A study on the constraints of implementing Information and Communication Technology (ICT) in Malaysian Construction Industry

Y L Lew¹, T C Toh¹, K L Lim¹, F Y Y Yan¹ and L P Yow¹
¹Department of Surveying, Lee Kong Chian Faculty of Engineering & Science, University Tunku Abdul Rahman, Sungai Long Campus, Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor

Abstract. Information and Communication Technology (ICT) refers to a combination of hardware, software and communication facilities. Often, ICT is introduced to equip construction stakeholders with information and analytical tools for a better control throughout the entire construction delivery process. The aim of this study is to investigate the issues relating to implementation of ICT in Malaysian construction industry with the objectives of: (i) to identify the benefits of adopting ICT in construction industry; (ii) to determine the constraints of implementing ICT in construction industry; and (iii) to identify the methods to encourage construction industry in adopting ICT. A questionnaire survey was conducted in Johor and Klang Valley of Malaysia, a total of 70 completed questionnaires were collected from contractors and quantity surveying consultation firm. Based on the analysis conducted, the top three benefits of adopting ICT in Malaysian construction industry ranked by the respondents are improvement on accuracy of measurement works, minimization on usage of paper by digitalization and allowed rapid sharing of information among project team. The barriers in implementing ICT in Malaysian construction industry identified included unaffordable initial capital and long term investment required, difficulties encountered to recruit capable and trustworthy in-house IT specialist, and security issues on confidential issues. Training and vendor’s efforts to improve their software have been agreed as the most achievable and practical methods to encourage ICT uptake. This study had explore the implementation and acceptance level of ICT in Malaysian construction industry. The views from both contractor and quantity surveying consultation firm were revealed. The findings from this study could be used as the baseline for future development of ICT in the local construction industry.

1. Introduction
Information and Communication Technology (ICT) plays an important role in nation’s well-being and prosperity due to its enormous and profound socioeconomic benefits. The practice of people live, work, learn and communicate with each other has been improved by the introducing of ICT [1]. Since ICT assists in transmitting data and messages among individual, new knowledge can be developed and shared in order to achieve innovation [2]. Adoption of ICT as an integral part of construction process can improve the current work practices in order to be more client orientated, more competitive as well as productive [3]. Advanced technologies tools can improve project performance in terms of budget and schedule, as well as the coordination within team member being improved, transferring and
handling of document being facilitated, bottlenecks in communication reduced and updated records of organization enhanced [4, 5].

In Malaysia, Construction Industry Development Board (CIDB) has developed a Construction Industry Master Plan (CIMP) to overcome some of the inherent weaknesses existing in the construction industry [6]. One of the strategic thrusts identified included leverage on ICT in construction industry. Nevertheless, there was limited evidence of adoption by the company due to various barriers presence in the industry. Therefore, this study is initiated to expose the issues relating to implementation of ICT in Malaysian construction industry.

2. Literature Review

ICT refers to a combination of hardware, software and communication facilities [7]. The adoption of ICT improves information management especially on delivery of project information from offices to construction sites [8]. Construction industry has been defined as an industry which is vulnerable to various technical, sociopolitical and business risks [9]. Due to the high risk prone of typical construction industry, the introduction and implementation of ICT within this industry can micrify the severe impacts beget from its uncertainty environment.

Benefits generated from ICT adoption in construction industry were innumerable and involved many aspects. Exchange of information supported by ICT application eliminates the mistakes occur during data input or transfer [10]. The automation in generating list of materials eliminate the human error in taking off, especially careless mistakes or any arithmetical errors which might have severe impacts on the construction cost. ICT is able to predigest an organization with high hierarchical structure into a flatter structure and coordination among staff can be improved [11].

Yet, the speed of internet connection in Malaysia still needs improvement as according to Malaysiandigest.com [12], Malaysia has been mentioned as one of the Top Ten Slowest Internet Speed Country in the world. Incompleteness of infrastructure works in suburbs areas discourage people from adopting ICT unlike more stable and higher speed of internet connections available in capital area. Government and industry bodies support have an immediate impact and responsible to popularize the application of ICT within industry [13].

Previous surveys have shown that the widespread “technophobia” is still happening even in the year 2010 [14]. In order to allow users to change accordingly, a realistic objectives and benefits must be informed. When individual understands how the ICT tools can improve company as well as individual work load and daily activities, this will make individuals less reluctance to change. The users’ input and comments on a new introduced product are useful and practical. Based on Kuncinas [15], Malaysia’s budget in year 2015 has been targeted to reinforce the ICT industry by improving local infrastructure. The prime minister has allocated budget for the expansion of high-speed broadband in urban areas. As the local network connection improved, the frequency of ICT uptake in organizations will be increased as well. CIDB [16] has launched ICT programme and targets to enhance the information exchange between each industry player via the use of ICT in respective industry. The collaboration of CIDB with Persatuan Industri Komputer Malaysia (PIKOM) and Multimedia Development Corporation (MDeC) aimed to increase the opportunity of ICT companies to involve in construction industry. In order to prove the effort being put in by CIDB to pursue a high usage of ICT in construction industry, CIDB has improved their administration works through ICT. The actively adoption of ICT by CIDB allowed it functions to assemble all the information and data in the form of digital information to allow CIDB’s external and internal usage.

3. Research Methodology

A questionnaire survey using five-point Likert scales was adopted for data collection. In order to overcome the low feedback from respondents, the combination of distribution methods were adopted, the questionnaires were distributed in the form of hardcopy and through an online survey tool – Survey Face. The questionnaire forms were distributed among the QS consultant firms and contractors within Kuala Lumpur, Selangor and Johor Bahru. Johor Bahru was included as the targeted area due to
the rapid growth of construction industry over these few years. Based on CIDB Construction Statistics Bulletin, the total number of registered contractors is 6,383 which is the third highest number while Kuala Lumpur and Selangor have the top two highest numbers of registered contractors as described in the quarterly report [16]. The targeted respondents for the questionnaires of this study are engineer, quantity surveyor, project manager, contract manager from both quantity surveyor (QS) consultant firms and contractors. These targeted respondents were selected as they were the group of professionals that mostly deal with the QS related software that studied in this study.

A total of 100 sets of questionnaires were distributed to the contractor and QS consultant firm selected by convenient sampling method with the estimated rate of more than 60%. The use of convenient sampling is ensure the high response rate for this exploration study. The questionnaire was divided into four sections, namely Section A, Section B, Section C and Section D. Section A included the profile and demographic details of the respondents. Section B is used to investigate the benefits of ICT adoption in organization, Section C is used to identify the possible constraints and limitations faced by individual while adopting ICT in construction industry whilst Section D is used to identify the methods available to encourage the ICT uptake in construction industry. Likert scale were used in the questions in Section B, C and D as it allowed the respondents to convey the degree of their agreement or disagreement about the research questions or statements [17].

Statistical Package for Social Science (SPSS) was adopted in this study to perform data analysis. Cronbach’s Alpha Coefficient is used to ensure the internal consistency among each individual variable in the research. Cronbach’s Alpha Coefficient equal or more than 0.700 is considered acceptable [18]. Spearman’s Rank Correlation Coefficient (rho) is used to measure the difference in ranking between two groups of respondent’s scoring a number of issues, attitudes or factors [19]. Use of non-parametric test is suitable for any data with no restriction of the normality of the data distribution. This test is used to find out whether there is any significant difference in the ranking between two groups of respondents. The respondents were grouped according to the type of organization, QS consultant firm or contractor. Correlation coefficient (rho) range from -1.000 to +1.000 indicating the significance relationship (degree of agreement) between two sets of results from two respondents groups. If the rho is nearer to 0, this interpret that there is only limited of degree of agreement towards the variables from two groups of respondents. While, when the rho is closer to -1.000, it shows that there is perfect disagreement towards the variables and if the rho is closer to +1.000, it shows perfect agreement towards the variables between two groups of respondents.

4. Results and Discussions

A total of 70 questionnaires were collected out of the 100 sets distributed. The respondents comprised of 55 personnel with work position of quantity surveyor (78.6%), 7 project manager (10.0%), 6 contract manager (8.6%), and 2 engineer (2.9%) with majority position of respondents are senior position. The personal details and company information of the respondents were not collected to ensure the guarantee of anonymity and confidentiality. There are 31 respondents (44.3%) who have working experience of 2 to 5 years, almost half of the total respondents are belong to this category. There are 20 respondents (28.6%) who have less than 2 years working experience and followed by the group of having 10 or above 10 years experience, which there are total of 12 respondents (17.1%) belong to this category. Lastly, there are only 7 respondents (10.0%) who have 6 to 9 years of working experience.

The respondents were asked to rank the benefits on ICT adoption, constraints of ICT adoption and methods to encourage ICT adoption using a 5-point Likert scale (5-Strongly Agree, 4-Agree, 3-Neutral, 2-Disagree and 1:Strongly Disagree). Cronbach’s Alpha analysis was carried out in order to measure the internal consistency or average correlation of items in a survey instrument in order to calculate the reliability of the Likert scale used [20]. It was found that all the scale used indicated good consistency with Cronbach’s alpha coefficient of 0.793, 0.710 and 0.816 respectively.
It was found that there were common agreements between two groups of respondent towards the top three benefits of ICT adoption (summarized in Table 1). Both respondents from contractor and consultant rated that the improved accuracy and preciseness of work done brought by different kind of software was the most beneficial results by adopting ICT. According to Autodesk [21], Quantity Take Off (QTO) software allowed users to expedite on taking off for similar components or materials on the drawings by using “Search Takeoff” function, hence a higher accurateness on compiling the same components can be attained within short time frame.

### Table 1. Ranking of Benefits on ICT Adoption

| Benefits                        | Consultant Rank | Contractor Rank | Overall Rank |
|---------------------------------|-----------------|-----------------|--------------|
| Sharing of information within project team | 3               | 3               | 3            |
| Improve accuracy of measurement works | 1               | 1               | 1            |
| Better communication            | 3               | 5               | 5            |
| Globalization                   | 6               | 6               | 6            |
| Project management tools        | 5               | 4               | 4            |
| Digitalization                  | 2               | 2               | 2            |

The second benefit which ranked by both consultant and contractor respondents is digitalization. According to Matsumura & Lewis [22], digitalization and dematerialization are the indispensable functions of ICT as different technologies able to convert the physical into digital or virtual. At the simplest level, electronic transmission of business documents created large savings in paper usage and postage [23].

The sharing of information among team members and minimized the errors during transferring of data has been ranked as the third benefit could be obtained by respondents by adopting ICT in their workplace. ICT tools facilitated efficient handling of large amounts of documents that originate from difference sources and in different formats [24], hence mistakes occurred during the data transmission process being eliminated.

In contrast, the lowest ranking of the benefit by both groups of respondents was the adoption on ICT able to improve globalization by materials and specialist procurement in order to enhance the quality of the end products. Globalization is closely linked with the international trade of goods and services and is closely related to the procurement on technical specialist and materials in construction industry [25]. This lowest ranking may due to the low awareness on the importance of globalization in Malaysia construction industry.

Table 2 summarised the value of correlation coefficient value obtained based on the ranking between respondents from contractor and consultant firm is 0.899 at a significance level of 0.05 (95% confidence level) for a two tailed test. This value indicated that the ranking between respondents from consultant and contractor has high and positive correlation. Thus there is a high degree of agreement between them and hence there is no significance difference in their opinions.

### Table 2. Spearman Rank Correlation Coefficient between Respondents from Contractor and Consultant toward the Benefits on ICT Adoption

| Consultant | Contractor |
|------------|------------|
| Consultant | Correlation Coefficient | 1.000 | .899* |
| Contractor | Correlation Coefficient | .899* | 1.000 |

*. Correlation is significant at p < 0.05 (2-tailed).

This agreement is due to the fact that benefits brought by ICT implementation are the same by almost all industry professionals regardless of their organization nature. The top three benefits ranked by two groups of respondents were mainly concentrated on the Triple Constraint (time, cost and quality) in
construction industry, which represented a model of the constraint of project management. By adding
benefits to each element in the triple constraint, professionals either from contractor or consultant able
to master the project in better ways and bring the project to success by different parties.
In Table 3, it was shown that there were contrary in the ranking of constraints on ICT implementation.
From the view of consultants, the barrier that they encountered mostly was due to large capital and
huge investment cost were vital to implement ICT tools at initial stage as well as a high budget need to
be allocated for the employee training. Besides than the procurement and installation cost, the annual
licensing cost and maintenance cost have contributed on the total cost of ownership become an extra
burden of cost for consultant firms.

| Constraints                                              | Consultant Rank | Contractor Rank | Overall Rank |
|----------------------------------------------------------|-----------------|-----------------|--------------|
| Create changes in the lines of communication and authority | 4               | 7               | 6            |
| Large capital and investment cost required                | 1               | 3               | 1            |
| Inability to recruit in-house IT specialist               | 2               | 4               | 2            |
| Issues arise from low speed of internet connection        | 5               | 4               | 5            |
| Security issues                                          | 3               | 1               | 3            |
| Unstandardised usage of ICT by different parties          | 7               | 4               | 7            |
| Encounter difficulties when deal with new ICT tools       | 5               | 2               | 4            |

The second ranked barrier by respondents from consultant was the inability to recruit an in-house IT
specialist group to support the users from time to time. Most of the firms need to depend on the
outsourcing services for ICT implementation which would increase the overall cost for ICT adoption
[26]. Besides, the user friendliness of ICT has been defined as one of the important barrier followed by
high capital cost required. User friendliness often depends on the vendor’s ability to offer software
support and training to the new users in order to maximize the number of staff who predominating
particular software.

Whilst the responses from contractors have different opinions towards the barriers on ICT
implementation as they have ranked the security issues as the top constraint. The second highest
ranked constraint by contractor is encounter difficulties and insufficient of grace period to implement
and wholly accustomed to the application of ICT in working life. As mentioned by Collins [27], many
organizations neglected the importance of providing adequate training to employees, even though
companies offered training to employees when new software was installed, but failed to train the new
employees when turnover occurred.

Similar to respondents from consultants, contractors also emphasized on the minimum administrative
cost in order to achieve the largest overall profit generated from each project. However, contractors
focused on the financial impact of ICT only came after the security issues and insufficient training
provided. The number of software licenses required in a contractor company was relatively lesser than
a consultancy firm, therefore, contractors might discovered other issues such as the insecurity and
unreliability of the ICT applications before the necessary cost to implement ICT.

Based on Table 4, the correlation coefficient value obtained based on the ranking from two groups of
respondents is 0.072 at a significance level of 0.05 (95% confidence level) for a two tailed test. This
value at almost equal to zero indicated that the ranking between respondents from consultant and
contractor category has no linear relationship and implying no relationship between them.
Table 4. Spearman Rank Correlation Coefficient betweenRespondents from Contractor and Consultant toward the Constraints of ICT Implementation

| Consultant | Contractor |
|------------|------------|
| Correlation Coefficient | 1.000 | 0.072 |
| Correlation Coefficient | 0.072 | 1.000 |

*Correlation is significant at p < 0.05 (2-tailed).

The different opinions given by both groups of respondents proved that different types of hindrance have been encountered by professionals from different nature of organizations. Consultants have rated the financial considerations as the first and most important barrier during the uptake of ICT but contractors have prioritized the security issues of their confidential data as the first barrier which hindered the uptake of ICT within their organization. The other related cost might be cost of supporting infrastructure and computer ancillaries cost which these cost must be related to expected income and return on investment, QS consultant firms often incurred a relatively higher license cost for QS related software compared to contractor firms. Consequently, QS consultant firms placed the financial considerations as the first encumbrance whereas this barrier had less impacted on contractor and only being ranked at third place by contractor.

Based on Table 5, consultants believed that the most practical way to improve the uptake of ICT within industry shall depends on the vendors’ effort to improve the user’s negatively perceptions towards the advanced software. Various training prepared for professionals would have significant contribution to the implementation of ICT within industry. The software vendors should owned the initiative to arrange various kind of training in order to allow user to fully comprehend and achieve the potential advantages of the software. In contrast, contractors have recognized that the importance of training available within industry was the main and prior concern in promoting ICT usage in the industry. Training on the latest ICT tools and software in the industry was equally important and effective regardless the nature of the professionals working with and hence vendors shall execute their responsibility in promoting their products in order to achieve win-win situation. Lastly, all respondents from contractors and consultancy attained common agreement that government’s effort to improve the local network connection was the least effective method in advocating the application of ICT within industry.

Table 5. Ranking of Methods to Encourage ICT Adoption

| Methods to Encourage | Consultant Rank | Contractor Rank | Overall Rank |
|----------------------|----------------|----------------|--------------|
| Training provided by software vendors | 2 | 1 | 1 |
| Vendors should improve user's perceptions | 1 | 2 | 1 |
| Government to improve the local network connection | 4 | 4 | 3 |
| Government provides special funding | 3 | 2 | 4 |

Based on Table 6, the correlation coefficient value obtained based on the ranking from two groups of respondents is 0.632 for a two tailed test. This value indicated that ranking between respondents from consultant and contractor category has positive and moderate relationship between them. The moderate relationship between two rankings also represented that there is only limited level of disagreement between two groups of respondents and hence there are certain similarities in their opinions on the methods to encourage and promote ICT.
Table 6. Spearman Rank Correlation Coefficient between Respondents from Contractor and Consultant toward the Methods to Encourage ICT Adoption

|            | Consultant | Contractor |
|------------|------------|------------|
| Consultant | Correlation Coefficient | 1.000 | 0.632 |
| Contractor | Correlation Coefficient | 0.632 | 1.000 |

*. Correlation is significant at p < 0.05 (2-tailed).

The contractors and consultants have almost the same opinions towards the methods available to promote ICT usage as they agreed that training was inevitable and give priority to promote ICT awareness as well as education amongst senior staff. Respondents from either contractors or consultants organization concluded that training and efforts done by software vendors able to make largest improvements and more practical to achieve the high adoption rate of ICT in the industry within shorter time frame. Efforts done by software companies were functional and able to realize the objectives in a shorter time frame compared to those implementation programme introduced and launched by government which relatively longer duration and resources were needed. Contractor and consultancy firms nowadays required the most efficient, highest return and method with certain assurance to implement a drastic change or evolution in their organizations.

5. Conclusions

The top three most significant benefits being ranked by respondents are focused on the accuracy of work done, minimize usage on the paper and ICT allowed sharing of latest information among team members within shortest duration. This strongly supported that the importance of work quality, cost allocation and time management in every single project, regardless the nature of organization within industry. The ideal benefits pursued by professionals were almost the same and owned the ultimate objective of achieving project success, within the allocated budget, time frame given and also realized the clients’ requirements.

The constraints and barriers encountered by professionals were relatively different due to the nature of organization, size of organizations, individuals’ experiences, individuals’ perceptions and so on. The challenging constraints agreed by the overall respondents in this study were the unaffordable initial capital and long term investment cost required, difficulty to recruit capable and trustworthy in-house IT specialist to support software and unwilling to expose their confidential data at high risk environment have hindered organizations to adopt and fully utilized the software in the industry. Whereas, the inability to recruit capable in-house IT support team may be due to the current trends in market as most of the firms relied on outsourcing IT consultant services. While, for the security issues on the confidential data can be improved by enhance the ICT knowledge among employees to ensure a better handling process on company data.

Based on the respondents’ suggestions, the importance of workshop and seminar cannot be neglected as well. Next, the incorporation of ICT content in tertiary education syllabus especially for construction professionals helped to enhance the quality and ICT knowledge of future fresh graduates and consequently assist in disseminating ICT knowledge within the industry. Besides that, clients’ role in ICT implementation cannot be overlook as well, clients’ interest on consultants and contractors’ ICT capacity became a driving factor to urge the ICT adoption within organizations. The rapid evolution of ICT in construction industry required more research to be carried out continuously in order to identify the latest issues in this challenging environment.

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