

ICT ADOPTION IN THE IRANIAN CONSTRUCTION INDUSTRY: BARRIERS AND OPPORTUNITIES

Ali Alaghbandrad^{1*}, Mohammad Bagher Nobakht², Mojtaba Hosseinalipour³, and Ehsan Asnaashari⁴

¹*Scientific Association of Construction Engineering and Management, Science And Research Branch, Islamic Azad University, Tehran, Iran*

²*Department of Construction Engineering And Management, Science And Research Branch, Islamic Azad University, Tehran, Iran*

³*Construction Group, Shahid Beheshti University, Tehran, Iran*

⁴*School of Architecture, Design and the Built Environment, Nottingham Trent University, Nottingham, UK*

* Corresponding author (a.alaghbandrad@srbiau.ac.ir)

ABSTRACT: In the competitive market of the construction industry, construction firms attempt to implement the projects with the least cost and time, and the highest quality. They try different ways to increase the efficiency of their projects. One of the most important factors which affects the efficiency of construction projects is Information and Communication Technology (ICT) utilization in construction. There are many software and hardware which have been developed to help planning, designing and executing of projects. Iranian construction firms also attempt to utilize ICT in their projects. However, ICT adoption in the construction industry is a complicated process and depends on many factors. The Iranian construction industry has advanced in applying ICT in projects, but there are still barriers and opportunities in this process. This paper clarifies the current problems and opportunities that the Iranian construction industry encounters in the process of ICT adoption. The research has a qualitative approach and focuses on meanings and opinions. Twelve semi-structured interviews were conducted with highly-experienced construction practitioners and software developers associated with the Iranian construction industry. Responses were qualitatively analyzed and a narrative interpretation developed. The results identified that infrastructure, cultural matters, training, regulations, user friendliness, financial issues and the lack of a common standard for ICT adoption among firms are the most important factors which should be considered to transform problems to opportunities.

Keywords: *ICT, Construction Industry, Construction Projects, Iran*

1. INTRODUCTION

Information technology is defined as a collective reference to the integration of computing technology and information processing and comprises a wide range of technical approaches to a variety of problems [6]. In construction industry, ICT can be defined as the application of decision support tools, which uses electronic machines and programs for processing, storage, analysis, control, transfer and presentation of construction information data during the whole life cycle of a construction project [6].

ICT development has influenced construction industry in the recent decades. New technologies have enabled

construction organizations to process and store their information easily and huge amount of data can be transferred quickly. A variety of technology-based approaches have been recently proposed to improve the monitoring of construction materials [7]. Heavy calculations are possible in little time and with high accuracy. Communication technology has provided fast communication tools for construction firms and the time and costs have been saved by emerging of new ICT tools. Internet acts as an important data base and communication channel. Electronic archive can decrease paper works and improve accuracy and accessibility. However construction

organizations face numerous barriers during ICT implementation in their companies. There are internal barriers and external barriers to the addition of IT to the construction industry [8]. Identification of these barriers can help the decision makers to transform problems to opportunities. In Iran, there is a deficiency of investigation in the barriers of ICT adoption in construction industry. This research clarifies the current problems and opportunities that the Iranian construction industry encounters in the process of ICT adoption.

2. LITERATURE REVIEW

Important role of ICT in construction has been emphasized by a number of researchers [1,2,4,6,7,8,9,10,12,13,14].

In Poland it was investigated that expenditure and investment in IT tools in construction sector is insufficient [10]. This research reviews the problems of usefulness of IT solutions on offer in construction sector. According to the research results, the period of prosperity for polish building companies who chose not to use IT on the regular basis is coming to an end. Polish companies generally look for such project management systems which would be integrated with financial management, human resources, stock management and machinery maintenance [10].

Results of a research revealed ICT implementation constraints in Australia [12]. According to the findings, constraints at the personal level include limited budget for ICT investment, commitment from other project participants, issues of ICT standardization, and security problems. At the organizational level, constraints include basic levels computer experience, time available to learn, and the identification of clear benefits of ICT use. Constraints at the group level include time available to share information, quality of personal contact and geographical distance [12].

In Malaysia, IT Benefits for Malaysian construction companies were categorized in a research [1]. This study categorized IT benefits in 12 clusters then came up with three main benefits as a result of the questionnaire survey. Briefly, the clusters of benefits are Client Satisfaction, Cost Reduction, Improving Management, Competitiveness Advantages, Improving Business Success Criteria (i.e. efficiency, effectiveness and performance), Increasing

Response Rate, Increasing Work Flexibility, Increasing Market Share, Improving Information Quality, Improving Organizational Growth, Improving Work Relations, and Reducing Working Time. The researchers of this study, believe that based on previous studies, IT problems of Malaysian construction industry are as following: insufficient bandwidth, lack of training, unavailability of expert users in construction companies in Malaysia. Furthermore, the existing infrastructure of IT is deficient and the number of trained workers is inadequate. Additionally, the full potential of the internet has not been utilized by Malaysian construction companies; however, 50% of them make a decision to implement IT without a feasibility study [1].

In Alberta, Canada, barriers to implement information technologies in construction were investigated in a research [8]. It was revealed that construction managers are concerned about their workers' skills level, if IT becomes a part of the work place. Managers indicated that they have experienced resistance from 'older' workers whenever a modern technology has been implemented. Also, Technology providers' concerns include: Lack of industry-wide standards, Lack of manager interest on IT, Lack of funding and people for new innovations, Unclear needs, Human issues [8].

A study in India showed that IT infrastructure at project sites and IT capability of site staff are important factors and need improvement in Indian construction industry [2]. Also connectivity through internet is poor in remote project sites and down time is very high. Training and education of construction students and executive is important. Hard copy storage of data and documents in organizations is substantial even if electronic copies are also kept as a back up. It was found that personal meetings are still preferred by construction professionals over teleconferences and other e-meeting solutions for managing building construction projects [2].

A survey was conducted by the ASCE Wireless Construction Committee to better understand how much construction contractors have advanced in adopting information technologies in general and wireless communications in particular [14]. Responses were

collected from 152 U.S. and 31 Korean firms. It was found that, overall, the strongest interest among the responding contractors is in document and content management applications. The data indicate that the use of information technology by contractors is generally higher in Korea than in the United States. The most important barrier to the use of Web-Based IT is the reluctance by project participants to share data and information in US. Additional important barriers are needed training and high cost and little return on investment. In Korea, lack of data security and virus threats and risk of system failure and data loss are significant barriers to the use of Web-Based IT [14].

A survey was conducted in Turkey to investigate the strategic role of ICT implementations from an industrial perspective, and explore if organizations within the architecture-engineering-construction (AEC) industry view ICT as a strategic resource for their business practice [9]. This research also investigates the 'perspective of academia' in terms of future research directions of Construction Informatics. Also, the greatest barriers related to successfully implementing and managing ICT were identified as, inefficient use of software, ill-defined processes and infrastructure related problems [9].

According to findings of a research, most of Iranian contractors believe that little actions have been done in field of information technology in Iranian construction industry [13].

In Iran, results of a study indicated that remote access to the information, integration of information systems in companies, and linking headquarters and sites are at the focal points of ICT development for construction industry [4]. Working in the wireless environment and audio/visual communication with site staffs are other ICT facilities that respondents expected to have them in near future [4].

3. RESEARCH METHODOLOGY

This research benefits from qualitative method to identify the current barriers and opportunities of ICT adoption in the Iranian construction industry. Qualitative strategy helps the research to be focused on personal histories, perspectives, and experts' experiences of construction industry [3]. The result would be notable and explanatory in nature and describes the current barriers and

opportunities of Iranian construction industry in ICT adaptation.

At the first stage of this research, previous efforts in this area in different countries were reviewed. Then a set of semi-structured interviews was carried out to collect valuable data for this research.

Selected sampling is the most appropriate sampling method for qualitative interviewing [11]. Therefore, owing to qualitative nature of the study, a small, but focused and carefully selected sample is chosen to be interviewed.

To achieve reliable data, interviewees were selected carefully among construction practitioners who have four specifications:

- a) to have work experience as a senior manager in a construction company,
- b) to have ten or more years of experience in construction,
- c) to be completely familiar with the culture and environment of construction industry in Iran,
- and d) to apply a minimum level of ICT in their organizations (to have personal computer, CAD/CAM software, Microsoft Office, and access to internet).

Ten interviews with the highly-experienced Iranian construction practitioners with above characteristics were conducted. In addition, to understand the role of software developers, two interviews were carried out with the senior managers of two local construction software developers. The selection of these two was based on recommendation of seven interviewees as they expressed that they use software supplied by one of these two developers in their companies.

During the interviews, respondents were asked to explain about using ICT in their firms and their plans for the future. They mentioned the values that ICT brought for their organizations and expressed examples of ICT tools which are used in their companies. Barriers and problems of ICT adoption in their organizations were asked in questions. In addition, owing to nature of semi-structured interviews, new questions were brought up during interview sessions. However, the interviews were based on the following main questions:

1. How do you appraise status of ICT in your company?

2. What are barriers and problems of using ICT in your company?
3. What are advantages and disadvantages of using ICT in your firm?
4. Can you describe an example of ICT application in your company? What benefits and values has it brought for your organization?
5. Do you prefer to store the information electronically or by paper in your company?
6. Do you educate your personnel in ICT field?
7. Do you have ICT department? What are its duties?
8. What are barriers and problems of using ICT in construction sites?
9. What are risks of using ICT in your firm?
10. How do you accustom your personnel with ICT?
11. What is your future ideal for your company in ICT?

Interviewing had been continued up to the point that desired level of data saturation was achieved. That was the point that the interviewer understood responses are being repeated by new interviewees and critical and sensitive information could not be received from them anymore.

By achieving valuable data, analysis stage starts by coding. The qualitative data are categorized and described by coding. In fact, codes are devices to label, separate, compile and organize data [5]. A comprehensive interpretation was developed to reveal the hidden barriers and opportunities of ICT utilization in construction projects. Wherever it was suitable, the participants' direct quotes are cited anonymously to make the interpretation more meaningful.

It should be explained that the result of this study is restricted to the participants' experiences and their viewpoints cannot be generalized in wider contexts. Furthermore, the result may not be the whole reality as in social studies like this there may be multiple realities.

4. QUALITATIVE DATA ANALYSIS

After twelve semi-structured interviews, the collected data was qualitatively analyzed. Based on the analysis results, seven factors were identified which should be considered to transform problems to opportunities. These factors include: (1) infrastructure, (2) cultural matters, (3) training, (4) regulations, (5) user friendliness, (6) financial issues,

and (7) the lack of a common standard for ICT adoption among firms.

4.1 Infrastructure

Based on obtained data from interviews, the respondents believe that ICT infrastructure needs to be improved in Iran. High speed internet and access to internet in remote construction sites were the most important concerns of interviewees. They believe that without high speed internet, some communication tools like video conference or IP camera can not be exploited effectively.

Most of respondents from large construction firms which were in high level of ICT utilization, believe that the ideal level of ICT utilization will not be achieved unless the infrastructure be improved.

4.2 Cultural matters

Some people have been adapted with paper based systems in their work over the years. It's not easy to accustom these practitioners with ICT systems and convince them to trust and use new ICT tools. Security of information in ICT tools, Strong back up system to avoid data loss, are the main issues which construction professionals worry about them in Iran. Some times construction practitioners resist against automation systems, because they think that these systems will make them unemployed. One of the respondents believes that the best way to accustom construction practitioners with ICT is that they experience ICT benefits themselves. Some respondents stated that they are worried about the design programs' outputs when inexperienced engineers work with them because they only rely on a computer output without any engineering judge and this issue may cause problem during the construction.

4.3 Training

Sometimes, the clients educate the personnel of contractor, especially when the client is a huge organization and works with numerous construction firms. There are also ICT educational institutions in civil engineering field in Iran. Small and medium size firms usually prefer to send their personnel to educational courses out of the firm, but large construction firms usually educate their personnel in the firm. Based on the experience of an interviewee, training outside the construction company is not as efficient as inside classes. The personnel sometimes attend outside

classes to be promoted in their salary and the lessons may not be very useful in their job, but inside classes are more useful, because the course content is tailored for that specific company.

In addition, during the interviews it was revealed that some leading construction firms in ICT consider ICT skills as requirement for applicants of job in their companies in Iran. This issue can encourage the job applicant to learn ICT skills before employment.

4.4 Regulations

During the interviews, it was understood that some regulations should be revised to facilitate ICT development in construction. One of the interviewees said “the current regulations of construction projects should be revised, because these regulations have been formed in a world without IT”. For example, according to the current regulations, electronic signature is not acceptable in lots of official documents in Iran or the official financial documents should be paper based and this issue increases paper works.

4.5 User friendliness

Based on the collected data from the interviews, one of the mentioned barriers of ICT adoption in the Iranian construction industry is lack of interest to use ICT among some construction practitioners, especially elderly or middle aged ones because some times they can not learn these technologies easily. However, this problem can be mitigated by making user friendly ICT tools. One of the local ICT developers said that their design software’s graphical environment is similar to other recognized programs in this field and the users can easily learn how to use this program because of their previous experience in use of similar environments. Also high support from ICT developers for their users can encourage them to use new technology. In the interviews, ICT developers said that if their customers encounter a problem in using the software and call them, they will help them and if needed, they will amend the software.

4.6 Financial issues

Sometimes the construction firms are not assured of funding of their projects. As a result, they can not invest in ICT systems development and skilled personnel in ICT in

their organization. Two respondents mentioned “financial stability” as a vital factor for ICT development in their company. This problem has been observed more in small and medium size construction firms in Iran.

4.7 Lack of a common standard for ICT adoption among firms

In the analysis stage, it was revealed that to develop ICT in construction, the whole of construction industry should be considered as a unit. ICT development in each construction firm can be a positive move to advance, but the ICT won’t be adopted in construction industry completely unless a common standard be defined among construction organizations. This standard should cover both software and hardware. One of the respondents believes that to develop ICT in construction, all organizations which are involved in a construction project should be equipped with ICT tools, otherwise if some of them be equipped, they can not be connected to each other and their ICT facilities will stay useless.

5. DISCUSSION

Based on the interviewees’ opinions, the government should invest more on ICT infrastructure and improve the internet speed and internet access nationwide. Personnel training should be more targeted and tailored for specific needs of them. ICT skills should be considered as requirement for job applicant in construction industry to encourage them for learning. Data security and back up systems should be improved to mitigate construction practitioners concerns and beside this, they should be aware of ICT benefits more. Highly experienced designers should supervise the design programs’ outputs to make these results more reliable for construction. Some regulations should be revised to facilitate ICT development in construction and should be adapted with ICT world. Paper based systems should be eliminated to the possible extent. ICT developers should make their products user friendly and improve their support systems to encourage construction firms use ICT. Financial issue is a vital factor for construction firms to invest in ICT tools and education. Extra financial support from client or government can encourage them to improve their ICT capabilities. A common standard and policy should be developed among

construction organizations to address ICT needs of construction industry and make an integrated ICT environment among all organizations which are involved in construction industry.

6. CONCLUSIONS

This paper presents the results of a qualitative study on the current problems and opportunities of ICT adoption in the Iranian construction industry. The purpose of this research is to clarify the barriers and opportunities of ICT adoption in the Iranian construction industry. Iranian construction organizations encounter various barriers and problems in the process of ICT adoption. Based on the data collected, these issues can be categorized into seven groups: infrastructure, cultural matters, training, regulations, user friendliness, financial issues and the lack of a common standard for ICT adoption among firms. Future efforts to develop ICT in Iranian construction industry should be focused on improving ICT infrastructure and internet quality and access, targeted training, data security and back up systems, regulation revision, user friendly programs with high support of ICT developers, financial support of construction firms to develop ICT in their organization, developing a common standard among construction firms to develop ICT.

REFERENCES

- [1] Abdul Kareem, H. I. and Abu Bakar A. H., "Identifying IT Benefits for Malaysian construction companies", *Journal of Information Technology in Construction (ITcon)*, Vol. 16, pg.477-492, 2011. Available at: <http://www.itcon.org/2011/28>
- [2] Ahuja V., Yang J. and Shankar R. "Study of ICT adoption for building project management in the Indian construction industry", *Automation in Construction*, 18, 415-23, 2009.
- [3] Bryman, A. and Bell, E. "Business Research Methods", Oxford: Oxford University Press, 2003.
- [4] Alaghbandrad, A., Asnaashari, E., Knight A., Hurst, A., "ICT Utilization in the Administrative Tasks in Iranian Construction Organizations", *Procs of 26th Annual ARCOM conference*, pg. 615-624, UK, 2010.
- [5] Charmez, K. "The grounded theory method: an explication and interpretation", In: *R M Emerson (ed.)*, *Contemporary Field Research: A Collection of Readings*. Boston: Little Brown, 1983.
- [6] El-Ghandour, W., and Al-Hussein, M., "Survey of information technology applications in construction", *Construction Innovation*, 3, 83-98, 2004.
- [7] Grau, D., Caldas, C. H., Haas, C. T., Goodrum, P. M. and Gong, J., "Impact of Fast Automated Tracking of Construction Components on Labor Productivity", *Procs 26th International Symposium on Automation and Robotics in Construction (ISARC)*, 2009.
- [8] Hewage, K. N., Ruwanpura J. Y. and Jergeas G. F., "IT usage in Alberta's building construction projects: current status and challenges", *Automation in Construction*, 17, 940-7, 2008.
- [9] Isikdag, U., Underwood, J., Kuruoglu, M., Goulding, J., Acikalin, U., "Construction informatics in Turkey: strategic role of ICT and future research directions", *Journal of Information Technology in Construction (ITcon)*, Vol. 14, Special Issue Next Generation Construction IT: Technology Foresight, Future Studies, Roadmapping, and Scenario Planning, pg. 412-428, 2009. <http://www.itcon.org/2009/27>
- [10] Kaplinski, O. "IT Application in Polish Construction Sector", *Procs 25th International Symposium on Automation and Robotics in Construction (ISARC)*, 2008.
- [11] Naoum, S. G. "Dissertation research and writing for construction students", 2nd ed., UK: Elsevier, 2007.
- [12] Peansupap, V. And Walker D. H. T. "Information Communication Technology (ICT) Implementation Constraints: A Construction Industry Perspective", *Engineering, Construction and Architectural Management*, Vol. 13 No. 4, pp. 364-379, 2006.
- [13] Rajaei, H., Movadi, F. and Tahami, S. A., "A system for recording, processing and managing information in construction projects", *Procs 1st Construction engineering and management conference*, 2009, Tehran, Iran. [in Farsi]
- [14] Williams, T., Bernold, L. and Lu, H. "Adoption patterns of advanced information technologies in the construction industries of the United States and Korea", *Journal of Construction Engineering and Management*, Vol. 133, No. 10, 780-790, 2007.