

Factors Supporting Information and Communication Technologies on Construction Projects

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ABSTRACT: Adopting collaborative information and communication technologies on construction projects faces a number of obstacles. Lack of trust between contracting parties and in the technology is a major barrier. A survey of 66 construction professionals was conducted to identify the most important factors on construction projects that could increase trust between contracting parties and the use of collaborative information and communication technologies in construction. The survey found that face-to-face communication and the support of owners are required to increase trust between contracting parties and the trust in information and communication technologies.

1 INTRODUCTION

The construction industry is faced with low productivity rates, low profit margins and low adaptation of advanced information and communication technologies. According to the Bureau of Labor Statistics, the U.S. construction industry has the lowest use of computers and the second lowest use of the internet of private industries (U.S. Department of Labor, Bureau of Labor Statistics, 2007). Technologies that foster collaboration in the construction industry improve project management, information management, transaction time, transparency of project information, relationships between partners, and profitability (Nikas et al. 2007). Even with these benefits the construction industry is notorious for its slow adoption of new technologies. Adopting collaborative information technologies on construction projects requires trust between the contracting parties (Rezgui 2007). However, with all the different factors found in a construction project it is difficult to know what factors strengthen or weaken trust.

2 BACKGROUND

The benefits of collaboration through the use of information and communication technologies on construction projects are well documented. Advanced technologies may contribute significantly to project performance in terms of cost and schedule (O'Connor and Yang 2004). Other benefits include improving coordination among team members; fa-

cilitating document transfer and handling; reducing bottlenecks in communications; reducing number of claims; and enhancing organization of updated records (Nitithamyong and Skibniewski 2006). Even with the benefits of technology, the construction industry lags behind other private industries in the use of technology. High levels of trust between contracting parties and in the technology are generally the most cited success factor for adopting technology in construction. Without building and maintaining trust, the probability of benefiting from the benefits of trust is less likely (Nuntasunti and Bernold 2006).

Erdogan et al. (2008) conducted nine case studies of construction firms in the U.K. and found that each firm failed to achieve the full benefits of virtual collaborative environments.

“The reason for this is found to be focusing too much on the technical factors and ignoring or underestimating the factors related to change, implementation, human, and organizational factors and the roles of the management and end users,” (Erdogan et al. 2008, p. 234).

Dossick and Sakagami (2008) researched the success and failure factors related to virtual collaborative environments in construction. They determined that factors of success and failure could be viewed from a number of different dimensions. These dimensions, each with a unique set of factors to be considered, included government and industry, company, project, individual and technical. Salem and Mohanty (2008) surveyed sixty-five construction professionals with the goal of investigating the practices of construction project managers in regard to

information and communication technologies. They found that challenges in using and implementing virtual collaborative environments often related to the lack of financial evidence for its support.

Building Information Model (BIM) is an example of an advanced information and communication technology that could be used on construction projects. BIM has evolved for over 30 years (Eastman 2008) and originated from the need to have a digital representation of the building process. BIM is characterized as a tool, process and/or product that develops virtual intelligent models linked to other construction management tools (i.e. schedule, estimates) that promotes collaboration, visualization and constructability reviews beneficial to all stakeholders throughout the lifecycle of the facility (Kymmell 2008; Succar 2009). Architects and contractors have context specific benefits and challenges associated with using BIM. Architects see BIM improving coordination, design, productivity, and business opportunities, where contractors see BIM improving schedules, estimating, show drawings, coordination, as built drawings and the amount of request for information. A number of challenges are associated with adopting BIM consisting of the learning curve, transition period, quality of BIM practitioners, and legal and insurance implications (Ernstrom 2006). Adoption of BIM on construction projects requires strong leadership and trust.

Adopting any new technology requires a set of key performance indicators. Cox et al. (2003) surveyed 64 construction industry professionals (executives and project managers) in five different sectors (commercial, heavy civil, industrial, mechanical and electrical) from large (ENR 100), midsize (ABCs) and small (ENR Regional Directory) construction companies. The construction professionals were asked to rank the most important performance indicator from a list of 15 quantitative and qualitative indicators. The results showed significant support for quality, productivity, schedule, profit, cost and safety as the KPIs on construction projects. This also suggests that the use of any technology on construction projects will have to improve these indicators as well.

3 METHODOLOGY

A comprehensive framework of construction project factors that could impact trust and the adoption of information and communication technologies was developed for this study. The factors were grouped in the following categories communication methods, document types, management skills, KPIs, stakeholders, contract types, elements of different con-

struction phases, and survey respondent characteristics. A telephone survey of ENR 2008 top contractors in the United States was conducted to identify perceptions regarding the impacts of trust of the factors in the framework.

In total, 66 construction professionals completed the survey. Each survey respondent was asked to provide information regarding their age, gender, education, years of experience, and company. Twenty-Seven percent (27%) of the survey respondents were employed by companies that engaged in commercial construction, 17% in heavy civil, 6% in industrial and 50% in commercial plus one or more additional construction type. Fifty-seven percent (57%) of the survey respondents worked for general contractors, 17% for design/build construction companies, 20% for construction management companies and 6% other types of construction companies. Sixty-four percent (64%) of the survey respondents worked for construction companies with annual volumes between \$100 million and \$499 million. (Thirty-three percent (33%) of survey respondents were owners or CEOs, 36% VPs or directors, 23% project manager and 6% other. Seventy percent (70%) of the survey respondents had more than 20 years of construction experience while 14% had 16 to 20 years of experience, 6% had 11 to 15 years of experience, 2% had 5 to 10 years of experience and 8% had less than 5 years of experience. Fifty-nine percent (59%) of the survey respondents had a bachelor's degree, 30% a master's degree, 2% an associate degree, 6% some college and 3% high school. Five percent (5%) of the survey respondents were of the age 30 or younger, 15% ages 31 to 40, 32% ages 41 to 50, 36% ages 51 to 60 and 12% over the age of 60. Ninety-two percent (92%) of the survey respondents were male and 8% were female. In summary, the survey respondents were highly educated males holding senior positions in large construction companies with considerable experience in the construction industry.

4 RESULTS

Each survey respondent was asked to rank the factor's impact on trust between contacting parties on construction projects. The trust factors were grouped into nine categories that included: communication method, document type, trustworthiness, KPIs, stakeholder, contract type, pre-construction and design phase, construction phase and management.

In the communication method category face-to-face communication was most preferred by the survey respondents followed by telephone, e-mail, video conferencing, BIM and project website (Figure 1). These results point to the importance of face-to-face communication when adopting and/or using

information and communication technologies on construction projects. It also indicates that using advance technologies on construction projects could challenge trust and require higher levels of trust compared to communicating face-to-face or on the telephone. The most preferred document type was a signed contract followed by complete contract documents, electronic schedules and estimates, digital pictures and videos, electronic documents, paper documents, BIM and project website (Figure 2). The findings indicate the preference of construction professionals for signed contracts and complete specifications and drawings but also their preference for electronic forms of documents.

The trustworthy category tested a number of factors. The factor that was perceived as being most trustworthy was being paid on time followed by reliability, competence, collaborating effectively, not litigious, minimizing risk, similar values, caring, familiarity, similar skills, similar experience, and socializing (Figure 3). This implies that the use of information and communication technology must be perceived to increase reliability, competency, collaboration, and be supported by the timely payments between contracting parties. In terms of working with stakeholders, the survey respondents perceived

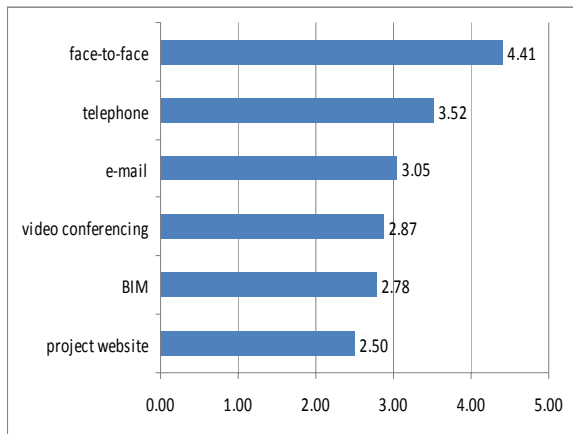


Figure 1. Communication Method

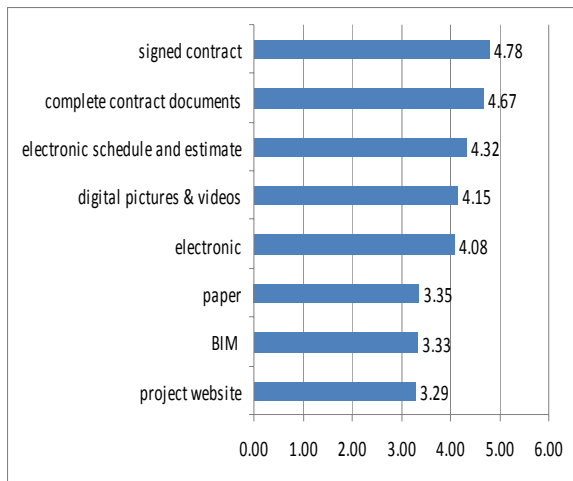


Figure 2. Document Types

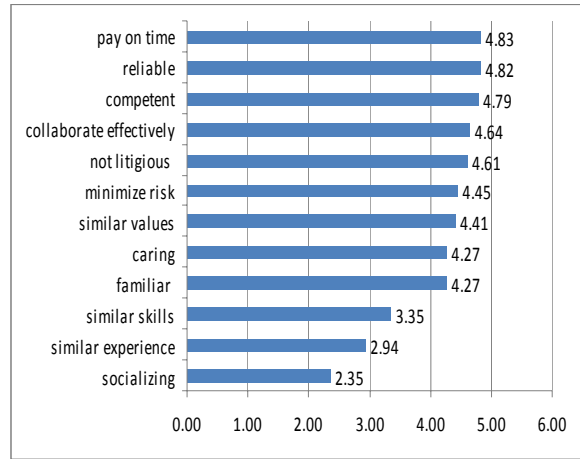


Figure 3. Trustworthiness

working with owners as most important followed by working with sub-contractors, designers, suppliers or vendors and construction managers (Figure 4). The preference of working with the owners signifies the importance of having direct access to decision makers and the low preference for working with construction managers suggests that construction professionals do not support additional measures of control. Each KPI (profit, cost, safety, productivity, quality, schedule) was ranked similarly indicating the perceived importance of each in fostering trust on construction projects (Figure 5) and the importance of information and communication technologies increasing these KPIs. It was the similar case for the rankings of contract types. Each contract type

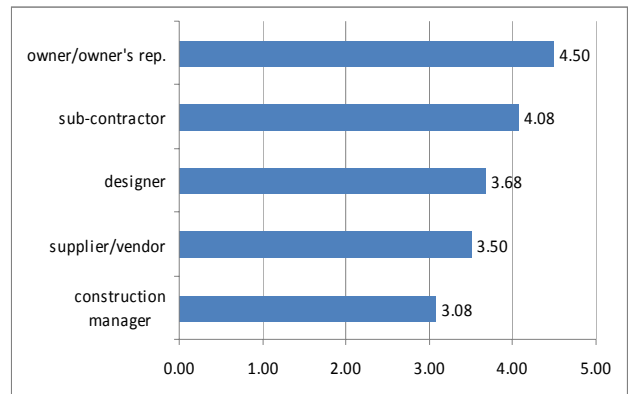


Figure 4. Stakeholders

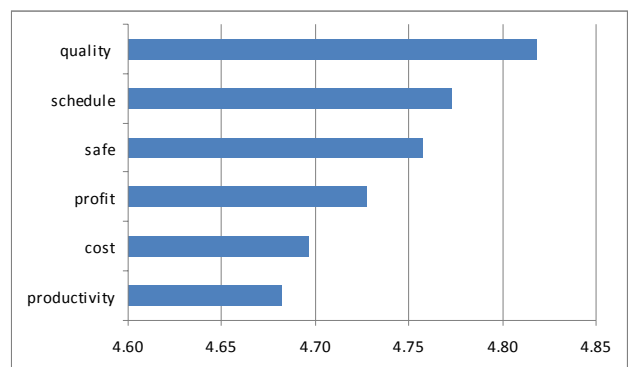


Figure 5. Key Performance Indicators

(cost-plus fixed fee, unit price, lump sum) had similar rankings revealing that trust is important on all contract types (Figure 6). In the pre-construction and design category all factors were perceived to support trust (Figure 7). Similarly, survey respondents perceived trust to be important to the negotiation process while responding timely and adequately to requests for information created trust. However, experiencing a high number of change orders and inspections by neutral third parties had a negative association with trust (Figure 8).

In the management category trust was perceived to enhance communication, team building, leadership and information sharing all factors that would improve the success of adopting and using information and communication technologies on construction projects (Figure 9).

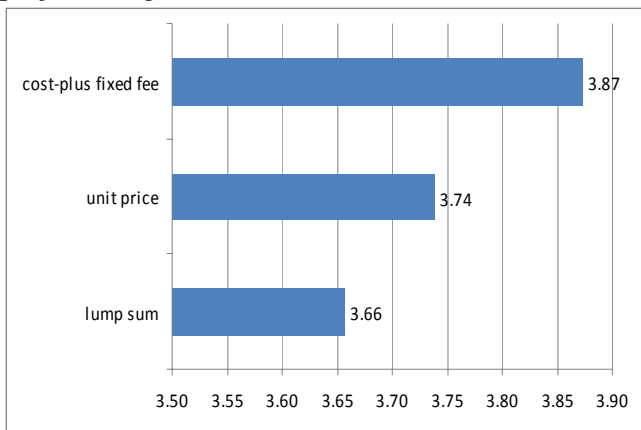


Figure 6. Contract Types

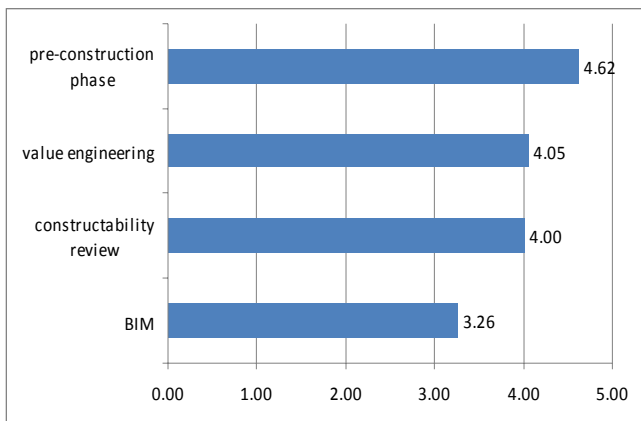


Figure 7. Pre-Construction and Design Phase

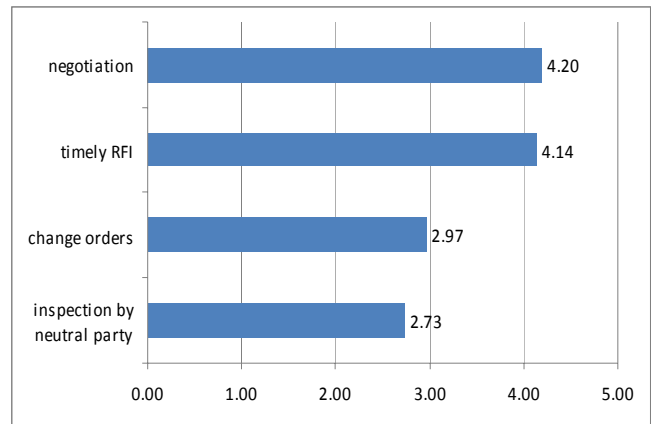


Figure 8. Construction Phase

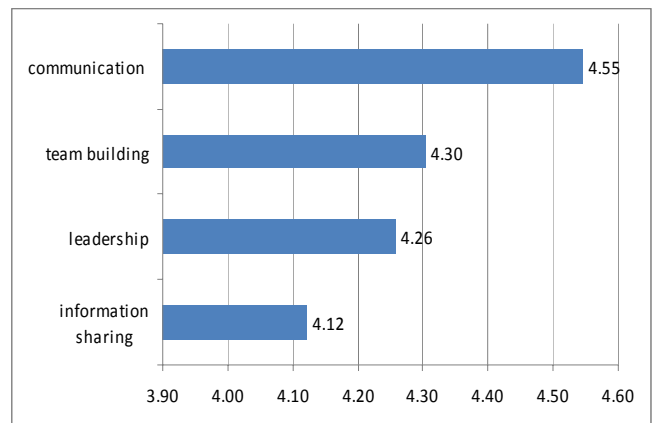


Figure 9. Management

5 CONCLUSIONS

Construction projects have many factors that influence trust between contracting parties and trust in using information and communication technologies on construction projects. A survey of construction professionals working for ENR Top 400 contractors in the U.S. revealed a number of important factors in understanding trust on construction projects. According to the perceptions communicated in the survey results, survey respondents indicated that face-to-face communication would support the successful adoption of information and communication technology on construction projects. Using advanced information and communication technologies such as BIM was perceived to challenge trust on construction projects. The over-use of e-mail could confuse communication and put additional stress on trust in using advanced technologies and between contracting parties. Any information and communication technology must be perceived as reliable, improving competency and enhancing for it to be supported. Additionally, if information and communication technologies are linked to improving any or all the KPIs (productivity, cost, schedule, profitability,

quality, safety) and/or to the support project owner, the likelihood of these technologies successful implementation increases. However, if the technology is being mandated or encouraged by a construction management company its success could be challenged. On the positive side, construction professionals participating in this survey clearly preferred electronic versions of documents. This could be interpreted as an increased inclination towards using technology on construction projects.

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