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An exploratory study on the impact of mobile ICT on productivity in construction projects

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An Exploratory Study on the Impact of Mobile ICT on Productivity in Construction Projects

Abstract

Purpose
The issue of low productivity has remained a very stern and chronic problem in construction projects. Previous studies have found poor communication as one of the leading causes of low construction productivity. Recent advances in the field of Information and Communication Technologies (ICT) have the potential to enhance communication and access to information in construction projects. However, the implications of the use of mobile ICT on construction productivity have not been investigated in sufficient depth, especially from the perspectives of its users i.e. construction management (CM) professionals.

Design/methodology/approach
A focus group session involving ten experienced CM professionals from different organisations of the South Australian construction industry was moderated by a group of four researchers to gather data on mobile ICT usage and its implications for construction productivity.

Findings
Lack of training and guidelines on effective applications of these technologies to construction projects is a major bottleneck. Results indicate that despite noticeable advances in mobile ICT, differences in usage style and user attitude have limited their overall impact on productivity.

Research limitations/implications
This paper is based on data gathered from CM professionals working in the South Australian construction industry.

Practical implications
The study highlights the importance of strategising the use of mobile ICT to achieve the desired productivity rates through policy, training, work-life balance, and deeper and wider understanding of these technologies.

Originality/value
The study examines the perceptions of CM professionals on the usefulness of mobile ICT in construction projects and its implications for construction productivity.

Keywords: Productivity, information and communication technologies, mobile devices, cloud computing

Introduction

The construction industry contributes significantly to both the economy and employment in various countries (Naoum, 2016). In Australia, the construction industry directly employs over one million people (around 8.9% of the total workforce) and contributes 7.7% to the Gross Domestic Product or GDP (Office of the Chief Economist 2015). However, the construction industry's productivity is low compared to service and other industries such as manufacturing. In a recent study on improving Australia's global competitiveness, the consultancy firm

McKinsey-Australia (2014) recommended a more focussed approach for the construction industry to improve GDP per-hour worked in Australia. The Productivity Commission (2015) has also noted that productivity rates in many sectors, including the construction sector, are not sufficient to sustain ongoing growth in Australia.

Many construction projects suffer from time delays and cost overruns due to productivity issues. Employment of unskilled workers and slow adoption of information and communication technologies (ICT) are found to be the major reasons for such low productivity (Jarkas, 2010). Due to involvement of multiple parties in a construction project, proper communication between them is critical to its success (Cheng *et al*., 2001). Although recent advances in ICT in the form of mobile technologies have changed the way communication and information sharing take place in many industries (Bresnahan and Yin, 2017), there are certain characteristics that differentiate the construction industry from others. A very high ratio of turnover to profit or low profit margins of construction organisations limit their capacity for any substantial investment on ICT. Moreover, the industry is heterogeneous, highly fragmented, geographically dispersed, labour intensive, highly regulated, and relationships in construction projects are temporary or short-term (Dainty *et al.*, 2006).

Despite the above limitations, mobile ICT such as smartphones and tablets, mobile applications, wireless network, and cloud storage can offer an effective way to overcome the problems of collaboration in construction projects. However, unlike other industries, its use within the construction industry has not been explored in sufficient depth. Since these technologies can close the existing gaps in communication and collaboration (Anumba *et al.*, 2012; Mathiassen and Sørensen, 2008), it is argued that leveraging these technologies to their full extent could pave a new direction in improving construction productivity. Consequently, this study aims to examine the use of mobile ICT in construction projects and its implications on construction productivity. The results are expected to shed some light on the above relationship, users' expectations, and barriers of mobile ICT in construction projects.

Literature review

As quoted by Lester (2014, p. 359), 'Information, together with communication, are the very lifeblood of project management'. From conception to completion of a construction project, as a means of record and communication, a large number of documents are generated and exchanged (Downey, 2006). However, the manual approaches to dealing with information often result in wasted time and increased cost in construction projects (Cervone, 2014; Mohamed and Stewart, 2003).

Based on a review of 42 articles on factors affecting construction productivity, poor communication was cited by twenty-two different studies (Hasan *et al.* 2017). Various communication issues such as misunderstanding between worker and superintendents, lack of clarity of instructions and technical specifications, low level of coordination among construction parties, delay in responding to requests for information (RFI), and slow decision-making have continued to impede productivity in both developed and developing countries (Dai *et al.*, 2009; El-Gohary and Aziz, 2013; Jarkas and Bitar, 2012). Hughes and Thorpe (2014) using a case study of Australian construction projects showed that poor communication has a moderate to strong effect on productivity.

The literature generally demonstrates that good communication and timely availability of information are prerequisites for achieving higher productivity rates in a construction project. However, Yang *et al.* (2007) argued that traditional ICT cannot meet the desired levels of

communication and information transfer in construction projects due to their functional limitations. On the other hand, mobile ICT has the potential to significantly improve field work, on-site information management, and productivity in projects because its users can access computing and communication functionalities seamlessly, regardless of space and time (Anumba and Wang, 2012; Son *et al.,* 2012). Mobile devices allow users to perform tasks more efficiently with greater accuracy and less management inefficiencies and thus enhance communication and collaboration (Ellis and Collins, 2015; Sattineni and Schmidt, 2015). Mobile applications augment the capabilities of mobile devices by performing a range of different tasks (Seewald, 2014). The professional use of social media is also gaining popularity across various industries for information exchange and collaboration (Azhar and Abeln, 2014; Burke-Garcia and Scally, 2014).

Currently, with the remarkable advancements in both hardware and software, the use of mobile ICT has increased enormously in the construction industry (Sattineni and Schmidt, 2015). A questionnaire survey conducted by Atalah and Seymour (2013) in the Ohio construction industry in the United States (US) found 72.1 percent of respondents showed a high level of interest in tablet PCs, smartphones, and wireless hotspots. Feldman and Feldman (2013) reported that half to two-thirds of contractors and subcontractors in US were using smartphones daily while about one in five tablets. In Saudi Arabia, Sidawi and Alsudairi (2014) found that the use of mobile ICT helps construction professionals to manage remote construction projects efficiently. Sattineni and Schmidt (2015) found that mobile devices are constantly used amongst superintendents and project managers on construction sites in the US construction industry.

From the review of the extant literature, it seems that the previous researchers have primarily focussed on the extent or type of mobile ICT being used in construction projects predominantly using quantitative research methods involving surveys. The interaction of users with these technologies and their impact on productivity has not been properly investigated. Therefore, more studies inquiring the perceptions of construction management (CM) professionals on mobile ICT could help the industry to develop strategies to overcome barriers of its adoption. Moreover, by studying the implications of the use of mobile ICT on construction productivity, new approaches to improve its effectiveness could be identified.

Research method

The choice of a particular research method is driven by research questions (Creswell, 2014). Due to the exploratory nature of this study, a qualitative research method was selected. A qualitative research approach is recommended in situations where the topic is new and key variables are unknown (Creswell, 2014; Fellows and Liu, 2003). Since this study focuses on mobile ICT from a user perspective, an in-depth investigation of its use and the relationship to productivity was undertaken through a focus group interview. Focus group interviewing is particularly suited for obtaining differing perspectives about the same topic from the people who are involved in the subject under investigation. It helps in increasing the depth of the enquiry and reveals less accessible aspects of the subject resulting from the discussion (Doody *et al.,* 2013). The main advantage of focus groups over one-to-one interviews is the insight and data produced by the interaction between participants (Lindlof and Taylor, 2002). Collis and Hussey (2009) suggested that if the topic is of interest and relevance to the focus group participants, the members will generate relevant discussion.

In regard to the number of participants, Murray (2010) concluded that a group of five to ten participants is the most effective for exploration of a topic. Consequently, a focus group session

was conducted with ten experienced CM professionals working in the South Australian construction industry. A purposive sampling technique was used to select the participants (DePoy and Gitlin, 2016). The mean age of the participants was 44 years (SD=12.87) whereas, the mean experience was 17 years (SD=7.73) which is considerably high and helped in achieving a rounded view about the topic under consideration. The main strength of the group was that eight out of the ten participants held a senior position in their respective companies. Hence, the participants were well experienced and capable of judging the implications of mobile ICT use on productivity. Moreover, the participants were from different sectors and had worked in different projects spanning across South Australia. Therefore, their views represented a cross-section of CM professionals working in the South Australian construction industry. Due to their long association with the industry, the participants were known to each other. Murray (2010) suggested that it is appropriate to select participants known to each other if the topic is not sensitive to members, as this allows for the discussion to take place in a natural setting. The profile of the participants is shown in Table 1.

Table 1. Profile of the focus group participants

Attributes	Classification	Number of participants
Age		
	21-30	2
	31-40	2
	41-50	1
	Above 50	5
Education		
	High school	1
	Diploma	1
	Graduate	6
	Masters	2
Role		
	Site Engineer (SE)	1
	Site Supervisor (SS)	1
	Project Manager (PM)	4
	Executive (EX)	4
Experience		
	Less than 5 years	1
	6-10 years	1
	11-15 years	2
	16-20 years	1
	More than 20 years	5
Organization and sector		
	Contractor-Residential Building (RB)	2
	Contractor-Commercial Building (CB)	4
	Contractor-Industrial Building (IB)	1
	Contractor-Infrastructure Projects(IP)	3
Focus group participants' code	*(1) SE-CB, (2) SS-IP, (3) PM1-RB, (4) PM2-CB, (5) PM3-IB, (6) PM4-IP, (7) EX1-RB, (8) EX2-CB, (9) EX3-CB, and (10) EX4-IP*	

The discussion of the focus group was recorded (with the permission of the participants), transcribed, and analysed, using code-based content analysis. Words, phrases, and sentences were used for coding the transcript. The 90 minutes session focussed on three major aspects of mobile ICT and productivity: (1) the type and extent of mobile ICT in the South Australian construction industry; (2) the implications of mobile ICT on construction productivity; and (3) the limitations of mobile ICT when it is used in construction projects. The session was moderated by four researchers from two leading universities in South Australia who had a range of expertise and experience conducting research in the area of construction management. The moderators assumed a neutral position towards the group members.

Findings and discussion

Any formal analysis of focus-group, interview, or panel discussion should include a summary of the most important themes, the most noteworthy quotes, and any unexpected findings (Breen, 2006). The analysis led to four themes: (1) user preference of devices and applications; (2) implications for productivity; (3) reflections on organisational practices and training; and (4) health and safety considerations for users. Anonymous quotes from participants have been used here. Due to space limitations, all quotes relevant to an observation cannot be included. Rather, one or two as example (representative) quotes have been used. In brackets the code of the participant is shown; i.e. the code (PM2-CB) refers to a Project Manager 2 (PM2) from a Commercial Building (CB) background. Table 1 shows the codes of all participants.

User preference of devices and applications

Smartphones and tablets have become an integral part of day-to-day process across every business sector, and the construction sector is no different (Corobrik, 2014). While CM professionals are using different kinds of mobile devices ranging from smartphones and tablets to convertible laptops in construction projects, the participants favoured the use of tablets on construction sites. It is usually more convenient to review and modify electronic documents on a tablet due to the larger display (Ballan and El-Diraby 2011; Latham, 2014). On the other hand, the small screen size of smartphones does not fulfil the keyboard computing needs of many applications (Ellis and Collins, 2015). Consequently, the form factor of the mobile device plays an important role in deciding its suitability for a particular job. This was also confirmed by the focus group participants. The following quotes are examples that best reflect their preferences:

> I rarely send an email from my smartphone if it is not concise. I (usually) send emails from my tablet (EX3-CB).

> I need data connectivity from mobile and then I write emails using my laptop even when I am on the site. However, I read or receive emails on my tablet rather than on my smartphone. It is because the tablet has a bigger display and it is closer to what I always prefer i.e. a hard copy (EX1-RB).

The functionality gap between smartphone, tablet, and the laptop, necessitates the use of a combination of these devices to serve different purposes (Ellis and Collins, 2015). However, the content, hierarchy, and timing or urgency of the communication also dictate the selection of ICT use on construction sites. In addition, size and importance of a document affect the choice of the device. These convictions are reflected in the transcripts, for example:

> If you are using smartphones for emails while working simultaneously in the field, there is a danger that you would send the information that you do not want to send. In the

> construction space, it is important that the information you are giving is correct because it can be traced back. If there is a legal aspect, do not do it on your smartphone (EX2-CB).

> On site, I am using a tablet but when in the office, I use the laptop. I use my smartphone primarily to contact people. Call - Text – Email to get their attention (EX4-IP).

While the younger generation is considered to be the main users of mobile devices compared to their older counterparts, the panel argued that it is not necessarily true. Some workers are more comfortable with these technologies than others and it does not have any correlation to age. The usage also depends on other factors such as educational background, type of job, and interest in technology. Atalah and Seymour (2013) also found that technology interest and use is becoming less dependent upon age. The following quote is an example of this general observation:

> We use a cloud-based project management application. If there is an instant report, one manager does straight on his/her (smart) phone and other one goes back to the office and takes a printout, fills it out, and then fills it in again on the computer. Even they are of same age, they have different backgrounds and attitudes towards technology and therefore, different ways of doing the same thing (PM2-CB).

Although it is argued that getting rid of paper can only direct the CM professionals to use these devices more efficiently, participants opined that the industry is still not ready for paperless work environment. Although Australia is considered as an advanced user of ICT and higher levels of electronic document exchange is expected, paper-based processes are prevalent at all levels in many areas of the Australian construction industry (Gajendran and Perera 2017). This has a major limitation on mobile ICT usage on construction projects. The following example quotes illustrated these dynamics:

> I cannot survive without paper drawings and a sketch book where I can draw up the details and explain how I am going to build a particular element (PM1-RB).

> We are in the middle of a transition (from paper to digital). We still like to see printouts and paper (PM3-IB).

Participants confirmed that delicate nature of devices poses handling problems for the construction organisations and the users alike. Ahuja (2011) also concluded that the harsh nature and location of construction sites affect the adoption of mobile ICT in projects. While few durable and rugged devices are available in the market, they are quite expensive. The following quote is an example of this general observation:

> The delicate nature of devices is a concern for site people even when it is our policy that they must have a hard cover on it (EX4-IP).

When it comes to mobile applications, it was found that a wide range of applications both in-built and custom made are used by CM professionals for various purposes. For example, weather updates help in organising and planning tasks such as concrete pours. Similarly, features like built-in cameras are used to take pictures and make videos of construction defects and work progress. The development of easy-to-use mobile application has benefitted the CM professionals in performing and completing their day to day work activities (Nourbakhsh *et al.*, 2012). Yuronich (2011) also found that using built-in cameras, photos and videos from the construction site can be shared with other project team members for an informed discussion. Mobile devices can also manage different types of data and provide accessibility from any device with a cloud-based solution and Internet access (Feldman and Feldman, 2013). Based

on the focus group discussion, the five most commonly used mobile ICT applications are: defect management, cloud-based project management, 4D software, AutoCAD (Computer-Aided Design) software, and built-in applications (Global Positioning System or GPS, weather forecast etc.). This corresponds to Gajendran and Perera's (2017) research which also found that construction firms in Australia use 'Internet' and 'CAD' at high levels of usage with 'cloud computing' and 'Building Information Modelling (BIM)' at lower levels of usage. It can be inferred from the current discussion that cloud services adoption is increasing in the Australian construction sector.

Implications for productivity

Participants agreed that mobile ICT has certainly increased the speed of information transfer and access which have resulted in faster decision making and better flow of information. Using cloud-based applications, data can be fed into mobile devices that can be later used instantaneously in the field to assess planning or design issues. As a result, accurate and timely delivery of information could prevent undesirable outcomes (Matusik and Mickel, 2011). The following quotes are examples that best reflect their experiences:

> I had an inspection on my site. I got an inspection report even before I reached the office. The architect was just typing down the report as he was walking around (on site). Less downtime between inspection and receiving the report increases your speed of construction (PM1-RB).

> It is also true that for a Supervisor, the information is readily available to make an informed decision rather than a judgement call (SS-IP).

The participants also opined that the use of these technologies has improved construction quality due to better reporting and less rework. By allowing seamless and effective transmission of information, it also eliminates the kinds of errors and delays that are inherent in manual approaches (Son *et al.*, 2012). It was highlighted that the use of mobile ICT has resulted in better contract management in construction projects. The following example illustrates this:

> I have seen some contracts in which if things get delayed, you get 24 hours to give notice for that. So, you can take a photo (using your smartphone), and include other information and send it to the Superintendent highlighting potential delays or cost adjustments (EX2-CB).

Although mobile ICT has potential to improve productivity in construction projects, the actual change in productivity rates is largely dependent on the ways in which these technologies are adopted (Fulford and Standing, 2014). Participants argued that the continuous flow of information at an incredible pace can be problematic sometimes. The following quotes are examples of their feelings:

> Within one hour, the architect can completely change the document on the cloud. The real challenge is that how do you get that information to the guy at the front line and it influences the productivity rates in your project (PM2-CB).

> A negative thing of mobile ICT is the architect's tendency to change drawings at the drop of a hat. Massive information flow is happening and it is not always a positive thing (PM1-RB).

Participants suggested that more frequent usage of these technologies could be counterproductive. Previous studies have also found that the reduced cost of communication can increase the number of interactions and time required to process them exponentially, thus resulting in more unproductive work (Bertschek and Niebel, 2016; Mankins, 2016). Moreover, temptation to check emails can cause a lot of distraction on sites. Some example quotes are given below:

> Sometimes you find that irrelevant emails and unnecessary information just drag you along and make you less productive (PM4-IP).

> Non-uniformity in sending and responding to information sometimes bring many people into the decision-making process even when they are not needed to be involved and this may cause a real productivity problem (PM1-RB).

Reflections on organisational practices and training

When asked about the organisational policy on mobile ICT, it was found that majority of organisations provide smartphones and tablets to CM professionals. The focus group findings confirmed that cost is not a barrier for introducing mobile ICT in construction projects, especially in developed countries such as Australia. Previous findings also indicate an increase in investment and use of ICT by construction firms (Rezgui and Miles, 2010). However, participants disclosed that data security is still a big concern for construction organisations. While most of the large construction companies have a dedicated IT department to monitor and regulate mobile ICT use, small and medium sized enterprises (SMEs) usually do not have a detailed policy framework. Consequently, CM professionals can use these devices for both personal and professional purposes which may lead to loss or misuse of confidential data and other security implications. Previous researchers have also identified some major risks, such as malware infection, copyright violation, reduced privacy and confidentiality, legal issues, user resistance, and misuse associated with the implementation of these communication tools in an organisational context (Turban *et al.*, 2011; Väyrynen *et al.*, 2013). According to the focus group participants, many organisations in South Australia are now using their own (internal) servers to reduce these potential threats by exercising more control on information flow.

It was also evident from the discussion that the implications of using social media by firms for organisational processes are not yet well-understood. It seems that social media applications are only used on construction sites to facilitate information searches to locate suppliers or find other local information. However, the potential of enterprise social networks in information dissemination and sharing, communication, collaboration, knowledge management, and training cannot be simply overlooked (Epstein *et al.*, 2014; Noorden, 2014). Furthermore, improper training or lack of awareness regarding mobile ICT usage can also create interpersonal issues and conflicts among the project team members. Also, the aspect of worker inclusivity was also raised in the focus group discussion. Few responses are given below to represent the views of the participants:

> Unlike an email, sometimes the use of language is not very courteous in text messages. It can create problems while working with people from different cultures due to cultural sensitivities (EX3-CB).

> Mobile ICT can empower people more than the process, so it can be more of an inclusivity tool so that nothing is missed out (EX4-IP).

Participants confirmed that training CM professionals to make the best use of mobile ICT and as a result, improve productivity has remained a challenge for many organisations. Considering the familiarity and user-friendliness of mobile ICT, the training needs are often ignored (Erdogan *et al.* 2009). Moreover, participants argued that it is getting more difficult to keep track of new technologies due to constant innovations in this area. The following example illustrates this need:

> I would like to see more practical training for industry professionals as many people do not know a lot of stuff that could be done using these technologies. It is mainly about lack of product awareness (EX2-CB).

Health and safety considerations for users

Participants emphasized the safety challenges related with the use of mobile ICT on construction sites. The following quote illustrates this:

> Safety is a real challenge when you are too immersed in these technologies. There have been a heap of slips and trips due to these mobile devices on my site (PM2-CB).

In addition to safety, participants raised serious concerns over the negative impacts of mobile ICT on the health and well-being of CM professionals. Although mobile ICT offers flexibility to work from anywhere, it has reduced personal autonomy of the users and their ability to disconnect from work (Mazmanian *et al.*, 2013). These findings were confirmed by focus group participants. The following quotes best reflect their feelings:

> Checking your phone and emails all the time even when you are watching a TV program with your kids has become a norm these days. Sometimes you pull the laptop out and start working out on a query and then you are there for another two hours even on a holiday (SE-CB).

> Most of us have email accounts on our smartphones. If I do not answer an email/call instantly, I have to answer many when I get back to work (PM4-IP).

> Having a phone somehow puts a compulsion to remain accessible because if the phone rings, you have to answer. You can never really break from this information flow (PM1-RB).

Consequently, users experience a huge pressure to make themselves accessible and responsive even during non-work hours (Matusik and Mickel, 2011). Moreover, the increased use of mobile ICT and more demands on employees' time and attention could create conflicts in their personal lives.

Implications of the study

This study provides certain measures that the construction companies could implement to improve construction professionals' use of mobile ICT and its implications on productivity. These measures include but are not limited to recognising the suitability of various devices in different context, understanding both positive and negative implications of these technologies on productivity, developing innovative solutions to address health, safety, and security risks, and focussing on training.

While smartphones provide maximum mobility, it was found that their small screen size and data input restrictions are still a major limitation for construction applications. Consequently,

the use of tablets and convertible laptops is expected to gain more popularity in the construction space. It is recommended that the organisations should invest in different mobile devices to address the specific needs of CM professionals rather than adopting one device for all purposes. This study also revealed that the extent of usage of mobile ICT is not age-dependent as widely perceived. It is usually governed by both job requirement and personal attributes such as educational background and interest in technology. Consequently, organisations can motivate old or mature age CM professionals, who were not exposed to this kind of technology earlier, with the help of training and incentives.

Due to lack of training, CM professionals have continued to use mobile ICT in their own style without much strategic consideration on productivity. Since these technologies have both positive and negative effects on productivity, it is recommended that the training programs intended for CM professionals should substantially be revised to include information on mobile ICT and their applications in construction projects. It was also found that within the construction industry context, social media applications are not efficiently utilised. Nonetheless, the findings revealed that positive effects of mobile ICT on construction productivity due to better flow of information across the supply chain, timely access to data, improved quality, less rework, and effective contract management are enormous. However, the negative impacts of these technologies on CM professionals' health, personal relationships, and work-life balance should not be overlooked and thereby, need due consideration.

Finally, it seems that most of the participants' construction organisations had no policy framework or detailed guidelines to regulate the use of mobile ICT on sites. The lack of awareness on mitigating safety and security risks was quite evident. It needs to be recognised that the personal use of the Internet that may take place whilst at work is not only counter-productive, but may also present significant safety challenges on construction sites. These findings could inform future revisions of the industry guidelines or code of practices that promote safe work on construction sites. For example, some guidelines to educate the users of mobile ICT could potentially reduce the incidents of slips, trips, collisions or other movement disturbances that usually happen when CM professionals are too immersed into these technologies.

Conclusions

Given current trends to increase the use of mobile ICT on construction sites, research into the implications of these technologies on productivity is highly warranted. While the previous studies have mainly adopted quantitative methods to investigate the diffusion of mobile ICT in the construction industry, the aim of this study was to examine the use of mobile ICT and perceptions of CM professionals on its impact on productivity. Using a focus group discussion, this research explored the uses and preference of mobile ICT along with its perceived impact on productivity and shortcomings. Furthermore, the implications of this study for practice were drawn from the findings. The study also uncovered some issues that require further investigation and thereby, may form important areas of further research in this domain. For instance, more studies to strategise the use of mobile ICT are needed to identify the health, safety, and training challenges from both user and organisational perspectives.

It can be concluded that the true potential of mobile ICT on construction productivity is yet to be realised in construction projects. The construction organisations need to embrace these technologies as opportunities by strategising their use in construction projects with the help of proper policy and guidelines, employee training, and deeper and wider understanding of their functionalities. Since these technologies have both positive and negative implications on

productivity, practitioners and future researchers need to devise innovative measures to address various issues highlighted in this research.

The findings of this study must be considered within the context of its limitations. As a focus group study, the inherent limitations of this methodology, such as the interdependence of participants' responses, facilitator bias through in-session behaviours and communication strategies, and the limited ability to examine the validity of the study, also apply to this research (Piercy and Nickerson, 1996). In addition, the data for this qualitative study was gathered only from CM professionals working in the South Australian construction industry and therefore, cannot be necessarily generalised to other contexts. However, despite these limitations, the findings enrich our current understanding of how CM professionals use mobile ICT and its perceived impact on construction productivity. The high quality of participants involved in this study, as discussed under methodology, provides valuable insights which otherwise cannot be obtained through any other research design. These insights can inform future qualitative and quantitative research in this area.

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