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ICT Implementation for Improving Communication among SME Contractors in Construction Industry

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Abstract: The lack of efficient communication and data exchange between SME contractors is a major contributor to poor performance in the construction industry. Small and medium-sized enterprises (SMEs) lacked dynamism compared to large-scale construction companies. Therefore, the purpose of this research is to enhance ICT implementation for improving communication between SME contractors. The objectives of this research are to investigate current practices, challenges, and influencing factors of ICT implementation to improve communication between SME contractors in the construction industry. To achieve the objectives of this research, secondary data thorough literature review was conducted and primary data were gathered through a quantitative approach. The respondents of this study involved SME contractors in Sabah. The respondents from SME contractors involved project managers, site managers, supervisors, and engineers with 134 respondents from G1 and 122 respondents from G2. The greatest frequency and mean score values were determined using IBM SPSS Statistic 26 software. Based on the findings, the highest mean for current practices of ICT implementation was E-mail and Short Message Services. The challenges of ICT implementation were a budget constraint for ICT investment and for influencing factors of ICT implementation were reliable telecommunication networks or telephone lines. In conclusion, this study adds to the understanding that ICT implementation might improve communication between SME contractors in the construction industry.

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Keywords: Communication, Construction Industry, SME, ICT

1. Introduction

ICT had been viewed as a critical tool for improving data and communication in the construction industry. In Malaysia, bookkeeping and handwriting were still used in the construction industry. When compared to large-scale construction enterprises, researchers generally agree that small and medium-sized enterprises (SMEs) dynamic in construction are not inventive (Acar *et al*., 2005). The construction industry has not maintained its position in the field of ICT. According to reports, ineffective communication and information and data exchange among contractors contribute to the industry's poor performance as the contractor was unable to deliver the project effectively within the three constraints of time, cost, and quality, resulting in subcontractor workmanship of poor quality (Chileshe, 2012). The strategic use of Information and Communication Technologies (ICT) in projects has become critical to achieving the goal more successfully. For example, the use of ICT can effectively facilitate massive information transfer among contractors on a specific project. The use of electronic mail and electronic commerce will improve communication among contractors. The benefits of ICT adoption apply not only to large corporations but also to small and medium-sized businesses (SMEs). Contractors can benefit from increased operational effectiveness, higher quality, shorter project timelines and costs, and higher profit margins (Gunasekaran *et al*., 2001). Therefore, the main purpose of this research is to identify ICT implementation for improving contractor communication, especially SMEs in the construction industry.

The benefits of ICT adoption apply only to large corporations, not to SMEs. According to Carayannis *et al*. (2006), SMEs are generally slow to adopt new technologies. Traditional information and communication flow in the construction industry are characterized primarily by manual processes. Poor communication among contractors is also caused by a poor communication platform, technological malfunctions, and other factors. The traditional method of producing numerous paper copies of documents and drawings is time-consuming and tedious (Othman *et al*., 2018). Most of Malaysia's construction industry lacks the technical, financial, and managerial capabilities to carry out construction projects (Gulghane & Khandve, 2015), especially SME contractors (Wolcott *et al*., 2008). Contractors are unable to recognize the advantages that ICT may provide for their business. In comparison to other industries, the magnitude of ICT adoption in construction practices remains low. Users must learn how to use ICT tools and change their working habits. Because of this, it is difficult to implement ICT in contractor communication. Therefore, the objectives of this study are to identify current practices, challenges and influencing factors of ICT implementation for improving communication among SME contractors in the construction industry. The research is expected to be used to improve communication among contractors through ICT implementation in the construction industry and for academic references related to the research.

2. Literature Review

The literature review section describes all relevant literature related to the research and is critically discussed. This section is structured based on the stated objectives and focus of the study or any logical order as deemed appropriate.

2.1 ICT Implementation for Contractor's Communication

As Hore (2006) implied, ICT upholds the whole construction process from commencement through operational support of building assets. This includes utilizing ICT tools and technology to make, communicate and exchange data. The application of ICT on a construction project can be divided into two categories: communication systems and technical decision support systems. Farag (2009) claimed that the communication domain including all the standard means of communication is currently computerized as PCs and web-based technology has offered the potential for extraordinary advances

in transferring data accurately and rapidly (Marosszeky, 2002). Traditional forms of communication in associations were helped by face-to-face interaction, paper-based drawings, letters and illustrations, and calls. The Internet and computer-aided communication are essential to closer collaboration among contractors. Electronic communication (e-communication) is a system utilized to send or recover messages through PCs or Internet associations. This incorporates a considerable number of communication tools. According to Mats and Sandhu (2007), the benefits of utilizing electronic communication include a decrease in the expense of communication as compared to traditional methods, especially for SMEs that face a lack of financial resources. There are some ICT tools and applications. Project Specific Web Sites are electronic applications for collaboration through an ICT investment platform (Becerik, 2004). It is an organization that uses Internet protocols and a public telecommunication system to communicate with contractors. Project owners, designers, contractors, and suppliers can share data and improve communication, coordination, and collaboration.

The main uses of the Internet include data sharing, interaction, and communication. Messages and project documents as attached records can be sent by electronic mail to individuals of a project team in various areas. For instance, contractors securely share part of their organization's data resources (Bowden, 2005). Details of work areas, for another instance, can be exchanged between the architect and the contractor. E-mail is probably the most well-known internet application. (Harris and MacCaffer, 2001). In the construction industry, teleconferencing permits all parts of construction projects to become one community (Sekou, 2012). Data conferencing allows parties to connect in order to present text and graphic documents only. In the construction industry, specific applications may incorporate Executive/Board/Shareholder meetings, Team Meetings, Job Training, Computer-aided Design (CAD)/Map/Map/Blueprint Reviews, and Collaborative Planning (Sekou, 2012).

Intranet is a type of communication infrastructure that is based on the web's communication and content standards. Construction organizations can set up an intranet to permit project managers to access information from central information banks (Hore and West, 2005). The appearance of the Internet has dramatically upgraded the operational scope of cooperation tools. One example would be the utilization of Electronic Data Interchange (EDI). EDI exchanges structured information according to agreed message standards between PC systems. An example of an EDI application in construction incorporates the procurement of materials that utilizes document type processing such as invoices. Computer-aided design (CAD) software is extensively used by design professionals. AutoCAD accounts for the lion's share of the CAD software industry and it has replaced manual drafting. Non-technical workers may benefit from 3D models since they can get a better understanding of the design elements. Site operation simulation programmers may simulate what occurs on a building site by simulating humans, equipment, and materials, and calculating the cycle of each step while considering a wide range of unpredictable circumstances, such as weather conditions. The simulator that has been designed facilitates communication between the four project participants. The summary of ICT tools and applications is shown in Table 1.

Table 1: ICT tools and application

No	ICT Tools and Application	Author
1	Project specific website	• Becerik (2004) • Bowden (2005)
2	Internet and electronic mail	• Harris and McCaffer (2001)
3	Teleconferencing	• Sekou (2012)
4	Intranet	• Hore and West (2005)
5	Electronic data interchange	• Harris and McCaffer (2001) • Peansupapp (2004)
6	Computer-Aided Design and Visualization	• Bernstein (2020) • Kirkman & Mathieu (2005) • Trivedi (2015)

7	Planning, Scheduling, and Site Management	• Kirkman & Mathieu (2005) • Abourizk (2010) • Jaeger & Adair (2012)

2.2 Challenges of ICT Implementation for Contractor's Communication

Research indicates that authoritative bodies in the construction industry were uninformed about the potential gains of ICT. Contractors might be hesitant to put resources into technology if they are unconfident about whether technology can achieve productive outcomes. Studies have shown that inadequate working environment communication can cost organizations an average of $420,000 each year (Patricia, 2013). Andipakula (2017) showed that most small firms are unwilling to adopt ICT if they perceive the cost of developing and maintaining the technology system to be higher than the benefits it generates. Website upkeep and upgrades are invigorating for companies that do a lot of business online. Over the long run, when the expense of transactions grows, maintaining the system will likewise increase. This brings about an issue for small firms with few technologically skilled employees (Parida *et al*., 2010). Organizational obstructions include the culture of the organization, top executives' attitudes, business processes, and company size. Culture is, by a long shot, the most robust component of an association. Culture assists in encouraging an uplifting attitude towards technology adoption. If the culture of a construction company is slanted towards continuous improvement, technology diffusion in the association will take place rapidly (Onyegiri and Nwachukwu, 2011). However, if the association is not available for innovation, technology diffusion will be complex and tedious (Parida *et al*., 2010).

Another factor that causes organizational limitations is that the construction industry adjusts to strict timelines. Contractors will spend less time learning new technology as they dread that they will waste their time. IT devices and business processes should be slanted to suit the industry (Ofori-Karugu *et al*., 2012). Peansupap and Walker (2005) completed a study to investigate ways of receiving and diffusing Information and Communication Technology as three of these components impacted ICT. The weak factors were negative feelings towards ICT utilization and disappointment experience while using ICT. Time is the most crucial factor in the construction industry. Projects have a constricted schedule, and employees of the industry should work accordingly. Introducing technological change in an organization and re-engineering methods are time-consuming processes. Not to mention there is a significant risk associated with re-engineering business processes while adopting new technology (Kasim, 2011). While the ICT constraints at an individual level, there is a personnel training and support gap which includes constraints of learning and training (Lack of preparation and learning opportunities ICT implementation in construction firms. On the off-chance, the contractor), technical support (ICT users need a sound and well-defined effective support system) and senior management support (the absence of help and support from senior managers will thwart ICT innovation diffusion in construction firms). ICT investment gaps will affect user adoption if there was insufficient investment and personal gaps such as a lack of computer skills (Peansupap and Walker, 2006). Table 2 shows the challenges of ICT implementation.

Table 2: Challenges of ICT implementation

No	Challenges of ICT Implementation	Author
1	Financial Constraint	• Andipakula (2017) • Patricia (2013)
2	Organizational related Constraint	• Parida *et al.* (2010) • Onyegiri and Nwachukwu (2011)
3	ICT diffusion constraint at the individual level	• Parida (2010) • Ofori (2012) • Peansupap and Walker (2005) • Kasim (2011)

- Peansupap and Walker (2006)

2.3 Influencing Factors of ICT Implementation for Contractor's Communication

There are internal and external factors that influence a contractor's communication and ICT implementation. For the internal factors in SMEs, the ICT adoption process is straightforwardly affected by top management (Nguyen, 2009). SMEs have straightforward and highly concentrated structures with chief executive officers (CEOs). Their decision has an impact on all firms' activities, both now and in the future (Smith, 2007). These choices are mainly based on their experiential knowledge derived from a combination of existing competencies (Carson and Gilmore, 2000). In most organizations, workers are viewed as significant assets that, along with the manager's role, the firm's survival and achievement seriously depend upon them (Nguyen, 2009). These resources, as the users of ICT within SMEs, are another valuable asset of firms (Caldeira and Ward, 2003). However, in the construction industry, architects and engineers have shown a significant degree of ICT adoption while construction managers and contractors have not. Various investigations that were completed into the adoption of ICT within SMEs have revealed various organizational characteristics influencing the adoption process (Acar *et al*., 2005; De Burca *et al*., 2005; Love *et al*., 2005). Larger firms in the small business group tend to adopt communication technologies more than smaller ones. As firm size becomes more significant, a higher effect of ICTs on construction performance will be seen by building contractors. Indian construction SMEs possessing higher turnover will have higher ICT appropriation, according to Ahuja *et al*. (2009) This finding was based on Premkumar's (2003) study of ICT adoption in 207 Indian SMEs. Despite the fact that there are numerous external factors, small businesses are vulnerable to client pressure.

SMEs received ICT due to demand from clients to develop the efficiency of their inter-organizational dealings (Levy *et al*., 2002). Drivers for ICT adoption in SMEs are also attributable to firms' desire and requirement to stay competitive and innovative as a necessity for their survival (Ghobakhloo *et al*., 2011). The main focus of SMEs is to use ICT in delivering a superior level of customer service and better communication with distant partners. The authors argue that credibility has risen as a significant motivator for adopting ICT tools within SMEs. They argue that this credibility could be achieved by fulfilling customers' and suppliers' pressures and, significantly, their expectation of receiving better services (Ghobakhloo *et al.,* 2011). Most SMEs suffer from a lack of ICT experts and recruit external consultants (Morgan *et al.,* 2006; Nguyen, 2009). A study shows ICT will be used to support all formal communication between the client, engineering company, contractor, and subcontractor (Adriaanse *et al.,* 2010). Because of the importance of external assistance to SMEs, these companies are in trouble (Stockdale and Standing, 2004). According to the literature, significant positive connections can be found between ICT adoption and government support (Ahuja *et al*., 2009; Tan *et al.,* 2009). SMEs are generally more reliant than other organizations on external resources and support (Alaghbandrad *et al.,* 2011). In Malaysia, SMEs generally disagree with the view that cost is an insignificant determinant of ICT appropriation. The government should provide more ICT applications and boost internet speed and internet access nationwide to improve communication among contractors (Tan *et al*, 2009). Table 3 below shows the summary of influencing factors of ICT implementation.

Table 3: Influencing Factor of ICT implementation

No	Influencing Factor of ICT implementation	Author
1	Internal Factor - Top Management - End-User - Organizational Characteristics	Nguyen (2009), Smith (2007), Carson and Gilmore (2000), Caldeira and Ward's (2003), Acar *et al.* (2005), De Burca *et al.* (2005), Love

		et al. (2005), Premkumar (2003), Ahuja *et al.* (2009)
2	External Factor - External and Competitive factor - External IT Consultant and Vendor - Government	Nguyen (2009), Levy *et al.* (2003), Adraainese *et al.* (2010), Ghobakhloo *et al.* (2011), De Burca *et al.* (2005), Ahuja *et al.* (2009), Tan *et al.* (2009), Alaghbandrad *et al.* (2011)

3. Research Methodology

The research discusses the tactics used in this investigation. The approach employed must ensure that the goal and scope of this research are met. The methodology is important in this study, and the research discusses data gathering methods. The research will propose an ICT implementation study to improve communication among SME building contractors and likewise discusses research design, research methodology, demographic and sample research, as well as instruments and strategies for achieving research objectives.

3.1 Research Design

This investigation will use quantitative methodology. According to Patrick (2015), quantitative approaches are those research approaches that generalize a number-dependent. These numbers were obtained from measuring unit objective scale and named variables. This research has a cross-sectional design that uses questionnaires as a technique of data collecting. Next, it includes data collecting and numerical value analysis.

Quantitative data would be quantity and numbers of data. These quantitative ways were used to identify social phenomenon realities and anticipate a permanent and quantifiable reality. Data were obtained by numerical comparison, measuring items and study. Finally, data will be reported through objective examination (McLeod, 2019). A survey questionnaire will be made using Google forms. Designs for data and findings received from the respondents, together with the literature review being reviewed and evaluated to meet this research's goals will be addressed. Figure 1 below displays the research methodology flow chart.

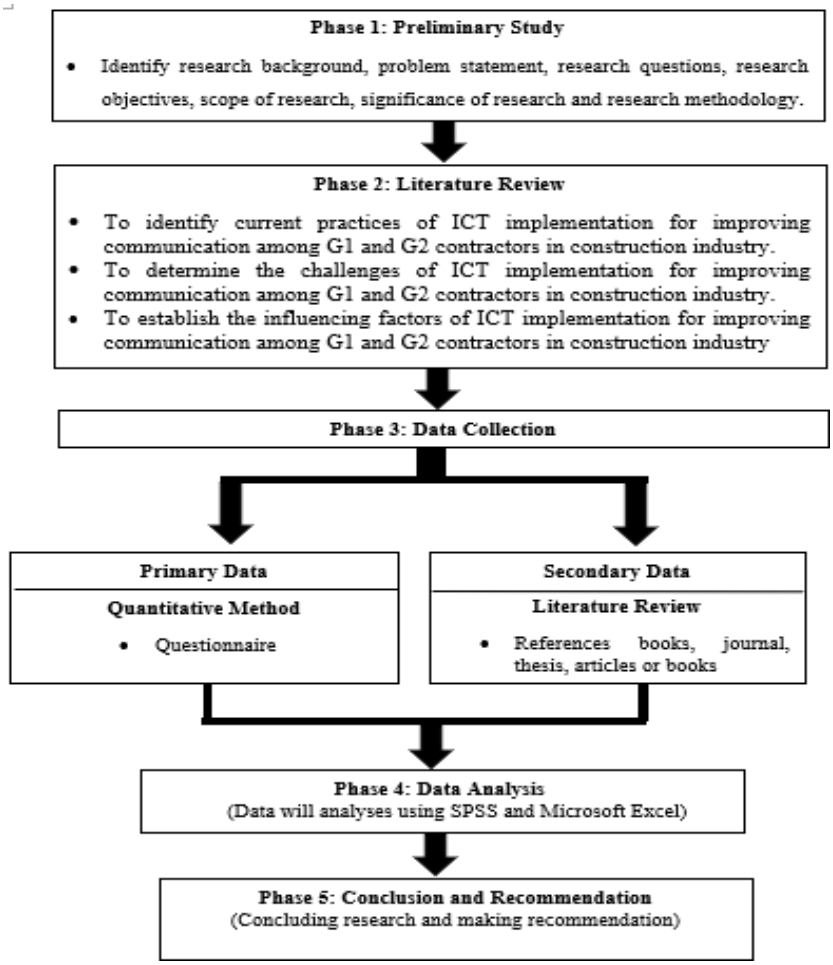

Figure 1: Research Methodology Flow Chart

3.1 Data Collection

To enhance accuracy, data must be obtained appropriately. There will be two types of data in this study: primary and secondary. All material is derived from primary and secondary sources and these data collection methods were thoroughly examined. The primary data is the data gathered by the researchers for the first time. Data sources incorporate surveys, observations, experiments, questionnaires, and personal interviews. This research will be utilizing the quantitative method to gather data by giving the questionnaire to the target respondents. On a contrary, secondary data is data that has been gathered or generated by others. The secondary data is only analysis and interpretation of the primary data with different purposes (Ajayi, 2017).

3.2 Data Analysis

Data analysis is the process of data collection, analysis, and alteration (Lutabingwa, 2007). IBM SPSS Statistics 26 will be employed to create output. Using SPSS, the information gathered from the questionnaire may be analyzed. Before submitting the study, IBM SPSS Statistics 26 delivers dependable findings for right and right responses. This was used for quick, minimal upgrades. The analysis is then concluded to acquire the frequency and mean score values in the next chapter.

4. Result and Discussion

In this section, the data collected were analyzed using Statistical Package for Social Science

(SPSS) Part A, Part B, Part C and Part D discuss the influencing factors of ICT implementation for improving communication among contractors.

4.1 Result

(a) Respondent's Background

Table 4: Summary of Respondent's Background

Item		Frequency	Percentage (%)
Contractor grade	G1	134	52.4
	G2	122	47.7
Highest academic qualification	Diploma	65	25.4
	Bachelor Degree	169	66
	Master	15	5.9
	PhD	7	2.7
Job Position	Site Supervisor	68	26.6
	Site Manager	78	30.5
	Engineer	54	21.1
	Architect	28	10.9
	Project Manager	20	7.8
Working experience	Less than 3 years	172	67.2
	4 - 6 years	56	21.9
	7 - 9 years	20	7.8
	10 years and above	8	3.1
Level of ICT usage in the communication	High	188	73.4
	Medium	54	21.1
	Low	14	5.5
Usage of ICT as communication in the organization	Desktop computer	211	82.4
	Laptop	199	77.7
	Tablet PCs	80	31.3
	Digitals cameras	78	30.5
	Multimedia projectors	157	61.3
	Mobile phone	191	74.6

As shown in Table 4 above, there is the respondent's background, including contractor grade, highest academic degree, position, job experience, level of ICT use within the company, and ICT usage as a mode of communication inside the organization. The following table summarises the frequency and percentage of responses from 256 respondents. According to the chart above, the majority of contractors are graded G1 (52.4 percent). Apart from this, the bulk of the highest academic qualifications is bachelor's degree holders (66 percent), owing to the fact that the majority of areas of study require bachelor's degrees. As a result, the bachelor's degree program is very participative. Additionally, the highest position is site manager, at 30.5 percent, owing to the fact that the majority of responder participants are site managers. Following that, the majority of respondents had fewer than three years of job experience (67.2 percent), which is consistent with the field of study where respondents have less than three years of work experience. The bulk of the organization's ICT use is high, at 73.4 percent. Furthermore, with 82.4 percent of the total, the desktop computer is the most commonly used ICT for communication in the firm. This is because the majority of respondents communicate frequently inside the organization using desktop computers.

(b) Current Practices of ICT implementation

From Table 5 below, current practices of ICT implementation which are email and short message service (SMS) get the highest mean value in ranking. Therefore, communication between contractors become increasingly electronic and formalized (Klinc *et al*., 2016).

Table 5: Current practices of ICT implementation

No	Item	N	Mean	Standard Deviation	Ranking
1.	Email and Short Message Services (SMS)	256	4.17	1.045	1
2.	Mobile Phone	256	4.04	0.894	2
3.	Messages communication apps (WhatsApp, Telegram, WeChat etc.)	256	4.04	1.001	3
4.	Video communication apps (Zoom, Google Meet, Lark etc.)	256	3.96	0.932	4
5.	Videoconferencing	256	3.80	0.752	5
6.	Electronic purchasing (E-purchasing)	256	3.70	0.907	6
7.	Teleconferencing	256	3.63	0.990	7
8.	Site surveillance technologies (e.g., CCTV, etc.)	256	3.61	0.852	8
9.	Integrated software (e.g., Enterprise Resource Planning (ERP))	256	3.61	1.008	9
10	Global Positioning Systems (GPS)	256	3.60	0.880	10
11	Electronic document management systems (EDMS)	256	3.57	1.034	11

12	Electronic tendering (E-tendering)	256	3.54	0.907	12
13	Geographic Information Services (GIS)	256	3.52	0.885	13
14	Project specific websites (Extranets)	256	3.52	0.990	14
15	Radio Frequency Identification (RFID) and barcodes	256	3.48	0.998	15
	Average Mean			3.72	

(c) Challenges of ICT implementation

From Table 6 below, the budget constraint for ICT investment gets the highest mean value in ranking. The high cost of ICT equipment and solutions has resulted from a small number of prominent vendors, presenting a budgetary difficulty (MUKHONGO, 2013).

Table 6: Challenges of ICT implementation

No	Item	N	Mean	Standard Deviation	Ranking
	Financial				
1.	Budget constraint for ICT investment	256	4.02	0.922	1
2.	Cost of training professionals in ICT	256	3.73	0.849	3
3.	Low returned on investment in ICT	256	3.67	0.842	9
4.	High cost of employing ICT professionals	256	3.71	0.883	4
5.	Teleconferencing	256	3.63	0.990	7
	Average Mean			3.78	
	Human				
1.	Inadequate IC content of construction education	256	3.60	3.69	0.918
2.	Lack of commitment by firm's management towards ICT	256	3.52	3.63	0.920
3.	Inadequate ICT content of construction education	256	3.48	3.64	0.865
4.	Lack of staff with appropriate skill and knowledge in ICT	256	3.52	3.61	0.988
5.	Fear of job losses	256	3.61	3.66	0.875

6.	Satisfaction with appropriate skill and knowledge in ICT	256	3.54	3.71	0.824
	Average Mean			3.66	
	Technical				
1.	Rapid changes in ICT technologies	256	3.91	0.881	2
2.	Problem of ICT integration	256	3.67	0.895	10
3.	Software and hardware reliability problems	256	3.65	0.864	13
4.	Security concerns	256	3.63	0.871	17
5.	High rate of obsolescence ICT products	256	3.64	0.888	15
	Average Mean			3.7	
	Legal				
1.	Risk for liability	256	256	3.71	0.954
2.	Lack of legal support for use of ICT	256	256	3.67	0.939
3.	Security implications of ICT transactions	256	256	3.68	0.868
	Average Mean			3.67	
	Total Average Mean			3.70	

(d) Influencing factors of ICT implementation

From Table 7 below, the influencing factors of ICT implementation which is reliable telecommunication network or telephone lines get the highest mean value in ranking. Contractors may use mobile communication to optimize workflow and increase production if they have access to a reliable telecommunications network or telephone lines. Contractors may utilize their mobile devices to access programs, answer emails, work on presentations, and engage in teleconference talks, among other activities (Scott, 2019).

Table 7: Influencing factors of ICT implementation

No	Item	N	Mean	Standard Deviation	Ranking
1.	Reliable telecommunication network or telephone lines	256	3.98	1.063	1
2.	Cost of acquisition of computer hardware	256	3.82	0.904	2
3.	Cost of acquisition of computer software	256	3.76	0.798	3
4.	Security and safety on the construction site and in the office	256	3.73	0.972	4

5.	Funds availability for ICTs implementation	256	3.71	0.913	5
6.	Cost of subscription to relevant sites	256	3.70	0.875	6
7.	Availability of appropriate ICT Media (e.g. Internet, Mobile phones)	256	3.66	0.894	7
8.	Staff participation in planning and implementation in ICT implementation	256	3.64	0.909	8
9.	Government funding to acquire ICT equipment	256	3.61	0.905	9
10.	Vendors of ICT equipment and consultants' advice and availability	256	3.61	0.988	10
	Average Mean			3.72	

5. Conclusion

In conclusion, this research has shown that all the goals of the study have been successfully accomplished through the SPSS questionnaire data collection. The results have shown that the current practices of ICT implementation were agreed upon by the public use and the challenges faced by the user can be solved. The influencing factors for ICT implementation for communication affect the number of users. However, there are also some limitations in this research and a few suggestions were provided to make advance the research result. Lastly, it is hoped the data that were collected could provide an insight to the industry players in understanding the potential and the challenges of ICT implementation for improving communication among SME contractors in the construction industry.

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