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THE TECHNOLOGICAL READINESS OF CONSTRUCTION CONTRACTORS

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ABSTRACT

The Australian construction industry is often criticized for its comparatively low productivity. The most significant future productivity gains are predicted to arise from improvement in the firm's project management. Information Communication Technologies (ICTs) are thought to offer such improvement. ICT adoption is particularly poor among Small and Medium Enterprises (SMEs). Existing studies provide only a general overview of adoption and diffusion of ICTs in SMEs, with no previous research measuring their readiness to adopt ICT. This paper outlines a theoretical approach to address this gap, exploring how to improve ICT adoption in Australian construction SMEs. A review of literature is undertaken to address the research question 'What is the best conceptual approach to understanding ICT adoption in SMEs?' The results emphasize the efficacy of a novel Technology Readiness and Acceptance Model (TRAM) to assess SMEs' ICT implementation readiness. The proposed model consists of four major constructs to measure readiness comprising (1) optimism, (2) innovativeness, (3) discomfort and (4) insecurity; two major constructs to measure technological acceptance comprising (1) perceived ease of use and (2) perceived usefulness; and two extension variables comprising (1) self-efficacy and (2) facilitating conditions. A limitation is that the performance of the conceptual model is yet to be tested empirically. Such research is planned in the coming year by the authors.

Keywords: construction contractor, ICT, SME, technology adoption, TRAM.

INTRODUCTION

The Australian construction industry had negative multifactor productivity growth in the 2012 and 2013 financial years (Australian Bureau of Statistics, 2014), against a long history of poor performance, signalling a need for new strategic interventions. Small and Medium Enterprises (SMEs), defined by the Australian Bureau of Statistics (ABS) as a business with less than 200 employees, account for a majority of all construction enterprises, employment and income in Australia. Their significant role in the Australian construction industry is reflected in the latest data available (Australian Bureau of Statistics, 2013).

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It has been suggested that the "unrealised productivity and efficiency gains in the Australian construction sector can be achieved via improvements in project planning, firm level operating and managerial processes, and use of technology" (Productivity Commission, 2014). Innovation through embracing Information and Communication Technology (ICT) can result in potential benefits to an SME (Tarutė and Gatautis, 2014). However, poor adoption of ICT in SMEs has been widely reported both internationally (Tarutė and Gatautis, 2014) and in Australia (MacGregor and Kartiwi, 2010). ICT consists of both hardware and software resources that facilitate the gathering, processing, storage, use, distribution, and manipulation of electronic information. This encompasses both standalone and organisation-wide (groupware) technologies such as the Internet, Intranet, Extranet, and e-Commerce.

SMEs have been criticised for being less innovative than larger organisations and for a tendency to adopt more traditional approaches when conducting business operations. The unique characteristics of SMEs are often a barrier for adoption of ICT, as they are typically:

(1) highly affected by economic and environmental uncertainty,
(2) operated under resource and capital constraints,
(3) focused on short-term survival decisions rather than innovation, and
(4) operated by owners who play a central role in decision making with limited reference points (Al-Qirim, 2007).

Although factors (1) and (2) are difficult to change, factors (3) and (4) are influenced by psychological factors that can be manipulated to improve ICT adoption rates. This paper outlines a theoretical approach for exploring how to improve ICT adoption in Australian construction SME's, with a particular focus on the role of SME owners in driving this process. Although some SMEs might have more than one owner/manager, usually one person drives the company. For brevity, this program of research refers to the SME 'owner' to capture this situation. The purpose of this review is to address the research question: 'What is the best conceptual approach to understanding ICT adoption in SMEs?'

Research problem and gap

Previous studies have mainly focused on benchmarks for ICT adoption, motivational factors and barriers to ICT investments. These studies have however failed to capture the extent to which ICT has been adopted, the readiness to adopt ICT, or beliefs about the consequences of adopting ICT. A key study conducted by Love and Irani (2004) examined the approaches used by SMEs for ICT evaluation using survey responses from 126 construction organisations operating in Australia. They found that different organisation types significantly differ in the proportion of turnover they invest in ICT, independent of firm size in terms of turnover and number of employees. They identified a lack of strategic vision from owners as a major barrier to justifying ICT investments and driving competitiveness. Their study did not expand on the role of the owners' psychological profiles and their influence on ICT adoption in SMEs. This is a gap the current study will fill.

SMEs are less formal in business practices, with owners able to make decisions without requiring approval from several organizational levels (Productivity Commission, 2013). Ramayah et al.'s (2003) study of Malaysian manufacturing SME

owners identified they were both simultaneously supportive and cautious of adopting new technology, and thus easily influenced in either direction if incentivised appropriately. An owner's general readiness to embrace new technology can thus support initial adoption, and their acceptance of a specific technology can encourage continued investment. The Australian Productivity Commission (2014) has similarly highlighted a general lack of understanding of how to incentivise SME owners to innovate.

Therefore, it is important for the Australian construction industry to focus on determinants of ICT adoption among SME owners, as a means to improving construction industry productivity. In particular, more work is needed to understand the role of SME owners' individual personality traits and general and specific beliefs about technology.

METHOD

A review of literature related to SMEs' nature, SMEs' ICT adoption behavior and the nature of ICTs and their capacity to improve enterprise level project management practices was undertaken. The most highly cited theories of Information Systems (IS) and Information Technology (IT) adoption were reviewed to develop a conceptual framework for the study, covering a timespan of early developments in the late 1980s up to recent refinements. Empirical studies were also reviewed to assess the practical efficacy of these theories, with a focus on papers published in the last 15 years as this is the time period over which interest in ICT adoption has grown most rapidly. The review's scope covered both academic journals accessed from popular databases and publishers such as Google Scholar, Scopus, Web of Science, ScienceDirect and Emerald Insight as well as relevant statistical data published by the Australian Bureau of Statistics and Australian construction industry reports identified through web searches using key words such as technology adoption, technology acceptance, technology readiness, ICT, TAM, TPB, PEOU, PU, technology adoption models, TR, TRI, TRAM, SME, owner, Australian construction industry, Australian construction SMEs, construction productivity reports.

RESULTS

Technology adoption is a widely explored area in the IS or IT field resulting in the publication of many models and theories to understand the determinants of adoption behavior or use of technological innovations. Most relevant are theories explaining user acceptance of technology as a voluntary individual behavior (see Venkatesh et al. (2003) for a brief overview). Amongst these theories used to explain or predict the motivational factors underlying user acceptance of a technology, the Technology Acceptance Model (TAM) is a particularly widely accepted model. This is because TAM is better at predicting individual-level technology adoption than other adoption theories as it focuses on beliefs about a technology's value, around perceived ease of use and perceived usefulness (Mathieson, 1991, Liu et al., 2008). This has been supported by Liu et al's (2008) review of 211 papers on IT adoption research which concluded that TAM is the dominant and most mature theory in the field.

Technology Acceptance Model (TAM)

TAM was proposed by Davis (1989) and has its roots in the Theory of Reasoned Action (Fishbein and Ajzen, 1975), which was expanded into the Theory of Planned Behaviour (TPB) by Ajzen (1991). TAM and TPB are two seminal behavioural models that have been used to accurately predict intention to use a technological system (Mathieson, 1991). The roots of TAM lie in the TPB 'attitude' constructs, with adaptation to measure beliefs about a specific technology. Its strength over the TPB lies in this adaptation, with the focusing of variables on information technology and systems contexts (Venkatesh, 2000).

The original TAM proposed the impact of two primary predictors of behavioural intentions: perceived ease of use (PEOU) and perceived usefulness (PU) (Mathieson, 1991). PU is defined as the extent to which a prospective user believes that using a technology will enhance his or her job performance within an organisational context whereas PEOU is defined as the extent to which a prospective user believes that using the technology will be free of effort (Davis, 1989) . The validity and reliability of the PU and PEOU variables have been supported by many studies (Liu et al., 2008).

Though TAM is easy to apply to different situations and predictive of behaviour, its broad focus does not provide adequate information for identifying particular factors that create user acceptance in specific circumstances. This has resulted in the common practice of generating context specific extension variables. The unusual part of context in this case is that the firms of interest are SMEs, which means they are resource constrained. The discussion below justifies the addition of (1) self-efficacy and (2) facilitating conditions, as extension variables to help understand the role of resource constraints.

TAM extension variables for ICT adoption

Extension variables tailor the research to a specific problem domain (Lee et al., 2003). When a technology has never been used previously, owners can not necessarily directly assess its usefulness or ease of use. Rather, they may make adoption decisions based on their own perceived ability to use a technology, or the degree to which they believe business conditions will facilitate technology adoption. Extension variables comprising self-efficacy and facilitating conditions can thus dictate whether it is easy or even possible to adopt a new technology such as ICT.

Self-efficacy is a psychological construct referring to a belief in one's own ability to complete a task. Relevant to the current context, this would refer to an owner's beliefs about whether they could successfully use ICTs in their day-to-day SME management (Patrick, 2001). As SME owners are a strong intraorganizational voice, their personal beliefs about being able to operate ICTs may dictate the ability for a system to be implemented at all. Therefore it is worthwhile to consider self-efficacy as an internal control belief that could affect owners' perceived ease of use of ICTs, and subsequently use intention.

In the context of SMEs, several facilitating societal and business environment conditions have been identified. These include firm characteristics such as

organizational policy and vision; and the level of resources that can be applied to the implementation and ongoing use of ICTs. External environmental factors such as competitors, external support from vendors, pressure from suppliers, availability of subsidiaries and adequate support from government are also critical (Tarutė and Gatautis, 2014). The relationship between facilitating conditions, internal and external to an SME, on ICT use intention must be explored further.

As with the two main TAM variables – perceived usefulness and perceived ease of use – it is important to remember that the extension variables will also be measuring perceptions. This is a common approach in the social sciences, but it should be acknowledged that actual conditions may differ significantly from perceptions (Venkatesh, 2000). This is a general limitation of opinion-based research that needs to be acknowledged. There are also specific TAM weaknesses that need to be addressed.

TAM weaknesses

Bagozzi (2007) criticised it for not considering the effect of an individual's general beliefs about technology on their decision to adopt a specific new system. Therefore, individual differences must be considered in addition to the TAM constructs to predict intention more precisely (Lin et al., 2007). In order to take individual differences into account, the concept of Technology Readiness (TR), or an individual's general technology beliefs, has been integrated with TAM in the current study, following the work of several other authors (Lin et al., 2007, Erdoğmuş and Esen, 2011). TR has an effect on acceptance of specific information technology and systems (Erdoğmuş and Esen, 2011). Positive and negative feelings about specific technologies may exist and likely vary across individuals.

Technology Readiness (TR)

TR refers to a user's general readiness to adopt new technology (Parasuraman, 2000). This is theoretically separate to a person's competence in using technology. Technology readiness has a likely effect on acceptance of ICT given the variance in individuals' positive and negative beliefs about technology (Parasuraman, 2000). The level of readiness to use technology can be measured using the Technology Readiness Index (TRI) developed by Parasuraman (2000).

The TR theory proposes four constructs as predictors of individual differences (Lin et al., 2007, Parasuraman, 2000). Optimism and Innovativeness are the enablers of technology readiness, whereas Discomfort and Insecurity are inhibitors (Parasuraman, 2000). The current study adopts Parasuraman's (2000) definition of these constructs as outlined below:

- Optimism represents a positive view about technology and a belief that it will offer increased control, flexibility, and efficiency for prospective users.
- Innovativeness reflects a tendency to lead in adopting new technology as a pioneer and thought leader.
- Discomfort indicates a perception of a user's inability to control technology and a feeling of being overwhelmed.
- Insecurity reflects distrust on the capability of the new technology and its ability to work.

Those who maintain a high level of optimism and innovativeness, and low level of discomfort and insecurity are more ready to use a new technology than others.

Technology Readiness and Acceptance Model (TRAM)

TRAM incorporates Technology Readiness with TAM in an attempt to better explain intentions to embrace new technologies (Lin et al., 2007). The focus of TRAM is on both individual factors (optimism, innovativeness, comfort and security) and an individual's perception of technologies (PU and PEOU) (Erdoğmuş and Esen, 2011).

TR has been integrated with TAM for information system studies in several contexts. Lin et al. (2007) in a study of consumer adoption of e-service systems concluded that TRAM could explain why those with a high technology readiness did not adopt a specific technology. This was attributed to the addition of perceptions of technology characteristics, such as usefulness and ease of use. Therefore, TRAM is particularly useful when adoption decisions are made autonomously, and can be appropriately applied to further exploring SME owners' ICT adoption.

Addition of new variables

Building on the discussion thus far in this paper, Figure 1 is presented as the proposed model to guide future research about SME ICT adoption. Figure 1 does not present the traditional TRAM model. Instead it is a novel TRAM model that incorporates the extension variables introduced earlier – self-efficacy and facilitating conditions. It can be seen that these variables are control beliefs that drive PEOU. Adding the extension variables will provide a clearer understanding on determinants of ICT use intention by taking into account owners' perceptions about their own abilities (self-efficacy) and the business environment in which their SME exists (facilitating conditions). Using this improved TRAM, this research will analyse the influence of the four indicators of TR, on the two indicators of TAM, accounting for the specific influences of the new extension variables, with the eventual prediction of ICT use intention.

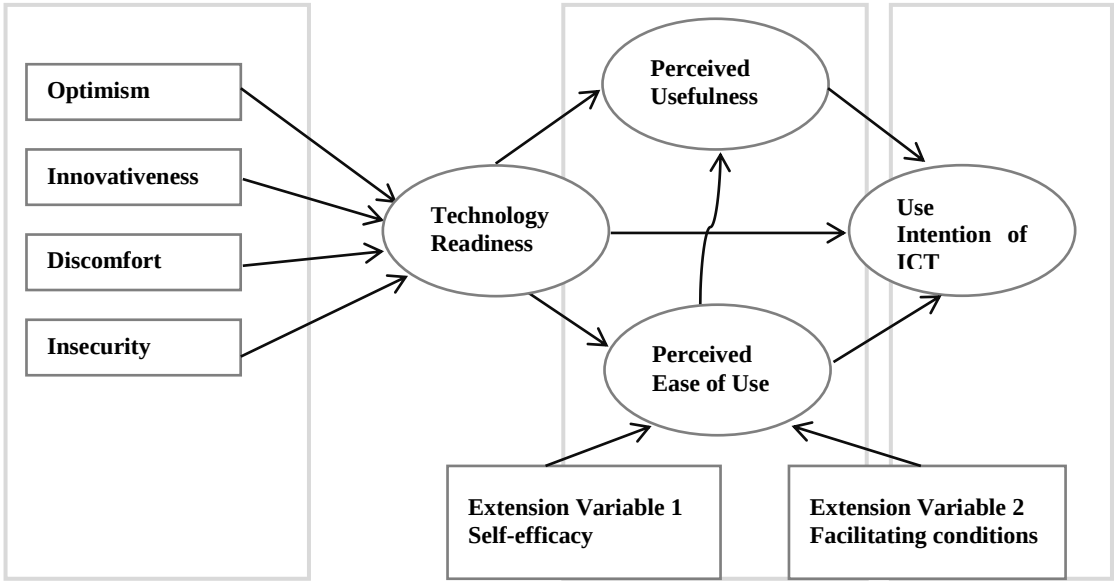

Figure 1: Novel TRAM model to predict ICT use intention by SMEs

CONCLUSIONS

This paper proposes a theoretical model for exploring how to improve ICT adoption in Australian construction SMEs with the focus on owners. The significance of this research is that it contributes to the limited literature on SME ICT adoption in the construction industry. As ICT will help to improve productivity, one key advantage of understanding the determinants of owner's intention is the opportunity that it presents to improve construction industry productivity by developing interventions to improve SME owner's ICT adoption. It is important to develop training and implementation support strategies tailored specifically to the construction SME industry. The value of proposed interventions will be high; driven by the detailed measureable items that have been validated in previous studies. These items will be used in the empirical phase of the current research.

A limitation is that the current paper does not provide an empirical test of the conceptual framework. Such work will be undertaken by the authors in future research. The next stage of this project involves the development of a survey based on Figure 1 to collect data from Australian construction contractor SMEs located in Queensland using an online administered instrument. Results will be based on statistical analysis and triangulation with an expert panel, to ensure their validity. Results are expected to confirm the validity of the model presented here and provide detailed practical guidance.

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