

An Investigation of the Factors That Impact the Intention to Adopt and Use mICT in the Libyan Construction Industry

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Abstract: Information technology has been identified as a vital means for supporting construction project processes, but the level of adoption in the construction industry has been low relative to other sectors. Mobile Information and communications technology (mICT) allows people to access information from wherever they are, and as work in the construction industry is mainly fieldwork with highly mobile workers, mICT holds promise for the sector, particularly in developing countries. The aim of the study reported in this paper was to investigate factors that could impact stakeholders' adoption of mICT in the Libyan construction industry. A model of mICT adoption was developed and tested using data collected from a survey of 202 construction industry stakeholders from 15 companies in Libya. The analysis was undertaken using structural equation modelling. It was found that perceived usefulness and ease of use are important in determining the intention to adopt mICT and that they are influenced by self-efficacy and facilitating conditions. The cost of technology was not found to be a barrier to adoption. Recommendations are made to the construction industry in Libya and relevant government authorities to help improve awareness of the potential of mICT and to help improve potential users' self-efficacy.

Keywords: Mobile technology, Libyan construction industry, Technology adoption

INTRODUCTION

In recent years, the construction industry has changed due to advancements in technology. Information and communications technology (ICT) has been identified as a vital means for supporting construction project processes; however, the amount of ICT use in the construction industry continues to be low relative to the use of similar innovations in other sectors (Australian Bureau of Statistics, 2015). Because of the potential benefits of the new technologies, research has been undertaken in developing countries to explore the constraints that prevent the adoption and usage of these innovations (e.g., Oladapo, 2006; Ikediashi and Ogwueleka, 2016).

In Libya, the level of ICT use in sectors such as telecommunication, oil and gas and banking has been investigated (Twati and Gammack, 2006), but at the time of publication, nothing had been reported with respect to the construction sector. The reconstruction of the country is one of the most important targets of the government (Department for Business, Innovation and Skills, 2011), and the adoption of ICT has the potential to support this goal.

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Mobile ICT (mICT) refers to ICT that allows people to access data and information from wherever they are. Work in the construction industry is mainly fieldwork with highly mobile workers. Therefore, mICT holds promise for the sector in terms of facilitating a wide range of processes that lead to improvements such as reductions in construction time, defects, costs, and accidents (Bowden et al., 2006; Zou et al., 2006). It also holds promise because despite Libya's poor Internet penetration rates, mobile phone usage has increased dramatically in the last decade, and many Libyans access the Internet through their mobile phones (Jones et al., 2012). This paper, therefore, focusses on investigating factors that could impact the adoption of mICT in the Libyan construction industry to address the need for the successful adoption and use of ICT in the sector.

BACKGROUND

The amount of ICT use in the construction industry has generally been low relative to its use in other sectors due to factors such as financial constraints (Australian Bureau of Statistics, 2015), privacy and security, and the reluctance of management to adopt new technologies (Peansupap and Walker, 2006; Froese, Han and Alldritt, 2007).

Studies have investigated how mobile technology can be used to improve business processes in the construction industry. For example, Bowden et al. (2006) reported that improvements such as reductions in construction time, defects, capital cost of construction, waste, accidents, and operation and maintenance costs can be achieved using mICT. Zou et al. (2006) and Venkatraman and Yoong (2009) argued that mICT can play a significant role in enhancing on-site communications and improving the efficiency of construction processes.

The potential benefits of ICT in the construction industry can be of particular value in developing countries; therefore, research has been undertaken in several countries to explore the constraints that prevent the adoption and usage of these innovations (e.g., Oladapo, 2006; Ikediashi and Ogwueleka, 2016). For example, a study in Nigeria found that factors such as insufficient or erratic power supply, high costs of hardware and software, a scarcity of construction specific software, low return on investment in ICT and a fear that ICT will make professionals redundant can negatively affect the uptake of ICT in the construction industry (Oladapo, 2006). Ikediashi and Ogwueleka (2016) identified cost as an ongoing issue and noted that commonly available software for word processing, accounting, communication systems and project management is the software most commonly used in the construction industry in Nigeria.

Ngab (2007) investigated the challenges that impede the development of the construction industry in Libya; however, although the study identified a lack of technical and managerial capabilities, it did not specifically consider the role of ICT or the factors that can hinder the adoption of it. There has been no previous research on ICT adoption and use in the construction industry in Libya.

The key factors in adopting, accepting and using any new technology are the users and their own perceptions of use of the technology. Identifying these factors and targeting them can prevent resistance and increase the chances of successful technology implementation (Shih and Chen, 2013). There is a large

volume of published studies that describe the role of users' perceptions in accepting new technology using models such as the Technology Acceptance Model (TAM) (Davis, Bagozzi and Warshaw, 1989), TAM2 (Venkatesh and Davis, 2000) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003). These studies have reinforced the importance of perceived ease of use and perceived usefulness, but it has been acknowledged that these factors do not fully encompass the technology factors that may determine user acceptance (Sun, Cao and You, 2010).

In the case of mobile technology, several models have been developed based on TAM to investigate the adoption of such technology. These include models in studies by Pedersen (2005), Luarn and Lin (2005) and Sun, Cao and You (2010). In addition to the TAM determinants, perceived ease of use and perceived usefulness, authors have highlighted other factors that are relevant to the construction industry as obstacles to adopting mICT. These factors include perceived cost (Luarn and Lin, 2005; Sun, Cao and You, 2010), facilitating conditions (Pedersen, 2005) and perceived credibility issues related to security and privacy concerns (Luarn and Lin, 2005; Sun, Cao and You, 2010). Other studies specific to the construction industry have also identified hardware limitations (Saidi, Haas and Balli, 2002), high technology cost (Ahsan et al., 2007; Anumba, Aziz and Obonyo, 2003), the fragmented nature of the construction industry (Saidi, Haas and Balli, 2002; Bowden et al., 2006) and organisational issues (Son et al., 2012).

RESEARCH MODEL

In this study, mICT is defined broadly and is considered to include all mobile ICT that allows people to access data and information from wherever they are. It includes everything from smartphone applications for communication used by construction workers to industry-specific software used by managers on laptops. This study was designed to answer the following research question:

What are the factors that could influence mICT adoption and use in the Libyan construction industry?

To answer the research question, a research model based on the broader technology acceptance literature and research on technology adoption in the construction industry was developed. The model was designed to provide a better understanding of the inter-relationships between factors proposed as likely to have a significant role in mICT technology acceptance in the construction industry. This study defines the intention to adopt and use mICT as the degree to which a user (client, project manager, contractor, consultant or worker) is willing and ready to adopt and use mICT in the construction industry. The research model (see Figure 1) includes a set of constructs believed to influence mICT adoption and use: these are perceived usefulness of mICT, perceived ease of use of mICT, perceived mICT self-efficacy to reflect users' concerns about their knowledge of mICT and their ability to use mobile ICT, perceived credibility of mICT to reflect users' concerns about the risks due to transferring data and information through mICT services, perceived high cost of technology to reflect users' concerns about the financial

resources needed to use mICT and facilitating conditions to represent the resources required to use mICT (e.g., infrastructure or other ICT-related resources). The majority of these factors have not yet been studied in the context of mICT in the construction industry.

Perceived usefulness has been defined as "the user's perception of the degree to which using the system will improve his or her performance in the workplace" (Venkatesh and Davis, 1996: 452). This study defines *perceived usefulness of mICT* as the degree to which a construction industry stakeholder (e.g., client, project manager, contractor, consultant or worker) believes that adopting and using mICT would improve the construction industry.

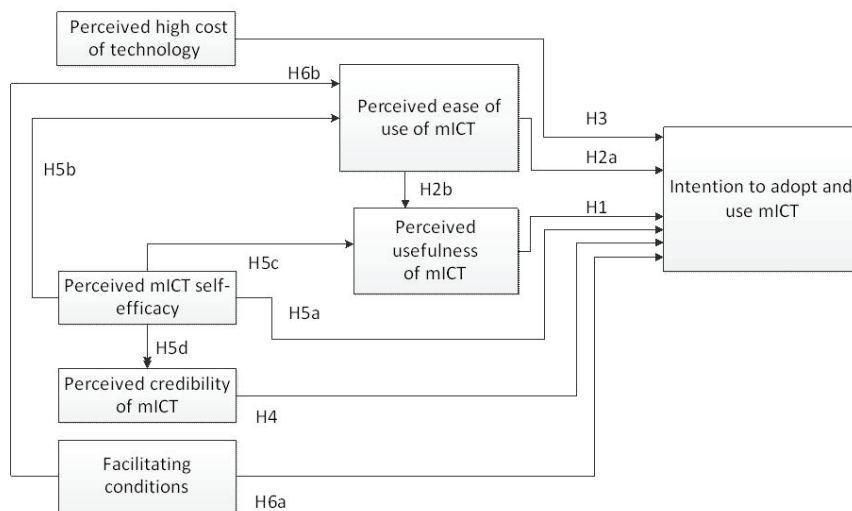


Figure 1. The Research Model

Perceived usefulness is a key determinant of the intention to use information technologies (Pavlou, 2003; Venkatesh et al., 2003; Zampou, Saprikis and Vlachopoulou, 2010). Pagani (2004) also found that perceived usefulness is an important factor in the decision to adopt mobile technologies. Therefore, this relationship is included in the research model, and the following hypothesis is proposed:

H1: Perceived usefulness of mICT will positively affect the intention to adopt and use mICT in the construction industry.

Perceived ease of use is "the degree to which a person believes that using a system will be free of effort" (Davis, 1989: 320). *Perceived ease of use of mICT* is defined in this study as the degree to which a user believes that using mICT in the construction industry would be effortless.

There is evidence that technology usage intention is affected by perceived ease of use (Agarwal and Prasad, 1999; Davis, Bagozzi and Warshaw, 1992; Hu et al., 1999; Venkatesh, 2000; Venkatesh and Davis, 1996; 2000; Venkatesh

and Morris, 2000). It is believed to affect the intention to use ICT directly and indirectly through perceived usefulness (Davis, Bagozzi and Warshaw, 1992; Venkatesh and Davis, 1996; Cheng, Lam and Yeung, 2006; Yaghoubi and Bahmani, 2010). In the case of mICT, Pagani (2004) found that perceived ease of use rated as the second most important factor in determining the adoption of mobile technology, and in the construction industry, perceived ease of use has been found to have a direct positive impact on perceived usefulness (Son et al., 2012). These relationships are therefore included in the research model, and it is hypothesised that:

H2a: Perceived ease of use of mICT will positively affect the intention to adopt and use mICT in the construction industry.

H2b: Perceived ease of use of mICT will positively affect the perceived usefulness of mICT in the construction industry.

Cost reduction is a focus of many construction projects (Manley, Marceau and Hampson, 2001). The costs targeted include construction materials and construction processes. Where ICT is used, the costs also include the acquisition of software and hardware and ongoing updates of the technology. In the construction industry, the diffusion of ICT has been hindered by factors such as the high cost of software and hardware and the high cost of engaging computing staff (Oladapo, 2006). This study defines *perceived high cost of technology* as the degree to which a construction industry stakeholder believes that the costs associated with using mICT in the construction industry are high.

In many studies, high cost has been rated as an important barrier affecting the adoption and use of technologies. For example, Brewer and Gajendran (2012) found that a high cost was rated the second most important barrier to engaging ICT across projects in a construction organisation. These findings are consistent with those of Chong and Pervan (2007) and Harindranath, Dyerson and Barnes (2008).

In terms of mobile technology, adoption and usage have also been found to be affected by obstacles such as high costs (Pagani, 2004). Consistent with this finding, Luarn and Lin (2005) reported that perceived cost had a significant negative effect on the behavioural intention to use mobile technologies. Consequently, the study proposes the following hypothesis:

H3: Perceived high cost of technology will negatively affect the intention to adopt and use mICT in the construction industry.

Perceived credibility is a construct that reflects security and privacy concerns associated with the acceptance of ICT (Wang et al., 2003). In this study, *perceived credibility of mICT* is defined as the degree to which a construction industry stakeholder believes the use of mICT in the construction industry will have no security or privacy threats. Security and privacy are important dimensions of perceived credibility and have been identified as determinants of the intention of users to adopt Internet-based systems (Wang et al., 2003; Warrington, Abgrab and Caldwell, 2000; Ong, Lai and Wang, 2004).

The role of perceived credibility in the domain of mICT has been studied by Luarn and Lin (2005) and Wang et al. (2003), who found that perceived

credibility significantly influences the behavioural intention to use mobile internet. This influence has not been previously studied within the context of mICT in the construction domain; however, it is hypothesised that:

H4: Perceived credibility of mICT will positively affect the intention to adopt and use mICT in the construction industry.

Computer self-efficacy has been defined as "an individual's perceptions of his/her ability to use computers in the accomplishment of a task" (Compeau and Higgins, 1995: 191). Computer self-efficacy has been shown to influence an individual's decision to accept or use ICT (e.g., Compeau, Higgins and Huff, 1999; Hsu and Chiu, 2004; Vijayasarathy, 2004). In this study, *perceived mICT self-efficacy* is defined as a user's belief about his or her ability to use mICT in order to enhance performance in the construction industry.

Luarn and Lin (2005), Sripalawat, Thongmak and Ngramyarn (2011) and Dasgupta, Paul and Fuloria (2011) all found that self-efficacy has a positive effect on the behavioural intention to use mobile technology. Consistent with this previous research, it is expected that as the self-efficacy the stakeholders in the construction industry increases, so will their intention to adopt and use mICT. Therefore, the following hypothesis is proposed:

H5a: Perceived mICT self-efficacy will positively affect the intention to adopt and use mICT in the construction industry.

There is also empirical evidence for a relationship between self-efficacy and perceived ease of use. For example, Igarria, Ibari and Maragahh (1995), Venkatesh and Davis (1996) and Venkatesh (2000) all found that self-efficacy significantly affects perceived ease of use. These results were supported by the findings of Luarn and Lin (2005), who provided evidence of a significant positive effect of perceived self-efficacy on perceived ease of use of mobile banking. Therefore, it is expected that as the self-efficacy of stakeholders in the construction industry increases, so will their ease of use of mICT. The following hypothesis is therefore proposed:

H5b: Perceived mICT self-efficacy will positively affect the perceived ease use of mICT in the construction industry.

There is also evidence of a link between perceived self-efficacy and perceived usefulness of technology (e.g., Agarwal, Sambamurthy and Stair, 2000; Wang et al., 2003), where users who have higher self-efficacy in using information systems are more likely to believe that they are useful; therefore, it is hypothesised that:

H5c: Perceived mICT self-efficacy will positively affect the perceived usefulness of mICT in the construction industry.

Wang et al. (2003) argued that self-efficacy might be positively related to the existence of concerns regarding the security and privacy of online exchanges. Consistent with this argument, Ong, Lai and Wang. (2004) stated that the more online experience individuals acquire, the more important their concerns about

control over their personal information become and that individuals with more experience are possibly more aware of the limitations and lack of privacy and security of information systems, implying that self-efficacy will have a negative influence on perceived credibility. The findings of their study provided evidence of a significant negative effect of self-efficacy on the perceived credibility of online information systems. Therefore, it is proposed that:

H5d: Perceived mICT self-efficacy will negatively affect the perceived credibility of mICT in the construction industry.

Facilitating conditions has been defined as "the degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system" (Venkatesh and Zhang, 2010 p.7). The absence of good facilitating conditions represents barriers to effective use and may hinder the adoption and usage of ICT (Kripanont and Tatnall, 2009). *Facilitating conditions* is defined in this study as the degree to which a construction industry stakeholder believes that an organisational and technical infrastructure exists to support the use of mICT in the construction industry.

Facilitating conditions has been found in many studies to have a significant effect on the behavioural intention to use information systems (Dwivedi et al., 2007; Ooi et al., 2011). However, some studies have not found the relationship to be significant (e.g., Venkatesh et al., 2003; Kripanont and Tatnall, 2009).

With respect to mICT, Lu et al. (2014) hypothesised a direct relationship between facilitating conditions and acceptance; however, the results revealed only marginal support for this hypothesis. Although there have been mixed results about the role that facilitating conditions play in the acceptance of ICT in other domains, it is anticipated that it will play an important role in enabling the uptake of mICT in the construction industry (Venkatraman and Yoong, 2009). Therefore, the following hypothesis is posited:

H6a: Facilitating conditions will positively affect the intention to adopt and use mICT in the construction industry.

As facilitating conditions are perceived enablers or barriers that influence a person's perception of the ease or difficulty of performing a task (Teo, 2010), the relationship between facilitating conditions and perceived ease of use has been studied. For example, Teo, Lee and Chai (2008) and Teo (2010) found that facilitating conditions have a significant influence on perceived ease of use. Consistent with this, this study hypothesises that:

H6b: Facilitating conditions will positively affect the perceived ease of use of mICT in the construction industry.

METHODOLOGY

This study was designed to test a model that explains the intention of stakeholders to adopt and use mICT in the construction industry in Libya, and a questionnaire was chosen as the data collection approach.

Participants

The population of interest for this study was stakeholders in the Libyan construction industry: consultants, project managers, contractors and workers. A cluster sampling approach was used to recruit the participants and the study was conducted using Libyan construction companies in three different cities to obtain a wide range of companies. The cities were Tripoli, Zawia and Zuwara, and the companies were drawn from different sectors: the public sector, the private sector and the self-employment sector (self-employment in Libya means that all employees in the company are the owners of that company.) The participants were recruited from 15 construction companies in the three selected cities. These companies were selected as representative from lists obtained from the Libyan Ministry of Housing and General Utilities.

Data Collection Procedure

Questionnaires and an information letter were distributed by the administration manager of each company to potential participants and returned in a provided stamped envelope. Potential participants needed to be at least 18 years old, to have owned or used mobile technologies (such as smartphones) for at least three years, and to be involved in the construction industry. Three hundred and twenty questionnaires were distributed, and 202 completed questionnaires were returned, giving a response rate of 63.1%.

The Questionnaire

The questionnaire was designed in English and translated to Arabic. The items were pilot tested with several members of the target population, and minor changes were made. The first section of the questionnaire collected demographic information. The second section included items to measure the constructs in the model. Wherever possible, the items used to measure these constructs were adapted for the construction industry domain from instruments used in previous research, with new items developed as needed. All model constructs were measured on a 5-point Likert scale that ranged from "strongly disagree" to "strongly agree".

Five items were used to measure *intention to adopt and use mICT*: two from Venkatesh and Davis (2000), one from Luarn and Lin (2005), one from Cheong and Park (2005), and one developed specifically for the study. *Perceived usefulness of mICT* was measured with 10 items. Six items were developed for this study based on Bowden et al. (2006). In addition, four from Davis (1989), Cheong and Park (2005), Pedersen (2005) and Venkatesh and Davis (2000) were slightly reworded for the mICT domain.

Five items were used to measure *perceived ease of use of mICT*. Three were from Davis (1989), one was from Agarwal and Prasad (1999) and one was from Venkatesh and Davis (2000). The items were modified for mICT and the construction domain. Five items were also used to measure *perceived high cost of technology*: three were developed for this study, and the others were from Kim, Choi, and Han (2009) and Cheong and Park (2005).

To measure *perceived credibility of mICT*, five items from Cheng, Lam and Yeung (2006) and one item from Wang et al. (2003) were used. *Perceived mICT self-efficacy* was measured using five items: two from Pedersen (2005) and two from Venkatesh (2000). These items were reworded to fit this study. One item was also developed for this study. Seven items were used to measure *facilitating conditions*. Six were from Pedersen (2005) and one was from Thompson, Higgins and Howell (1991).

Data Analysis

The relationships in the model were tested using partial least squares (PLS). A two-step approach commonly used in structural equation modelling was used. In this approach, the fit and construct validity of the proposed measurement model are tested first. Once a satisfactory measurement model is obtained, the structural model is estimated. SmartPLS version 2.0 was used for this process.

RESULTS

In the Libyan construction industry, as in other construction domains, most workers are males, which can be attributed to the nature of work. Consistent with this pattern, only 26 females completed the questionnaire (12.9%) and 176 respondents were males (87.1%). The most common age group was 30 to 39 (43.1%), and only 17.3% were between 18 and 29. Responses were fairly evenly divided between the public (50.5%) and private (46.0%) sectors, with only 3.5% from the self-employed category. Levels of previous mICT experience were also of interest, with 86.1% of participants reporting intermediate levels of mICT experience and only 3% considering themselves to be beginners.

Measurement Model

The measurement model was assessed in terms of convergent validity and discriminant validity. Items that did not load satisfactorily on their constructs (≥ 0.7 , Hair et al., 2013) were dropped from the measurement model. All remaining items loaded significantly on their latent construct ($p < 0.05$).

The other criteria used for evaluating convergent validity were composite reliability, Cronbach's alpha and average variance extracted (AVE). As observed from Table 1, all values of composite reliability and Cronbach's alpha were satisfactory at more than 0.70, and all values of AVE were more than 0.50 (Hair et al., 2013). Consequently, all criteria to establish the convergent validity of the research constructs were met.

Table 1. Convergent Validity Measures

| Construct | Composite Reliability | Cronbach's Alpha | AVE |
|-----------------------------------|-----------------------|------------------|-------|
| Perceived usefulness of mICT | 0.924 | 0.901 | 0.672 |
| Perceived ease of use of mICT | 0.882 | 0.823 | 0.653 |
| Intention to adopt and use mICT | 0.931 | 0.907 | 0.731 |
| Perceived credibility of mICT | 0.970 | 0.963 | 0.847 |
| Perceived high cost of technology | 0.911 | 0.868 | 0.774 |
| Perceived mICT self-efficacy | 0.904 | 0.841 | 0.758 |
| Facilitating conditions | 0.938 | 0.912 | 0.794 |

Two procedures were used for assessing discriminant validity. The first procedure involved comparing item cross loadings to construct correlations. Items should be strongly correlated with their construct and weakly correlated with the other constructs in the model, and all values of the outer loadings of items on their construct were found to be higher than the values of the cross loadings. The second procedure involved comparing the ratio of the square root of the AVE of each construct to the correlations of the construct with all other constructs (Hair et al., 2013). Table 2 shows that the square root of AVE for each construct was greater than any correlation between the construct and any other construct. Therefore, both criteria were satisfactorily met, and the discriminant validity of the measurement model was demonstrated.

Table 2. Discriminant Validity

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| 1. Facilitating conditions | 0.891 | | | | | | |
| 2. Intention to adopt and use mICT | 0.460 | 0.855 | | | | | |
| 3. Perceived credibility of mICT | 0.614 | 0.407 | 0.920 | | | | |
| 4. Perceived ease of use of mICT | 0.577 | 0.584 | 0.516 | 0.808 | | | |
| 5. Perceived high cost of technology | 0.461 | 0.214 | 0.334 | 0.270 | 0.880 | | |
| 6. Perceived usefulness of mICT | 0.587 | 0.612 | 0.571 | 0.526 | 0.299 | 0.820 | |
| 7. Perceived mICT self-efficacy | 0.657 | 0.388 | 0.436 | 0.615 | 0.285 | 0.424 | 0.870 |

Structural Model

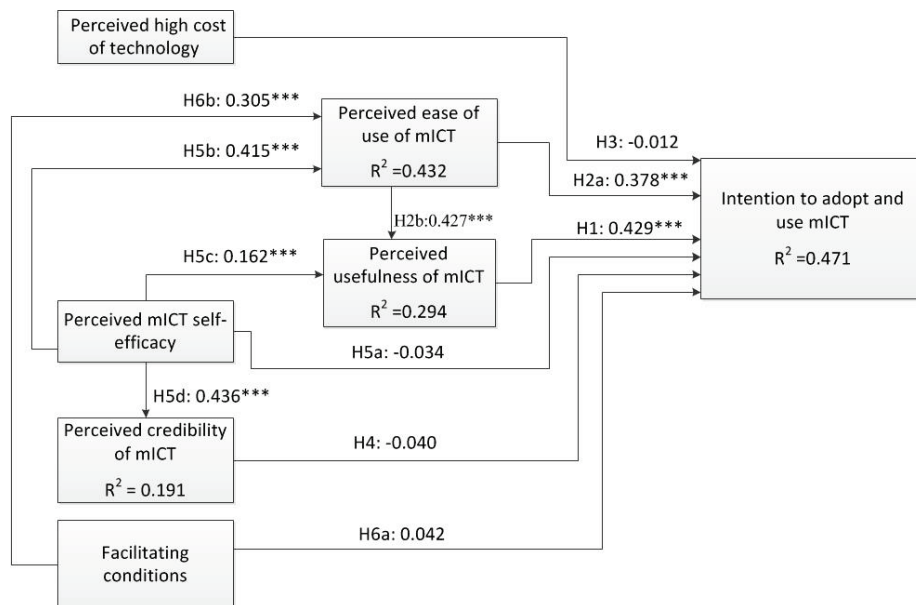
Four aspects of the structural model were assessed: collinearity, significance of path coefficients, coefficient of determination (R^2) and predictive relevance (Q^2).

A collinearity assessment was used to check whether there were significant collinearity levels between groups of predictor constructs. Collinearity is assessed relative to tolerance or variance inflation factor (VIF) guidelines, where each predictor variable's tolerance should be higher than 0.2 and lower than 5 (Hair et al., 2013). The following three groups of constructs were assessed for collinearity, and the VIF values of all predictor constructs in the structural model

were below 5; collinearity among the predictor variables was, therefore, not an issue in the structural model:

1. Perceived mICT self-efficacy and facilitating conditions as predictors of perceived ease of use of mICT.
2. Perceived ease of use of mICT and perceived mICT self-efficacy as predictors of perceived usefulness of mICT.
3. Perceived high cost of technology, perceived ease of use of mICT, perceived usefulness of mICT, perceived mICT self-efficacy, perceived credibility of mICT and facilitating conditions as predictors of intention to adopt and use mICT.

The bootstrapping technique implemented in SmartPLS 2.0 was used to evaluate the significance of the hypothesised relationships. Figure 2 shows the standardised coefficients for each hypothesised path in the model. Seven of the 11 hypotheses were supported.



Notes: ** $p < 0.01$; *** $p < 0.001$

Figure 2. Hypothesis Testing Results

As observed, perceived usefulness of mICT had a significant influence on the intention to adopt and use mICT in the Libyan construction industry; consequently, H1 was supported. Perceived ease of use of mICT had both a significant impact on intention to adopt and use mICT and a significant effect on perceived usefulness of mICT, so both H2a and H2b were supported.

Perceived high cost of technology had no significant influence on the intention to adopt and use mICT in the Libyan construction industry. Therefore, H3 was not supported. H4 was also not supported as perceived credibility of mICT did

not demonstrate a significant impact on intention to adopt and use mICT in the Libyan construction industry.

Perceived mICT self-efficacy had no significant effect on intention to adopt and use mICT in the Libyan construction industry; therefore, H5a was not supported. Perceived mICT self-efficacy did, however, significantly influence perceived ease of use of mICT and perceived usefulness of mICT, so H5b and H5c were both supported. It was proposed that perceived mICT self-efficacy would negatively affect the perceived credibility of mICT (H5d). Perceived mICT self-efficacy did not, however, demonstrate a negative effect on the perceived credibility of mICT but rather had a positive effect; therefore, this hypothesis was not supported.

Facilitating conditions had no significant direct impact on the intention to adopt and use mICT in the Libyan construction industry, and as a result, H6a was not supported. Facilitating conditions did, however, positively influence perceived ease of use of mICT, so H6b was supported.

R^2 values are measures of the ability of the model to explain the variance in the dependent variables and are reported in Figure 2. The model explained 47.1% of the variability in intention to adopt and use mICT in the Libyan construction industry. The variability in the precursors of intention to adopt and use mICT was also of interest: the model explained 29.4% of the variance in perceived usefulness of mICT, 43.2% of the variance in perceived ease of use of mICT and only 19.1% of the variance in perceived credibility of mICT.

Finally, a predictive relevance assessment was performed using Stone-Geisser's Q^2 test (Geisser, 1974; Stone, 1974). In this study, a cross-validated redundancy approach was used to obtain Q^2 , as recommended by Hair et al. (2013). Q^2 represents a measure of how well-observed values are reconstructed by the model and its parameter estimates. $Q^2 > 0$ implies that the model has predictive relevance, whereas $Q^2 \leq 0$ represents a lack of predictive relevance. The outcomes of this assessment showed that the Q^2 for intention to adopt and use mICT was 0.350, the Q^2 for perceived ease of use of mICT was 0.275, the Q^2 for perceived usefulness of mICT was 0.195 and the Q^2 for perceived credibility of mICT was 0.159. All Q^2 values were above zero and thus suggested that the model had good predictive relevance.

DISCUSSION

Libya faces the challenge of reconstructing its infrastructure destroyed by civil war, and mobile technologies can support the construction industry in achieving this. The study described in this paper was carried out to address the need for the successful adoption of mICT in the sector and to investigate factors that may influence it. No previous published research has explored the role of ICT in the construction industry in Libya, so this paper makes a timely contribution.

A model to explain stakeholders' intentions to adopt and use mICT was introduced and tested. The factors investigated were perceived usefulness of mICT, perceived ease of use of mICT, perceived high cost of technology, perceived mICT self-efficacy, perceived credibility of mICT and facilitating conditions.

Intention to adopt and use mICT was found to be directly affected by two key factors, perceived usefulness of mICT and perceived ease of use of mICT, and indirectly influenced by perceived mICT self-efficacy and facilitating conditions. The results, therefore, suggest that when stakeholders in the Libyan construction industry believe that mICT will be useful, they are more likely to intend to adopt and use it. In addition, perceived ease of use of mICT plays an important role. Perceived ease of use of mICT was influenced by both perceived mICT self-efficacy and facilitating conditions and in turn influenced perceived usefulness of mICT and intention to adopt and use mICT.

The model explained 47.1% of the total variance in the stakeholders' intended adoption and use of mICT. This finding is consistent with prior studies such as Zampou, Saprikis and Vlachopoulou (2010), whose model explained 38.3% of the variability in the intention to adopt mobile services. However, the explanatory power could possibly be increased by including the influence of other factors. For example, Son et al.'s (2012) model of factors that influence the successful implementation of mobile computing devices in the construction industry explained 67% of the variance in the intention to adopt and included social influence. Moreover, other factors related to individual characteristics, such as resistance to change, have been shown to have a significant influence on the success of ICT implementation in the construction industry (Henderson and Ruikar, 2010), so they should be considered in future research.

The Role of Perceived Usefulness of mICT

This study revealed that perceived usefulness of mICT plays a significant role in influencing users' intention to adopt and use mICT in the construction industry. This finding is consistent with other studies such as Son et al. (2012), Luarn and Lin (2005) and Sun, Cao, and Yu (2010), who all found that perceived usefulness had a significant effect on users' adoption intention and acceptance of mobile technology.

The Role of Perceived Ease of Use of mICT

Perceived ease of use of mICT was found to have a significant direct influence on intention to adopt and use mICT and a significant direct effect on perceived usefulness of mICT. The direct relationship between perceived ease of use of mICT and intention to adopt and use mICT is consistent with studies such as Son et al. (2012), Luarn and Lin (2005) and Sun, Cao and You (2010). Likewise, the relationship between perceived ease of use of mICT and perceived usefulness of mICT is consistent with the results of previous studies such as Luarn and Lin (2005), Yaghoubi and Bahmani (2010) and Son et al. (2012), which means that perceived usefulness of mobile technologies in the construction industry increases when stakeholders perceive that mICT technologies are easy to use and that not much effort will be required to use them.

The Role of Perceived High Cost of Technology

Perceived high cost of technology was hypothesised to directly influence intention to adopt and use mICT. However, the relationship between perceived high cost of

technology and intention to adopt and use mICT was not as expected. Although participants were aware that the price of mICT technologies could be high, they also considered mICT beneficial to their jobs rather than a financial burden. These findings are inconsistent with those of Luarn and Lin (2005), Harindranath, Dyerson and Barnes (2008) and Brewer and Gajendran (2012), as their studies all reported a negative relationship between perceived financial cost and behavioural intention to use mobile technology. This difference may be because in Libya stakeholders are aware that mICT facilities and infrastructure in public sector and government companies are financially supported by the government, and they recognise that mICT can be used to complete work in the construction industry even if there are financial barriers.

The Role of Perceived Credibility of mICT

Surprisingly, the results also did not support the proposed direct relationship between perceived credibility of mICT and intention to adopt and use mICT. This result is inconsistent with Sun, Cao and You (2010), who reported that their study supported the findings of Luarn and Lin (2005) and Wang, et al. (2003), who showed that perceived credibility influences the behavioural intention to use mICT. The majority of participants in this study believed that mICT is very secure and did not have concerns about using it for work in the construction industry.

The Role of Perceived mICT Self-Efficacy

The results showed that perceived mICT self-efficacy indirectly influenced intention to adopt and use mICT via both perceived ease of use of mICT and perceived usefulness of mICT. These results are consistent with the findings of Wang et al. (2003) and Luarn and Lin (2005). The results also confirm the proposed direct relationship between perceived mICT self-efficacy and perceived credibility of mICT, which is consistent with Wang et al.'s (2003) findings. It was interesting to note that perceived mICT self-efficacy had a similarly strong influence on both perceived credibility of mICT and perceived ease of use of mICT but a weaker influence on perceived usefulness of mICT. This implies that if stakeholders feel confident about their mICT skills, they generally demonstrate a higher perception of credibility and ease of use of mICT; it also suggests that users with high expertise might rate mICT as more secure and easier to use than those with lower expertise.

Role of Facilitating Conditions

Consistent with previous studies such as Venkatesh et al. (2003) and Kripanont and Tatnall (2009), the findings of this study did not support the proposed direct relationship between facilitating conditions and intention to adopt and use mICT, even though this relationship was supported by Dwivedi et al. (2007) and Ooi et al. (2011). However, an indirect relationship between facilitating conditions and intention to adopt and use mICT via perceived ease of use of mICT was found, and this provides a possible explanation for the marginal relationship in Lu et al. (2014). Users find mICT easier to use when they have adequate technical support and good communications infrastructure and when there are no compatibility problems; this in turn influences their adoption.

Practical Implications for the Libyan Construction Industry

This study has highlighted factors that can impact the success of mICT adoption in the Libyan construction industry. Attention should be paid to these factors by construction organisations in Libya and in other developing countries that plan to adopt mICT. Construction companies could adopt plans to improve construction stakeholders' self-efficacy with mobile technology and improve project performance by organising training courses in various mobile technologies, thus increasing stakeholders' familiarity with mICT, which in turn can positively influence the intention to adopt and use mobile technologies.

In addition, this study recognises the importance of government support for mICT. Libya has been involved in a serious civil war that has destroyed buildings and infrastructure; reconstructing and rebuilding the country is one of the major targets of the government, and innovations such as mobile technologies can support this goal. Understanding the factors that influence successful adoption will help the authorities who are involved in the Libyan construction industry (e.g., the Ministry of Housing and Utilities) to avoid the impediments that can negatively affect the adoption and usage of these technologies. Authorities should provide gateways to disseminate an mICT culture among construction stakeholders by, for example, conducting seminars or disseminating newsletters regarding this technology and expanding training programmes to improve the mICT skills of construction stakeholders.

The results of this study suggest that the construction industry in Libya is ready to adopt mICT and that the provision of government support will enable a smooth transition.

CONCLUSIONS

Work in the construction industry is mainly fieldwork with highly mobile workers. This work can be facilitated by the use of mobile technologies. This study investigated the factors that affect the intention of stakeholders to adopt and use mICT in the Libyan construction industry, and a research model based on the broader technology acceptance literature was developed to provide a framework for the research. The study found that the intention to adopt and use mICT in the Libyan construction industry was directly affected by perceived usefulness of mICT and perceived ease of use of mICT and indirectly affected by perceived mICT self-efficacy and facilitating conditions. This means that the more stakeholders perceive mICT useful as and easy to use, the more likely they are to intend to adopt and use it. Similarly, for perceived mICT self-efficacy, the more stakeholders feel confident about their use of mICT, the more likely they are to intend to adopt and use mICT. Likewise, for facilitating conditions, the more adequate technical support and the fewer compatibility problems stakeholders have using mICT, the more likely they are to find it easy to use and hence adopt it. It was proposed that the cost of the technology would also influence the intention to adopt it, but this was found not to be the case. The model included additional factors that had not been previously tested in the construction domain, and this adds to the understanding of enabling factors in this area in developing countries.

There are, however, limitations of the research that have implications for future research. First, the participants in the study were drawn from just 15 companies in three cities; a larger sample drawn from more companies across the country would have been more representative. Second, the participants were most likely older and more educated than might be expected in the industry. Possible differences resulting from this could be explored in future research that targets underrepresented groups of stakeholders, possibly through targeted interviews. Additionally, the ability to explain intention to adopt and use mICT could potentially be improved by the addition of other factors to the model. For example, social influence has been shown to have an impact on the decision to adopt mobile computing devices in construction (Son et al., 2012) and may a useful addition that could be explored in future research. Future comparisons of the Libyan construction industry and that in other countries in terms of adopting mICT may also provide valuable insights into how to facilitate successful adoption and use.

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