IT usage in Alberta's building construction projects: Current status and challenges

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ABSTRACT

The Construction Industry lags behind other industries in its acquisition and use of modern technology. As a result construction workers are dissatisfied with the level and availability of communication systems and channels. Construction managers are not confident to acquire modern technologies to the construction workplace, because of the unavailability of information on worker abilities, available technologies, possible outcomes, related costs and benefits and so on. Technology providers are also lagging in the understanding of the information related to construction industry specific needs. There were no direct studies noted in Canada that were focusing the construction stakeholder views — workers, managers, and technology providers — related to the information technology (IT). This paper presents the views of three different construction industry stakeholders regarding the possibilities and opportunities in using Information Technology in construction project to improve communication and worker satisfaction. The paper ends with a set of recommendations for enhancing the usage of IT tools and systems on construction projects.

1. Background

The construction industry is seen by many as backward in deploying information technology systems and tools. Application of IT has been quite piecemeal and very few contractors have a comprehensive and integrated information system for its core business [1]. Even though construction is a dynamic information dependent industry [2], it is still considered as a "computer-free" zone. Eisenblaetter [3] attributes this to the harsh construction environment which makes it difficult to employ computers. The construction industry faces many challenges in the 21st century. It will be forced to change and to incorporate new advanced technologies into the construction process to gain a new competitive edge in the market [4]. The exact position of information technology (IT) in the construction industry is uncertain. This uncertainty springs from the continually changing nature of the technology and the numerous failed attempts made by the construction industry to use that technology [5]. Despite an explosive growth in Internet use in the last decade in many areas of business and commerce, the construction industry has not kept pace to the same degree [4,6].

Hewage and Ruwanpura [7] discussed the dissatisfaction of construction workers around the issue of available communication systems and practices. A similar problem was identified by the work of previous researchers; Bowden et al. [8] and Mohamed and Stewart [9]. These researchers found that only 20% of the information passes to the operational (worker) level from the management level at a construction site. The research conducted by Hewage and Ruwanpura [7] also found 45% of interviewed construction workers, from the participating Alberta commercial construction sites, describing their frustration with inadequate communication on their construction sites. Workers identified inadequate communication as the main reason for low motivation and productivity.

In Alberta, Canada, the use of IT to overcome communication barriers on construction sites is quite limited. Two-way radios are the only observed communication device in use on construction sites during the observations conducted by researchers during the last three years. This is not adequate to solve the issues related to the adequacy of on-site communication which was a concern described by both construction managers and workers.

Reasons cited by other researchers for slow infiltration of technology into the construction industry include the open work environment, the wide variety of work scope, dust and moisture, and portability issues [10–13].

Present status of technology adoptability — takes up the ideology, practice, and method of someone's technology and uses it as one's own [14] — in the construction industry has not been comprehensively analyzed and documented by academics and the industry [15]. Decisions regarding the adoption of new technologies are made by senior management whose current knowledge of the latest technological advances and choices available tends to be limited. They may not be informed as to the advantages and disadvantages these new technologies offer to their particular area of specialization. For this reason, adoption of new technologies could take considerable time while management familiarizes themselves enough to make prudent decisions [16].

There are very few citations in the literature of "direct" research work — where the construction workers technological abilities and

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expectations, construction managers' technology implementation concerns, and technology providers' abilities and concerns have been comprehensively identified. Hence, the University of Calgary has conducted an extensive research to investigate the potential uses of information technology in construction industry by contacting all the major stakeholders; construction workers, construction managers, and technology providers. Six leading commercial construction companies and three research organizations participated in this research.

The objective of this paper is to present construction industry stakeholders' views on IT implementation and usage that were revealed during an industry investigation conducted during January 2004 to February 2007. This investigation is part of a wider research work on construction productivity that involved six construction companies and a few other organizations including National Sciences and Engineering Research Council of Canada (NSERC). The use and application of technology based communication is one of the ten strategic areas of the overall research program to improve the productivity and efficiency [17].

2. Research method

In conducting this investigation, the researchers followed two major steps:

- A comprehensive literature review was conducted to investigate the previous research and body of knowledge related to information technologies, its' applications, and implementation issues in the construction environment.
- Several rounds of workshops, interviews, observations, and questionnaire surveys were conducted with construction workers, construction managers, and technology providers. These were as follows:

  a) Workshops and questionnaire surveys with workers: Fifteen workshops were conducted with construction workers and foremen from four different construction companies. A questionnaire form was issued after an audio-visual presentation was made by the researcher which shared the initial results of the research related to productivity and worker motivation and on-site communication (Hewage and Ruwanpura, 2006a). The construction workers were encouraged to discuss the said findings with the researchers and other workshop participants before the questionnaire surveys were filled-out.

  b) Interviews with workers: Sixty one one-on-one worker interviews were conducted after the workshops and questionnaire surveys. Interviews were conducted with open-ended questions related to IT and communication on construction sites. The format was casual, to encourage workers to share their thoughts, comments, criticisms and ideas. The purpose of the interviews was to confirm the understanding of workers experience, views, concerns and expectations on IT usage.

  c) Observations of workers: On-site observations of communication and use of information technology was conducted for a period of 6 months (from March 2006 to September 2006). The objective was to understand the current communication channels in use and then identify the possible areas for IT usage. The communication process which was observed fell into three categories.
    ▪ Communication between the foremen and the workers
    ▪ Communication between the area superintendent and the foreman
    ▪ Communication between the main site office and the area superintendent.

  The information exchanges between these groups were closely observed at two construction sites during the said period. The researcher participated in daily and weekly instructions and progress meetings in these construction projects. In addition, researcher spent at least 3 days per week for the full day in construction site environment to be familiar with on-site communication process. The challenges faced by the construction workers

who were using technological devices on site (modern surveying devices and power tools) were observed. Hundreds of informal interviews were conducted during the observation time.

  d) Interviews and questionnaire surveys of construction managers: All the managers (14 managers) responsible for technology decision making with the four participating companies were interviewed. The number of interviews with each manager was dependent on the information needed. Each interview lasted about 45 min to 1 h. These interviews were conducted to assess technology adoptability issues experienced by the construction managers. Almost all the questions were open-ended and were based on the company profile. In addition, all members (>100 leading construction related companies from across North America) of the USA based construction technology organization — FIATECH (Fully Integrated and Automated Technologies) were contacted by emails and asked to complete the questionnaire survey. The contacts at FIATECH were either general contractors or construction company owners.

  e) Interviews and questionnaire surveys with technology providers: Interviews and questionnaire surveys with technology providers were conducted to assess the currently available technologies and future focus areas. The questionnaire was sent primarily through FIATECH to the technology providers by emails (>50 technology providers were contacted).

3. Research findings

The findings of this investigation are grouped to the views of the three stakeholders, namely, construction workers, construction managers and technology providers.

3.1. Construction workers' views

As mentioned, 61 construction workers from 4 construction projects were questionnaire surveyed, interviewed, and observed to derive the following conclusions of construction worker perceptions on IT regarding the following broad categories.

a) Computer usage of construction workers
b) The use of automated devices
c) The usage of information technology on construction sites
d) On-site communication in construction sites

3.1.1. Computer usage of construction workers

It was observed (and the literature review confirmed) that the modern construction industry does not encourage workers to use contemporary technologies (like computers) on site. Moreover, none of the researched companies identified computer skills as a requirement of employment for construction workers. Without this job requirement, the role of computer skills, and technology adaptability would not surface as a need of the workers.

It was concluded that workers access the Internet every time they use a computer. The average computer usage of a construction worker is 5 times (4.8) per week (with the standard deviation of 1.82, median of 5, mode of 7, maximum of 7, and minimum of 1). This is far above the expected level of computer literacy of construction workers as identified by their construction managers. Workers were using computers for two main purposes, personal and work related. Like the general population, personal reasons for using the computer are email access, banking, and entertainment. For work related use, they search for information on materials and other construction related operations. Table 1 provides the detailed computer access needs with percentages.

The questionnaire surveys also asked the workers to self-define their skill levels on computers using the same 1 to 7 Likert scale (A type of composite measure using standardized response categories in survey questionnaires). The average rating was 4.2 (with the standard deviation of 1.43, mode of 5, minimum of 1, maximum of 7, and