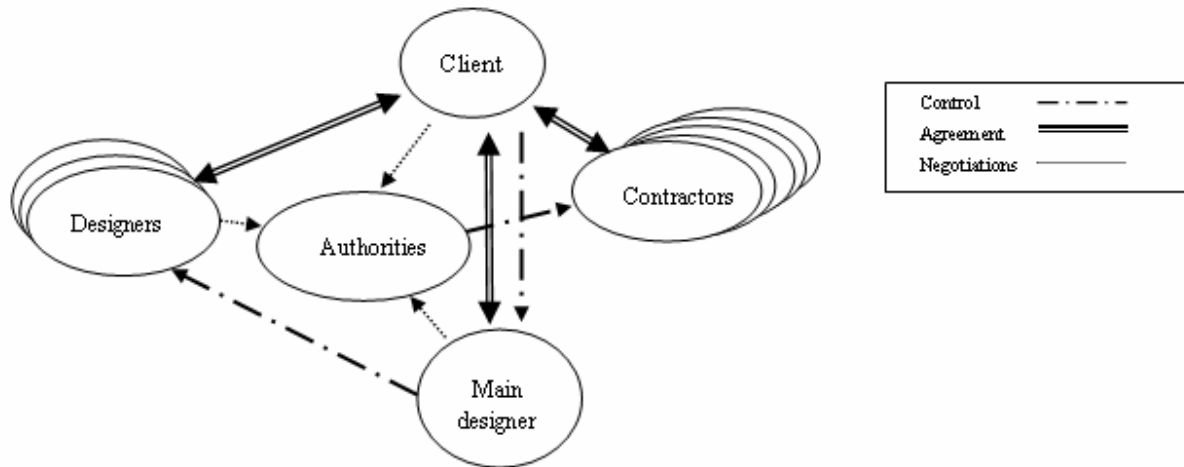


FIG. 2: The contractual system in CASES 1. & 4.

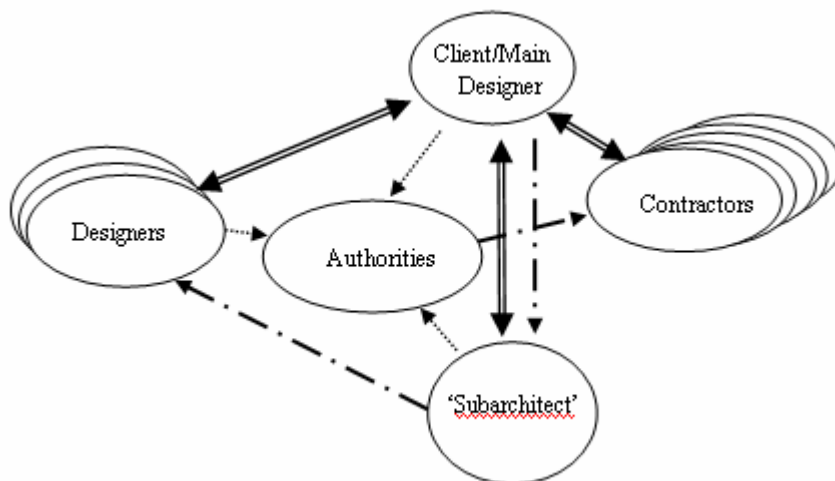


FIG. 3: The contractual system in CASE 2

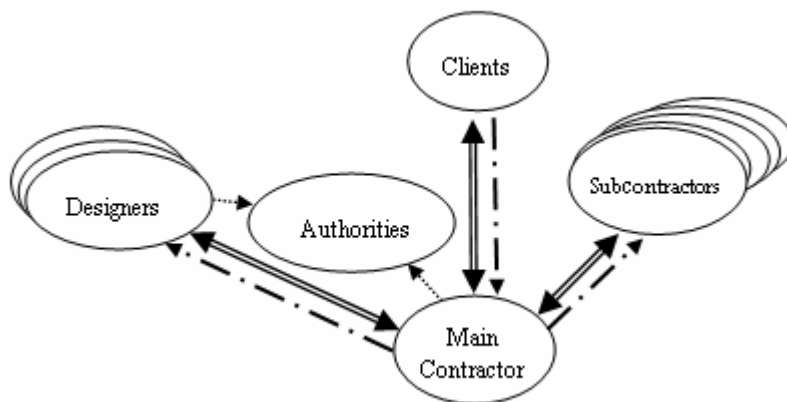


FIG. 4: Contractual system in CASE 3

The communication media used was specified in the contract of every case project, such as the use of e-mail for Cases 1, 2 and 4 to deliver meeting information. The contracting system in the case studies were typical Finnish contracting systems where the ICT tools were not agreed in the contract. The case project 3 was not very typical project. In Case 3, the ICT tools were agreed in the main contract and the main contractor defined them also in subcontracts.

4.1 Case Study 1 School renovation

There were 168 participants in the project, consisting of 100 end users (teachers, kitchen staff, cleaners and caretakers, etc.); 8 designers; 20 officers; and 40 construction site workers. E-mail was the main communication tool used. There was a total of 40 interviews. Some of the interviews were group interviews. Examples of using online communication via e-mail are as follows:

Example 1: Secretary sends emails

The secretary sent an e-mail memo to attend a meeting, along with its agenda, to 32 people. The recipients were designers, contractors' representatives, town officials and end-user representatives. Problems encountered in communication were:

- Respondents did not reply directly to the secretary.
- Respondents who could not attend the meeting replied instead to the project manager.
- Some respondents phoned the project manager instead of replying by e-mail.
- The e-mail was sent as information to the end-users, who then turned up at the meeting when not required to do so.

From this example it would appear that recipients of the email did not trust the secretary, as there is a distinct lack of competence trust by the recipients. Recipients could not believe that the secretary has the competence to deal with the problem at hand.

Example 2: Sharing design knowledge

Designers sent design documents through online communication. Problems encountered were as follows:

- End-user representatives did not get the information.
- Project manager could not open the document and needed help to print it.
- Although designers replied and forwarded messages among themselves, these messages were never forwarded to end-user representatives.
- Many designers had problems opening the documents initially.
- Messages were usually sent out very late.
- Initially architects only talked to end-users at meetings.
- After meetings, architect and end-users began online communications regularly.

This example shows that there are different types of trust missing. For example, the reason end-user representatives did not get the information was because the designer believed that the information would not be understood by the end-users. This shows that knowledge-based trust is missing. In the case of the project manager not being able to open the documents and needing help to print them shows that the manager lacks technology-based trust. With regard to the designers replying to and forwarding messages among themselves, but not to end-users; this is because designers have competence trust with each other, but not with the end-users. The designers believed that the end-users did not have the necessary knowledge-based trust. Many designers had problems opening the documents initially, which illustrates that designers lacked technology-based trust to undertake the task. In the case of messages being sent out late, this shows there was a lack of benevolent trust because the designers did not believe that what was originally agreed would be honoured. Normally there are many last minute changes introduced by both end-users and architect. The reason that, after meeting, architects and end-users began online communication regularly is that initially architects only talked to end-users at meetings. This was due to project manager and architects not having personality-based trust. After meeting, architects and end-users began regular online communication because as they got to know one another they developed interpersonal trust.

Example 3: Decision making events

Architect sent project manager, contractors, end-user representatives and town officials, questions via e-mail.

The use of e-mail for decision making was much harder than in face to face meetings. This problem continued throughout the project. Since the architect wanted to find out who had made a decision, she decided to use email as a quick response to her enquiry. It was considered easier to get the answer by email rather than in a face-to-face meeting. The architect has technological-based trust that the use of email would help her to get a quick response. Swift trust was also presented because a fast response was needed.

Example 4: Peer to peer meetings

Despite regular meetings between peers through phone conversations and face to face meetings, there were no memos sent to the project manager concerning the outcome of these meetings. Because of this, problems only surfaced during the construction stage of the project. This shows that there was an absence of technological-based trust among users. Users also perceived that the project manager did not require the information. This shows that there was no situational trust presented.

Example 5: Use of Integrated Project Intranet

The use of integrated project intranet was rejected because the organisation felt that they did not have the experience to use the tool and that the cost was not worth the investment. This shows there was a lack of competency and technological-trust.

In summary, every partner of the project received the project meeting agenda online. Some replied to the project manager instead of the secretary who sent the e-mail, if they were unable to attend the meeting. Many contacted the project manager by phone instead of e-mail when they had queries. Partners who were meant to be there did not attend. Conversely, there were those who were not meant to be there turned up instead. There was no online discussion of the agenda's content. Although the designers sent the design documents among themselves and discussed these documents, the end-users were left out. They did not receive the communication between designers.

4.2 Case Study 2 Hospital for Senior Citizens

There were 188 participants in the project, consisting of 120 end-user representatives (nurses, patients, relatives of patients, kitchen staff, cleaners, caretakers, etc.); 8 designers; 20 officers; and 40 construction site workers. . There were total 24 interviews.

Example 1: Project manager Sends emails

Project manager sent an e-mail message about a meeting to 16 participants including designers, contractor representatives; town officers. Participants replied to sender if they could not attend the meeting. However, if they had any serious concerns, they phoned instead of replying by e-mail. This shows that participants had no technological-based trust because they did not have the competency to write emails concerning their problems. It also reveals a lack of knowledge-based trust here.

Example 2: Sending of designer documents

Designers sent documents to all participants. The problems encountered were:

- Designers often had to change the format of the documents when sending to end-user representatives. The reason designers often had to change the format of the documents when sending to end-users was because designers believed that end-users did not have the technological-based trust to read the documents. End-users also felt that they did not have knowledge-based trust to deal with the documents.
- Project manager thought it would be good to use online communication since it would provide a better means of collaboration among participants, especially between him and the designers. In the event, there was no improvement in communication because designers often ignored the communications. The project manager here has technological-based trust that online communication would be a better communication method. Designers ignore the communication because they could not trust the project manager not to change his mind at the last minute with the project. This shows a lack of knowledge-based trust.
- Designers had to have face to face meetings with end-user representatives to explain the design documents. Designers did not believe end-users have the expertise to understand the designers. They lacked knowledge-based trust towards the end-users.

Example 3: Peer to peer communications

There were no memos sent to the project team. Most of the communications were by phone or face to face. Designers sent each other short email messages. Designers sent each other emails because they had interpersonal trust among themselves. There were no memos sent to the project team because benevolent trust was missing among the project team. There was also a lack of technological-based trust in preferring face to face meetings to using ICT.

Example 4: Integrated Project Intranet

This was considered to be unnecessary, due mainly to the expense required to purchase the tools. The organisation also felt that they lacked the expertise to use the tools especially as they have to learn to use them.

In summary, the designers were happy to use the online communications among themselves, but end-user representatives did not participate in online discussions. There were often misunderstandings of requirements between designers and end-user representatives because of the lack of communication.

4.3 Case Study 3 A Large Public Business

This project had more than 3000 participants, including 2000 end-user representatives (150 business units, bus terminal representatives, metro station experts, and future owners of 70 flats); 400 designers; 20 officers; 600 construction site workers. The project was a large public private partnership project, in which the traffic was rearranged and large commercial building built. There was only 1 interview. This case study is here as a reference of a large project. The project used online communication via an integrated project database.

Example 1: Meeting for partners

The purpose was to arrange a meeting for the project. Using the online communication tool, the project manager saved the documents and the system automatically sent e-mail to the various groups. Although the project manager had many different user groups, the system took care of this. An online diary was kept, however some partners would have preferred the manual diary system. This shows there was technology-based trust among the people. Situational trust was also present.

Example 2: Sharing design documents

Through the use of the online system, designers were able to save the design documents and these were sent automatically to other designers, the project manager and the end-user representatives. The problem was that external auditors did not have the project intranet, so they could not benefit from its use. They had to communicate via e-mails. Although the system was useful, the complaint was made that there were too many meetings. This shows there was knowledge-based and technology-based trust here. However, the lack of technology on the part of the auditor prevented the full benefit of the system being realised. The complaint of too many meetings shows that people still prefer the interpersonal trust rather than the use of technology.

Example 3: Lorry information

The site manager sent the lorry drivers information about his delivery times. The lorry drivers had to deliver their loads according to a given time. This required punctuality on the part of the lorry drivers. One of the main problems here was that the lorry drivers had a separate system for traffic management.

The participants used the intranet because the technology was forced upon them by the organisation. This is an example of organisational trust. Because of organisational trust, management found the technology useful. In the case of the lorry drivers, they trusted the technology because it helped to schedule their work, i.e. they have technology-based trust.

4.4 Case Study 4 University Project

This project had about 210 participants involving 90 end-users (researchers, professors, kitchen staff, cleaners and caretakers etc.); 10 designers; 10 town officers; and 100 construction site workers. There were total 20 interviews.

Example 1: Use of integrated project tools to inform meeting

The project manager saved the documents in the database and an automated e-mail was sent to all participants of

the meeting. The problems encountered were:

- Some recipients replied to the project manager that they could not attend the meeting, but many phoned instead of replying.
- Participants phoned the project manager instead of e-mailing him if they had queries.

This again shows that there was a lack of technological-based trust among the users.

Example 2: Sharing design documents

Designers communicate with each other via e-mails, fax and phone. They could have used the integrated database intranet to communicate, but they chose e-mails to communicate among themselves. They used faxes to send design changes to the site instead of using the integrated tools. Different technologies were used here: designers used email because they had technological-based trust in emails. In the case of the integrated database, they felt that they lacked technological-based trust to use it.

Example 3: Peer to Peer meetings

Despite the use of online communication, there were no memos sent to the project manager. Instead, peer to peer meetings were conducted by phone or face to face.

In summary, although the project had specified the use of the integrated database intranet as the tool for communication, this was not used. There were even rewards given to those who would use the tool, however, this was not successful. The site manager insisted on using the phone when he had queries for the designer concerning the design. The designer sent the updated drawings by fax rather than use the tool. All site personnel preferred face to face communication because they believed that they were able to deal with the problems better. Designers also preferred to discuss design changes with partners through face to face meetings, despite the availability of the integrated database tool.

5. IMPLICATIONS OF TRUST AMONG CONSTRUCTION TEAMS

Trust is the most important precondition for knowledge exchange (Rolland and Chauval, 2000, p 239). It is a prerequisite for tacit knowledge sharing. (Ford, 2002). Although the transfer of knowledge is a voluntary behaviour, we often need to share values and /or establish a common shared objective with someone before we are willing to transfer any knowledge. Conversely, trust is also voluntary; especially to trust initially is a voluntary act of faith. Another factor that links trust and knowledge is that of equality in meeting expectations (Ashleigh et al, 2003). If inequality or imbalance is perceived in a relationship, this can lead to mistrust (Sitkin and Roth, 1993). Identification of perception of fairness between two parties is a prerequisite for transferring knowledge (Nieoff and Moorman, 1993).

In online applications, trust is the positive experience one person has of another person or an organisation, based on past performance and truthful guarantees. It is about expectation of the future (Shneiderman, 2000). Users are more likely to participate in online discussion if they receive assurances that they are engaging in a trusting relationship.

Shapiro and others (1992) identified three consecutive stages through which trust develops: Calculus-based, Knowledge-based and Identification-based. In the beginning, calculus-based trust exists when neither party is familiar with the other. During this early stage, it is important to establish initial trust. Initial trust was lacking in most of the four case studies for the construction firms in Finland. Initial trust is the trust that surfaces when parties first meet or interact. It is based upon an individual's disposition to trust or an institutional cue that enables one person to trust another without prior knowledge (McKnight and Cummings 1998, p. 474). Because the team members from each partner lack initial trust, there is no way of forming credible and meaningful information about the other person.

How do we build initial trust? From our experiences (Uden, 2006) initial trust can be achieved through orientation. This means getting together all of the partners involved in the project before online communication is initiated. Through orientation, participants involved in the project have a chance to meet the others and help to break barriers. Another useful approach is that of institution-based trust. This can be achieved by having signed contracts making sure that all parties know in advance what is expected of them.

The knowledge-based stage is entered when information flow increases and behaviour becomes more

predictable, therefore adding more mutuality to the relationship. Knowledge-based trust was achieved in Cases 1, 2, and 4. This can be seen between the architect and end-users as their relationship deepened and they communicated more frequently.

Finally, trust develops into the information-based stage. By that time, there should be complete empathy within the relationship and a full understanding of each others' needs, wants and intentions (Ashleigh et al, 2003). This type of trust was shown in Case 2 when designers expressed that they understood each other well and messages flowed frequently among themselves.

According to Levin and others (2002), two types of trust are necessary for knowledge sharing: benevolence-based trust and competence-based trust. Benevolence-based trust is one in which an individual will not intentionally harm another when given the opportunity to do so. Competence-based trust describes a relationship in which an individual believes that another person is knowledgeable about a given subject area. Both types of trust were necessary for teams to work effectively and share knowledge.

It is generally acknowledged that although there is benevolence-based trust present in all cases, the impact was limited. There were many other trusts lacking between partner members in all four cases. Competence-based trust is essential for knowledge sharing to occur. However, this was absent in many situations as evidenced in Cases 1 and 2 when respondents refused to reply to the secretary, preferring instead to deal directly with the project manager. This showed a distinct lack of trust in the secretary's knowledge about the meeting. They all believed that she was not knowledgeable about the project. Capacity trust that is related to the degree to which it is believed an individual is capable of using the knowledge correctly was also evidenced in Case 1, Example 2. Although designers communicated among themselves with their design documents, those documents were never sent to the end-user representatives. This was because designers did not believe that end user representatives had the knowledge capacity to understand these documents. Another example of the lack of capacity trust is in Case Study 2, Example 2 when designers had to change the format of the documents when they were sent to end-user representatives. Designers also required face to face meetings with end-user representatives in order to explain the design documents.

Context plays a crucial role in trust and knowledge. Knowledge, particularly tacit knowledge, can only be transferred through social activities (Nonaka and Takeuchi, 1995). Trust can be developed across remote project teams by the creation of a social context through initially swapping information among team members (Jarvenpaa and Leidner, 1998). Knowledge is not a physical commodity, but is an ongoing social accomplishment, constituted and reconstituted in everyday practice (Orlikowski, 2002, p. 252). Similarly, trust is also a dynamic process. As knowledge increases through the practice of sharing and giving, so trust is nurtured (Styhre, 2002, p. 230). Knowledge grows rather than diminishes with use (Alder 2001, p216). Trust also grows with use (Hirschman 1984). This can be seen in Case Study 3, Example 2 where designers were able to use the online integrated database to send out design documents automatically to other designers, the project manager and the end-user representatives because of the social context through which they operated.

Sharing knowledge involves risk for both parties. Trust will lead to risk-taking in a relationship (Mayer et al, 1995). Where there is little trust in a situation, the individual will rely on a third party to mitigate the level of risk. This can be from organisational policies and rules to mitigate the level of risk. Controls are available to mitigate the likelihood of harm. If knowledge sharing can be institutionalised and sanctions exist to limit opportunistic behaviour, then knowledge sharing should occur.

Although the use of the integrated database intranet provided potential benefits to construction organisations, many of these organisations had chosen not to implement it because of a fear of wasted investments. In order to overcome this, organisational policies and rules are necessary to mitigate this risk. To do this, it is important to have institutional-based trust. This is when an individual can trust another person because there are rules and regulations that will reprimand the trustee if he/she shows harm to the trustor. In Case 3, the project contract needed to be in place that specified the use of the integrated database online system.

Besides institutional-based trust, there was also an example of interpersonal trust. Interpersonal trust is based on positions and not on the actual person. This can be clearly seen in all of the case studies. People did not trust the secretary. Instead they wanted to deal with the project manager because of his position in the organisation.

Central to all four case studies was the lack of technological trust. It is obvious that participants did not trust the use of e-mails, but preferred in most cases to use traditional methods such as face to face meetings and

telephones. Project participants could not trust that online technologies would be reliable. They feared that they would not be able to perform effectively with the technologies. This could be due to the fact that they were not familiar with the technologies.

Trust can be enhanced when users are familiar with their environments, what norms are expected and how they behave. This also means that there was a lack of transferred trust, i.e. that the participants did not trust the institutions or organisations that recommended the technologies.

6. CONCLUSION

We believe that it is important to provide a rich social and organisational context in the construction environment so that trust can be developed between members of different teams. To do so requires us to develop a common understanding among team members regarding the nature and goals of the use of ICT in construction. It is imperative that organisational partners have technological trust. They should be taught how technologies can benefit them in their work. It is important to have initial trust when users first come online. We believe that it is also important to identify the type of knowledge a trustee has before the first interaction. Differentiating users based on their knowledge is the first step to understanding their trust.

We believe that the most pertinent determinants for trust are open communication, inclusion in decision making, sharing of critical information, as well as feelings and perceptions. These determinants of trust would increase the likelihood of trust building among partners. Trust is fundamental for construction projects if they are to be successful, especially in online systems where participants are separated from one another physically. Among the different types of trust that are important in our four studies are knowledge-based trust, benevolent trust, competence trust, calculus trust, interpersonal trust, identification-based trust, technological-based trust and institutional or organisational trust. These trusts are not easy to find or to implement in construction projects where there are different stakeholders involved, each with his/her individual interests and perspectives. When there is little trust in a situation, a third party trust is useful to help mitigate risk taking in relationships when trying to build trust. This can be achieved through organisational policies and rules. If trust can be institutionalised and sanctions exist to limit opportunistic harm, then trust can occur.

Working is a social process involving teams of people. Building relationships for online use is vital to the knowledge sharing. It is our belief that there is a positive link between member relations and team performance for both short-term teams and long-term teams.

The trust that individual members develop within their team helps them to predict others' behaviour. There should be an initial 'getting to know you' session. This encompasses sharing much cultural information. These individuals exchange information about shared values, assumptions, opinions and beliefs. There is also a sharing of personal information such as hobbies, interests, family life, work life, personal expectations of team, equipment, resources, etc.

The ability to communicate can be hindered by limited typing skills. Clear communication is essential for online teams to function effectively. Building trust fosters effective online communication. Trust enhances group working and development. It is important to get organised by establishing team meetings, developing team norms, creating time lines and instituting workflow procedures. This can be achieved by occasionally engaging in team activities and discussions.

Conflict is unavoidable and it is vital to resolve personal conflicts if the team is to be successful. This can be achieved by asking team members to find out how other people on their team would like to be treated and then act accordingly.

To help to build trust there should be recommendations for organisations to support communication and sharing of personal information as well as enhancing interdependency and the creation of networks among partners. It is our belief that knowledge transfer can be encouraged by the development of interpersonal trust and/or organisational trust. No-one can force an individual to trust another, because trust is based on the relationship between two individuals. Trust also involves a person's perception and willingness.

However, organisations do have influence over policies, procedure and organisational culture and the related expectation. This can help to initiate trust building in organisations. Organisational laws, sanctions and policies can be used to help develop institutional based trust that will encourage people to share their knowledge and generate new knowledge. This happens because people know that there are safety nets protecting their self

interests. This also helps to develop organisational trust.

Communication and the ability to work together in teams are the basics of trust building. This is also true of building online trust in construction. People in teams need to have the ability to be flexible and respond to changes of information. This is particularly necessary in construction where information may be incomplete at the time of contract and changes often arise as a project progresses. Organisations have an impact on building trust. They should be aware that their reputation as a company to be trusted is an asset. We have introduced trust building following our studies. Firstly we provided training to all stakeholders that the use of technologies is essential for knowledge sharing in order to build technological-based trust. With regard to competence-based trust, group progress meetings were conducted to allow different parties to get to know each other and thus build interpersonal trust. For teams to work successfully and effectively, trust must be ingrained in the culture of the groups. We believe that building trust begins with creating a shared sense of commitment across the teams. For members to share and work effectively they need to be open and honest with one another. To promote this we held regular face-to-face seminars so that members got to know each other personally to build interpersonal trust. This also helps to build integrity-based trust among members. As the groups got to know each other, their competence trust of the others increased and this also built benevolence. When users realised that they have instituted trust in the use of ICT for their work, this further helps to facilitate trust among the different parties.

Our studies only provide a glimpse of the enormous problems facing construction firms in knowledge sharing. Further studies are required to identify how trust can be built and knowledge sharing promoted in construction projects. We are currently working with Finnish construction companies to identify ways of overcoming many of the problems outlined above.

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