J. Basic. Appl. Sci. Res., 4(5)29-35, 2014
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ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Adoption to Online Collaboration in the Construction Sites of Developing Countries

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Received: February 3 2014
Accepted: April 10 2014

ABSTRACT

Collaborative working is one of key success factors in construction industry as it is fragmented and multidisciplinary in nature. Online collaboration was introduced to the construction industry to provide a platform for project stakeholders to collaborate by exchanging information and documents smoothly within one repository system. A large number of merits were brought by using online collaboration like faster communication, less disputes and higher quality of project management. However, the level of adopting online collaboration among developing countries' construction sector is not satisfactory. Therefore, this study was designed to identify those of factors hindering the adoption of online collaboration in the developing countries construction industry as well as proposing actions to improve the adoption level. Literature survey was conducted to gain sound knowledge on the research area and develop a comprehensive questionnaire form. Then, questionnaire forms distributed among experts to collect the primary data for this study. Findings and results show that online collaboration is very uncommon. It was also found that the major factors hindering its adoption in the construction industry are "Lack of awareness", "Unavailability in local market" and "Weak IT infrastructure". Furthermore, few solutions were determined to improve using online collaboration medium.

KEYWORDS: Developing countries; online collaboration; Collaboration technologies; Construction Industry.

1. INTRODUCTION

Construction industry is one of the top industries in terms of growth and job demand. The increasing demand for construction makes pressure on the construction industry to respond promptly which requires an efficient manner to conduct the construction. Construction projects are executed by several teams: from the design team up to the maintenance and utilization teams. Construction team is responsible for converting what is stated in the design documents into a physical tangible construction. The construction team consists of several individuals coming from different disciplines and different organizations. They include owner, main contractor, consultant, subcontractor and suppliers. In complex project like infrastructures, number of the individuals and sub-teams involved is enormously high and managing the communication and collaboration among them requires a great deal of effort. Furthermore, these individuals of the sub-teams could be located in different places and sometime in different countries [1-3].

The construction industry is heavily depending on timely transfer of information among the parties involved in the construction project [1, 4]. Ineffective communication process along with fragmentations of the industry lead to poor performance and failure of construction projects. Therefore collaboration technologies have been introduced to the industry to support the information flow between project parties and overcome the fragmentation problem [1]. After the invention of World Wide Web, FTP and email were introduced as collaboration technologies to link project teams. They allowed project teams to exchange information and enhanced the collaboration among them. Nonetheless, FTP & email has several Limitations to create a collaborative working environment [5].

Due to the complexity of project information exchange and demands for real-time data exchange, online collaboration was introduced to the construction industry. It allowed project participants to have synchronized considerations in editing drawings and documents. As a result, the waiting time for the other teams to see the changes is zero. Approvals and comments can be made easily and quickly without any further delays. In addition, all information is kept in one repository system and can be accessed through internet from anywhere by authorized team members[5, 6].

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The adoption of collaboration technology has enhanced the efficiency in communication, reduced the effect of fragmentation and proved smooth and timely exchange of information in the construction industry[2, 7, 8]. However, adoption level in the developing countries to such technologies is still in very low levels [2, 9, 10].

The main aim of this study is to improve the adoption level to online collaboration technologies in the developing countries construction industry. Therefore, first, this study will investigate the current practice among the industry. Second, those of factors which hinders the adoption of online collaboration within the construction sector will be identified, and finally; the right actions for enhancing this type collaboration platform will be recognized.

This study is targeting Iranian and Yemeni engineers, as representatives of developing countries, involved in the construction sites for the purpose of data collection.

2. LITERATURE SURVEY

Wilkinson(2008) defines collaboration as a creative process undertaken by two or more interested individuals, sharing their collective skills, expertise, understanding and knowledge (information) in an atmosphere of openness, honesty, trust and mutual respect, to jointly deliver the best solution that meets their common goals[5]. As the definition suggests, successful collaboration is a process of value creation that cannot be achieve through traditional, often hierarchal structure. However, the vital communication takes place, whether face-to-face or virtual- it tends to require the giving and receiving of feedback in an atmosphere of mutual trust and respect between all the interested participants, each specialist in their own fields. This feedback will often results in reassessment of an initial idea, and as the collaborators develop a shared sense of what they are trying to achieve, the outputs can be greater than the sum of all individuals' expertise and knowledge inputs[5].

Information and Communication Technology (ICT) is defined as technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and Fax, satellite systems other communication mediums as well as the various services and applications associated with them, such as videoconferencing [11].

Online Collaboration Platforms in the context of construction are defined as: a combination of technologies that together create a single shared interface between multiple interested individuals, enabling them to participate in the collaboration process, while simultaneously creating an auditable electronic record of the people, processes and information employed in delivery of the solution[5].

Construction is a multi-organization process with heavy dependence on exchange of large complex data and information. The successful completion of a project depends on the accuracy and timing of information exchange within the construction consortium[12, 13].

In addition, the construction industry is highly fragmented. It is fragmented due to the uniqueness of its production processes and the products themselves. It is worth noting that the fragmented nature of the construction industry limits the scope of collaboration among the various participants in constriction project. The adoption of online collaboration technology is premised to increase collaboration in construction projects by facilitating new ways of communication[12]. IT infrastructures at construction sites are important enablers for adopting to an effective online collaboration [6].

Construction project management requires effective coordination and collaboration between multiple project members. It can be achieved through real time communication flow between all. The Online Collaboration Platforms are introduced to serve this purpose[6]. Two third of the construction problems were caused by inadequate coordination and inefficient means of communication or project information and data. To this end, online collaboration platforms for construction necessitates efficient management of information in terms of structure and use [4].Lack of consideration of human factors was a barrier to collaboration and to the use of collaborative technologies[14]. The highest ranked barrier to online collaboration platforms adoption within the construction industry is 'initial cost and cost of updating IT infrastructure'[9].The lack of training is another considerable barrier to the adoption of online collaboration among users with limited computer skills and the consequences included a sub-optimal utilization of the available technology as well as users' dissatisfaction[15].

Limited number of research have been conducted for the adoption of collaboration technologies other than the ones initiated by private sectors, i.e. service providers on the adoption of new tools and technique in the construction industry[2].Despite the technological advancement in hardware and software in online collaboration technology, it has been observed from real life examples and contemporary literature that the human affinity in its use has not forged ahead at the same pace[16]. Construction practitioners are not confident with the benefits brought forward by the collaboration systems with all the barrier and obstacles in mind. Further measurement and research on the factors hindering its adoption and on its benefits, particularly on the counterbalance on the cost and time saving against the

cost of investing in the technology is suggested[2, 17, 18].The rate of adopting online collaboration in the construction industry has been less than in many other industries. Adoption may be hindered completely or just delayed by various barriers, as the effects of the barriers wear off over time[10, 17].

3. DATA COLLECTION

For the purpose of data collection, questionnaire approach was selected. Questionnaire form was developed based on previous literature and distributed online by means of emails. The respondents were in the selected developing countries (Iran and Yemen). Targeted sample for the study was concentrated on the professionals working in the construction industry like: Project managers, Project engineers, and Site engineers. In order to generalize the results, it is necessary to select a sample that has adequate years of experience in the construction phase. Thus, respondents were selected on the basis of their experience of working in the construction sites and minimum experience of five years is acceptable, as the respondent with less experience do not have enough projects experience to respond the questionnaires and also can make data unreliable. The responses were received from the metropolitan cities across the chosen countries like Tehran, Sanaa, Al Hudaydah, Tabriz, Mashhad and also from medium size towns/cities. Thus the regional bias within these countries was also minimized.

In the questionnaire the emphasis was given to have minimum number of questions so that the time taken to respond also will be less and it also fulfills the purpose of data collection according to the objectives of the study. It consists of four sections containing total 29 numbers of questions. Section one contain four questions designed to obtain general information about respondents. Section two to four consists of twenty five questions aims to obtain agreement of respondents on the current practice of collaboration, hindering factors of online collaboration and those of the potential actions and initiatives which can improve the online collaboration platform.

In section one respondent other than their names and company names were requested to choose a relevant answer from multiple choices. Questions in section one assesses:

- Education field of the respondent; and
- Years of experience in the construction sites.

For section two to four of the questionnaire Likert scaling method is used to collect data from respondents. Likert scaling method uses a multiple choice inquiry system of questions where the answers are given the choices from negative to positive views[19]. Respondents are requested to answer constructs which are not directly measurable; therefore multiple-item scales and Relative Importance Index (RII) are used to quantify the interested construct (table 1). Furthermore, the questions for questionnaire were derived from the studied literature and nine interviews which were done with experts and professionals who had extensive collaboration in construction projects. Five people were interviewed individually and for the rest, a small group or committee interview was held.

Table 1: Assessing criteria according to mean index

1	**Not Significant**	**1.00 ≤ Average Index < 1.50**
2	Slightly Significant	1.50 ≤ Average Index < 2.50
3	Moderately Significant	2.50 ≤ Average Index < 3.50
4	Very Significant	3.50 ≤ Average Index < 4.50
5	Extremely Significant	4.50 ≤ Average Index ≤ 5.00

Total 113 questionnaires were sent to the targeted group by means of email.46 questionnaires were returned with 40.7% response rate. Seven respondents which had less than 5 years of experience were rejected and only 39 respondents were selected, with final response rate of 34.51%. For postal surveys in the construction industry, 30%–40% response rate is considered satisfactory[20].

Among the respondents there were 29 civil/structure engineers accounting for 74.35% of respondents and architect were 10 (25.65%) (Figure 1). 20 (51.28%) of the respondents have experience between five to ten years. 14 respondents with ten to fifteen years of experience account for 35.9%; 5 (12.8%) respondents have experience more than 15 years, which indicates that the data of this research has been collected from respondents with adequate experience of construction site (Figure 2).

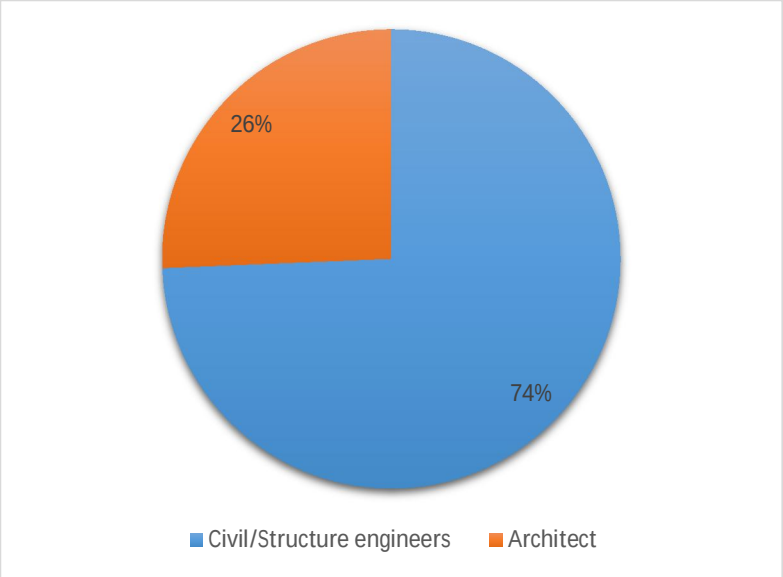

Fig. 1. Distribution of the respondents' profession

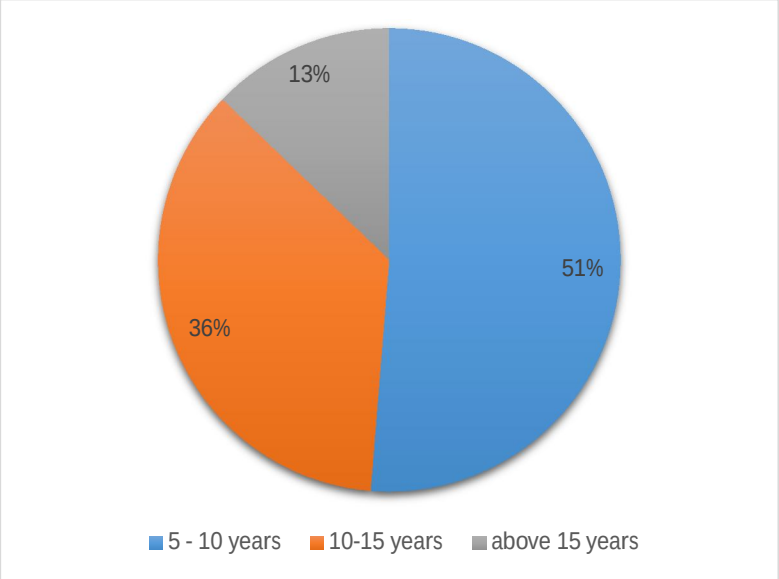

Fig. 2. Distribution of the respondents' years of experience

4. ANALYSIS

The reliability of data was determined by calculating Cronbach's alpha (α). Cronbach's alpha (α) is a test which estimates the internal consistency of the variables through a single test administration. Cronbach's alpha is the mean value of all reliability coefficients that may be achieved for all potential combinations of items when split into two half tests[21]. For data collected coefficient value (α) of 0.773 was derived, which is considered acceptable. The data is considered reliable and can be further analyzed. Furthermore, Relative Importance Index [22] is adopted to evaluate the ranking of different factors by the respondents. The higher index value denotes higher importance with maximum index value for any factor not more than 1.

Table 2 is showing the level of frequency in using collaboration technologies in the construction industry. Phone calls are the fastest way of communicating and exchanging information. It was determined that respondents are using phone calls most frequently in their collaboration process. Email is an efficient way of communication and

exchanging information in documents. Email was ranked as the second frequently used with RII of 0.697. Then come the Fax, SMS and File Transfer Protocol (FTP) as the top frequently used tools for project collaboration.

Table 2: Technologies used for collaboration among project stakeholders

	How frequent the following collaboration technologies being used	Mean	RII	Rank
1	Email	3.48	0.697	2
2	Fax	2.71	0.542	4
3	File Transfer Protocol (FTP)	2.03	0.406	5
4	Phone Calls	4.52	0.903	1
5	SMS	3.03	0.606	3
6	Teleconference	1.77	0.355	6
7	Online Collaboration	1.26	0.252	7

Table 3 illustrate those of factors hindering the adoption of online collaboration platforms. The 5 factors hindering the adoption of online collaboration platforms obtained highest score are lack of awareness of its advantages (RII=0.742), unavailability in the local market (RII=0.742), weak IT infrastructure (internet and maintenance) (RII=0.710), lack of training (RII=0.697), and language of the technology (RII=0.568).

Table 3: Factors hindering the adoption of online collaboration platform

	Factors hindering the adoption of online collaboration platforms (technology)	Mean	RII	Rank
1	High cost of the technology	2.71	0.542	2
2	Lack of awareness of its advantages	3.71	0.742	2
3	Unavailability in the local market	3.71	0.742	2
4	Lack of training	3.77	0.755	1
5	Language of the technology	2.84	0.568	6
6	Weak IT infrastructure (Internet and maintenance)	3.55	0.710	5
7	It is only for big scale projects	2.19	0.439	7
8	The perception that it is not a necessary tool	1.81	0.361	8

From Table 4, all proposed actions and initiatives have relative importance index of more than 0.700 signifying the respondents have placed high importance on the proposed suggestions to improve the adoption of online collaboration technology in the construction industry.

Table 4: Potential initiatives and actions to improve the adoption of online collaboration technology

	Initiatives for adoption improvement	Mean	RII	Rank
1	Inclusion of a clause in the form of contract to enforce the adoption of online collaboration	3.77	0.755	6
2	Government should take the initiative to start adopting Online collaboration	3.97	0.794	3
3	Main contractor should take the initiative to start adopting Online collaboration	3.71	0.742	7
4	Client should take the initiative to start adopting Online collaboration	3.65	0.729	9
5	Coordinate and redirect research and development (R&D) efforts	3.87	0.774	5
6	Simplification of the current Online collaboration technologies and devices for the use of construction industry	3.94	0.787	4
7	Technology providers should take the initiative to promote for online collaboration solve the issue of high cost and language	4.00	0.800	2
8	Evaluating the current online collaboration level within the companies and consulting with them about the ways to improve it	3.58	0.716	10
9	Provision of user-friendly and secured networks for the purpose of data exchange	4.07	0.817	1
10	Educating the upcoming construction students	3.67	0.735	8

5. RESULTS AND CONCLUSION

This study mainly developed to find the adoption level of the developing countries to online collaboration among their construction sites. Therefore, first focus was on the collaboration platforms which are widely used. It is found that “phone calls” are the most commonly used technology for the collaboration purpose. This result can be attributed to the fastest way of data or information exchange phone calls can make. In addition, its shows that informal ways of communication are still very common as collaboration practices among construction projects. However, using of online collaboration have the lowest rank among the other collaboration mediums.

The analysis of results indicate that the most important factor with highest relative index hindering the adoption of online collaboration platforms is lack of awareness which reflect the low level of adoption to the technology. Besides, it makes us understand that the Universities and other educational institutions are not playing properly their role regarding to this issue. Unavailability in the local market is found as the second important factor contributing to the low adoption level. When construction organization don't find a local provider supplying recent trends of technology with compatible applications, it makes them reluctant toward this matter. The third most important factor hindering the adoption of online collaboration technology is weak IT infrastructures due to slow internet speed and other IT issues. Internet connection within these countries is considerably slower compared to the developed countries and this issue substantially demerits the motivation of any company to adopt any new technology empowered by internet. In addition, it demotivates technology providers to invest with such technology in the developing countries construction industry. One of the most important factor which was ranked as the fourth important factor is lack of training. Lack of institution offering training for the online collaboration technologies is a main hindrance factor to its adoption.

Furthermore, it is determined that the construction industry of the developing countries need to make commitment for taking the initiatives that would improve the adoption to online collaboration technologies. Many initiatives has to be taken from government, IT companies, clients, contractors and universities including:

- Inclusion of a clause in the form of contract to enforce the adoption of online collaboration;
- Government should take the initiative to start adopting online collaboration;
- Main contractor should take the initiative to start adopting online collaboration;
- Client should take the initiative to start adopting online collaboration;
- Coordinate and redirect research and development (R&D) efforts;
- Simplification of the current online collaboration technologies and devices for the use of construction industry;
- Technology providers should take the initiative to promote for online collaboration solve the issue of high cost and language;
- Evaluating the current online collaboration level within the companies and consulting with them about the ways to improve it; and
- Provision of user-friendly and secured networks for the purpose of data exchange and educating the upcoming construction students.

The results of this study can improve the awareness of construction stockholders of developing countries regarding to the online collaboration and it obstacles. Also, the suggested solutions would enhance the online collaboration level.

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