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## A LITERATURE STUDY OF ICT USAGE IN CONSTRUCTION PROJECT

Mohd Farhan Mohd Mukelas<sup>a</sup> and Emma Marinie Ahmad Zawawi<sup>b</sup>

Universiti Teknologi MARA (Shah Alam), Malaysia

<sup>a</sup>mfarhanfarhana@yahoo.com, <sup>b</sup>emmarinie@yahoo.com

### Abstract

*This paper presents literature of ICT usage in construction project. The objective of this study are to identify the type of ICT can be used in construction industry, to identify the ICT implementation constrains and benefits against construction, and to analyze the training of ICT program. The study revealed that there were 17 types of ICT application identified which could be used during construction process, for example e-tendering system used for contractor to find open tender electronically. In addition, 3 ICT training characteristic were found: There are Training company support, ICT training mode preferences, and ICT competences expectation. Eventually 15 benefits were found by adopting ICT in construction projects. One example is ICT application lead to time saving. Meanwhile only 7 weaknesses were identified: one of them is ICT software is costly. This research also aims to produce framework of ICT development plan by conducting a survey among Malaysian construction organization in order to seek for actual ICT status and their plan for improvement.*

**Keywords:** ICT, Construction Project, E-Tendering, Software and Hardware.

### 1. Introduction

This research presents a synthesis of various studies on ICT application in construction field. The aim of this research is to understand the trend and issues on the evaluation of current ICT usage in construction field. Each phase in construction process requires effective communication of underlying knowledge and coordination. Peansupap (2005). Effective communication is important to monitor and control projects activities according to the project plans and for achieving project goals. Ahuja (2009). Therefore, in this present scenario, it can be achieved through adoption of information and communication technology (ICT) Ahuja (2009). ICT usage refers to the usage of information and communication technology, both in the form of computer-mediated networks and normal usage of computers by firms in facilitating business processes ABAS (2005).

### 2. Literature Review

ICT can be used in construction through many ways. Normally, the usage of ICT in construction can be benefited to construction industry through its application during the whole building construction process. The building construction process can be highlighted by Peansupap (2005) when the most construction projects involve many phases such as feasibility, design, construction and maintenance. However, basically contractor may only involve in the construction phase and thus the research focus and limit to cover the ICT usage in construction phase. This is because, the whole physical construction activities are held during this stages and therefore mass communication between contractors and others construction stakeholder occur. For example, the internet is widely used for electronic mail (e-mail) and electronic commerce (e-commerce) including electronic invoicing, payments and receipt of materials process. Kamarani (2002).

Global economic competition trend has also become apparent in construction industry, with client expecting a better service and project that meet their requirements more closely. Sarah (2006). Plus with our bad reputation of construction industry delivery and this approved by Kamarani (2002) the Malaysian construction industry faces serious problems such low productivity, heavy reliance on a large pool of unskilled and foreign labor and labor intensive construction techniques. This has challenged our industry to become more competitive in local and abroad marketplace and this can be achieved through the adoption of ICT into their projects. Better project delivery through

various benefits gain affects from the adoption of ICT in construction. For example the construction information has greatly benefited from advances in ICT through increasing the speed of information flow, enhancing the efficiency and effectiveness of information communication and reducing the cost of information transfer Chen (2011). With this clear problem appear in our construction environment, therefore it is crucial for our contractors to innovate their construction activities.

There were many ICT application available nowadays through continual research and development made that contribute to invention of newly ICT application for construction uses. The continuing development of affordable mobile technologies such as a handheld computers, Smart phones and Tablets PCs alongside the latest generation communication infrastructure (3G, WLAN, and GPRS) could provide the “last mile” connection to the point of activity. Sarah (2006). Therefore, it is essential to keep doing research and development in order to keep reveal the widest area of ICT application for construction uses especially on the preparation of guideline for contractors to invest ICT into their project.

### 3. Methodology

Literature was selected based on different issues of ICT application and implementation in construction field including the benefits, weakness, usage and training trend against ICT implementation in construction field. Computerized searches were conducted using online databases from Science Direct, Scopus, Emerald, and American Society of Civil Engineer (ASCE). Combination of the following keywords were used to guide the search: ICT usage in construction field, Challenges and constraint of ICT usage in construction industry, benefits and weaknesses of ICT usage in construction field, and Training trend against ICT application against construction company.

This paper was drawn from theoretical, review, and empirical studies, both quantitative and qualitative. Literature was chosen to illustrate the bread of knowledge on ICT issues. A greater emphasis was placed on literature that addressed the type of ICT application used in construction activities at particular country, its benefits and weaknesses against implementation of ICT application. And trend of training to upgrade the employee skills against ICT knowledge specifically for Contractors Company.

### 4. Result and Analysis

According to Govindan and Tang (2010), to perform an effective evaluation, it is necessary to first define what to evaluate before deciding how to evaluate. The past study has provides clues of issues to evaluate the status of ICT against project implementation. So that, the researcher has decided to categorize the related issues into 3 broad areas as experience by Kajawski (2001) which can be explained as follows:

- i. The use of ICT devices ( Hardware and Software )
- ii. ICT training and competences of employees.
- iii. ICT trends and opinion on the benefits, barrier and limitation on implementation.

#### 4.1 The use of ICT devices (Hardware and Software)

Table 1: IT application for each task of construction, Howard (2004)

| TASK         | IT APPLICATION   |
|--------------|--|
| Requirement  | Business and Information Management                      |
| Design       | CAD and Visualization & Building Engineering Application |
| Tendering    | Computer Aid Cost Estimating                             |
| Construction | Planning, Scheduling and Site Management                 |
| Maintenance  | Computer Aid Facilities Management                       |

Table 2: Type of ICT application according to construction task

| PROJECT TASK | ICT APPLICATION   | AUTHORS       |
|--------------|---|---------------|
| Requirement  | Personal Computer (PC), Internet Networking (LAN/WAN and Intra/Extranet),.  | Pamulu (2004) |
|              | CDROM, CD Writer, and Scanner facilities, word processor, spreadsheet, email software, administrative software, lowest databases and self | Gaith (2009)  |

|           |   |                        |
|-----------|---|------------------------|
|           | developed program   |                        |
| Tendering | E-Procurement System (e-Tendering, e-Marketplace, e-Auction/Reverse Auction, and e-Catalogue/Purchasing). | Croom and Jones (2004) |

Table 3: Type of ICT application according to construction task (Cont'd)

| PROJECT TASK | ICT APPLICATION   | AUTHORS                    |
|--------------|---|----------------------------|
| Construction | Web based information project management system   | Ahuja, et al (2006)        |
|              | Two-way radios phone,   | Hewagea et.al (2008).      |
|              | Global Positioning System (GPS), Geographic Information System (GIS),   | Isikdag (1993)             |
|              | multimedia application (digital projector supported by Personal Diary Analysis (PDA), email, skype application, web cam in yahoo messenger, Fax machine, fixed line telephone, mobile computer and microsoft office power point software) | Sarshar and Isikdag (2004) |

#### 4.2 ICT training and competences of employees.

In order to investigate the competency and training level against staff, the ICT training characteristic should be understood first. Following are ICT training characteristic issued by Kajawski (2001).

##### 4.2.1 Training company support

The researcher feels that the company can support their staff to undergo for ICT training in many ways. It begin with the willingness of employer to allocate time and workload in working hours just for ICT training. And it follows by training initiative at organisation level which Ahuja et.al (2010). In Malaysia, the training provider can be come from both government and private agency. For example, Jabatan Kerja Raya Malaysia (JKR) has introduced ICT training and it was open for public especially those from contractor's company. the training was named as course Microsoft Project Applications (Work Program CPM) in project implementation JKR Terengganu (2011).

##### 4.2.2 ICT training mode preferences

ICT training can be held through various modes, which is the mode of training depending on types of ICT training. Based on Kajawski (2001) study, the training basically held in the company (internal program), online teaching room, informal discussion groups, with professional consultant (external program), at academic faculty ( University etc ), and at private ( self taught via internet, CD and books ).

In Malaysia, most of training mode was held with professional consultant. For example, the training by Malaysian Construction Industry Development Board (CIDB) was conducted at CIDB itself and participated by various construction stakeholders such contractors, consultants, and so on. The course mode is conducted for 3 days and the advanced course is conducted for 2 days CIDB (2011).

#### 4.3 Benefits and Weaknesses of adopting ICT into construction project

##### 4.3.1 Weaknesses perspective

According to Stephenson(1993) the data format may not be in a compatible form to load directly into another department's software package. It is happen when the different software used to received the sending file, the result will not allow for the file to be opened. This lead to transferring data to be manually handled and resulting in lost time and duplication. This problems basically occur because of the different Information Technologies capabilities between each members and thus it shows the advanced software producing file that cannot be opened at the others backing advanced software. In this case, the members involved should know their IT capabilities to be parallel with the others members in order to have collaborative sharing document at the future.

Besides that, the problems also may occur within the people in organisation itself. According to Stephenson(1993) the introduction of information system therefore can cause organisation and cultural changes in addition to the immediate changes in the data proceeding. Due to this cultural changes to the organisation committee, it may lead to many self-mistaken. Besides that, longer period will be taken during processing the data due to in experts enginers to be adopted with newly IT system into their operation system. Its called as learning process that's taking several weeks to be well-experts on the newly operation system.

Other than that, the problems of slows down server has became major problems during implementing the system. According to Mui(2002), The researcher feels that it can be caused by inadequate capacity of Internet server used to be served to all parties, the other reason could be wrong server provider used by the construction company whereby there are using the lowest ranking server provider in Malaysia that provide slow connectivity. It give problems to the parties involved in downloading document and thus delay the activity such submitting and receiving document like revised drawing to be study by both contractor and consultant to be applied on site. This will generally delay the construction progress The infection of virus also threatened to all parties due to online transmission through internet website. According to Mui(2002), the two major problems during implementation of IT in communication are (49%) slowdown of internet and (50%) is virus transmission. The transmission of virus could be caused by not practice anti-virus programme at most of time in their hardware. The virus is able to corrupt the document in the hardware and thus influence efficiency of transferring document among parties. The application of antivirus urgently needed at most of time to keep secure all upload and latest document in the hardware. Other than the other 47% of the respondents faced connection problems where the major complaint is the difficulty in connection and the frequency of disconnection (Mui,2002). Difficulty to sieve information (27%), error in sending and receiving mails (21%) and security problems (21%) (Mui,2002).

The researcher feels that the frequently connection problems or disconnecting is also by low connectivity by server and not caused by the hardware. It is thus give problems in many activity that needed to be online such online remote construction site progress or online meeting. It also contributes to have inefficiency construction progress as need delay in making progress meeting. Inconsistent internet server would rise to other disadvantages including of difficulty to sieve information and error in sending and receiving mails. It would give problems during transferring data through web online which is the data could be cannot be sent and difficulties in open the receiving files. The delay in receiving files will effects the work on site, for example the delay in receiving Engineer’s Instruction to pour a concrete in the structure will delay the actual project on site which is the concreting work cannot be proceed without instruction by engineers. Besides that, the researcher feels that the difficulty in sieving information also contributes to ineffective web based application in construction. The difficulties can be in searching desired information which needs to pass through many files in server. The time lost during searching information has reduced the efficiency and productivity of this application and it can effects the wholes works in construction.

#### 4.3.2 Benefits perspectives.

Table 4: Benefits of adopting ICT into building project management vabita (2009).

| CATAGORIES                                     | BENEFITS  |
|--|---|
| Benefit related to measures of project success | <ol style="list-style-type: none"> <li>1. Project completion as per estimated time</li> <li>2. Project completion as per the estimated budget</li> <li>3. Project completion as per the specification</li> <li>4. Life cycle concept becomes a competitive factor</li> <li>5. Project information obtained in real time</li> <li>6. Richer information made available to managers</li> <li>7. Less time spent in query and approval process</li> <li>8. Effective change management</li> <li>9. Reduced risk of errors and network on prioject</li> <li>10. Effective concurrent construction management</li> <li>11. A complete log of all communication maintain for tracking purposes.</li> <li>12. Effective material procurement and management</li> <li>13. Effective contract management</li> <li>14. “One-Source” documentation archive maintained for clients</li> <li>15. Client Satisfaction</li> <li>16. Reduced administrative cost of document handling and distribution to multiple parties</li> <li>17. Project managers spend more time on managerial work.</li> </ol> |
| Benefits related to effective Team management  | <ol style="list-style-type: none"> <li>1. Effective collaboration and coordination between project team members</li> <li>2. Effective communication management between project team members</li> <li>3. Greater management control</li> <li>4. Effective joint decision making.</li> <li>5. Motivation of workforce.</li> </ol>   |

Table 4: Benefits of adopting ICT into building project management vabita (2009). (Cont'd)

| CATAGORIES  | BENEFITS  |
|---|---|
| Benefits related to increased organisational efficiency | <ol style="list-style-type: none"> <li>1. Increase in overall organisational efficiency</li> <li>2. Better information assessment and management within the organisation</li> <li>3. Useful information compiled and disseminated to other projects.</li> </ol>   |
| Benefits related to effective use of technology.        | <ol style="list-style-type: none"> <li>1. Increased information portability in the ICT environment</li> <li>2. Reduced hard copy storage of documents/drawing</li> <li>3. Flow of accurate information</li> <li>4. Ease of retrieval of informational</li> <li>5. Improved capability of the system to cross-reference to other correspondance.</li> <li>6. Multilocational availability of information.</li> </ol> |

## 5. Conclusion

In conclusion, this research paper found various types of ICT application which classified based on type of construction and project activities. All of these ICT applications used to assist in many ways including in term of communication between both staff in construction site and others construction stakeholders, project management activities, project meeting, looking and submission of tendering.

In addition, the power of ICT could assist to the success of project delivery through their benefits. These main benefits including real time project information delivery, effective collaboration and coordination or project management team. Promotes paperless formal communication and increase of overall organizational efficiency. Therefore, these main benefits clearly shown that the ICT investment is worthwhile to both construction project and construction organization since they promote very effective activities in delivering the project.

Besides the benefits of ICT adoption, there were weaknesses of this application that contribute to reduce the confidence level of construction stakeholder especially contractor to invest in ICT to be used in their construction project. With poor of ICT infrastructure in both office and construction site give high ranking in ICT weaknesses. For example, the respondents faced connection problems where the major complaint is the difficulty in connection and the frequency of disconnection.

In the other hand, the skills of ICT among construction staff mainly depending on the ICT training conducted by their employees. However, there were many limitations that contribute to the willingness of employees to allow for their staff undergo for ICT training. These are including the willingness of employer to allocate time, money and workload in working hours just for ICT training.

Therefore, this reseach paper has achieved its aim which is to to understand the trend and issues on the evaluation of current ICT usage in construction field. This knowledge can be further discussed in others broad area especially in evaluating the status of ICT usage in construction project in particular country. Thus, the status result may assist in development of improvement plan on ICT adoption in construction project for a better innovative construction environment especially for particular country.

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