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Factors affecting the acceptance of information systems supporting emergency operations centres

Raj Prasanna*, Thomas J. Huggins

Joint Centre for Disaster Research, Massey University, New Zealand

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ABSTRACT

Despite the recognition that information system acceptance is an important antecedent of effective emergency management, there has been comparatively very little research examining this aspect of technology acceptance. The current research responded to this gap in literature by adapting and integrating existing models of technology acceptance. This was done in order to examine how a range of technology acceptance factors could affect the acceptance of emergency operations centre information systems. Relationships between several of these factors were also examined. Questionnaire data from 383 end-users of four different emergency operations centre information systems were analysed using structural equation modelling. This analysis concluded that technology acceptance factors of performance expectancy, effort expectancy, social influence and information quality explained 65 percent of variance in symbolic adoption, which is a combination of mental acceptance and psychological attachment towards an information system. A number of moderating effects of age, gender, experience of use and domain experience were also identified. A mediating component, of performance expectancy, explained 49 percent of variance between facilitating conditions, information quality, effort expectancy, and resulting symbolic adoption. These findings highlight a need to re-focus technology acceptance research on both mediating and moderating effects and the importance of considering domain specific factors. Applied recommendations are also made, for successfully implementing relevant information systems.

1. Introduction

Information systems that support emergencies have the potential to save lives and minimize economic loss. As stated by Prasanna, Yang & King (2013), information is the most important resource in emergency management as it is the core input for decision making. Around the world, the importance of using information systems to support decision making of emergency operations centre personnel has been acknowledged since major disasters such as the 9/11 and the London 7/7 bombing (Prasanna, 2010).

Emergency operation centre information systems (EOCISs) are different from other information systems which are used in day-to-day office environments (Prasanna, 2010). EOCISs operate in extreme and stressful environments, where end-users not only need static information but also dynamic, real time updates. EOCISs are also characterized by infrequent use (Turoff, Chumer, Van de Walle, & Yao, 2004), which represents a further complication. They may sit relatively unused until an emergency, when they are picked back up by emergency managers and volunteers, performing roles which are very different to their day-to-day jobs.

EOC operators' information requirements remain complex, dynamic, and ad hoc. To cope effectively with natural or man-made hazard events like fire, flood, tsunami or terrorist attack and to avoid fatal catastrophes, it is essential to have appropriate information about the way these situations are developing. Emergency responders need to identify the situational context of an emergency, for example a large fire in a building, so that a range of key decisions can be made quickly and accurately (Jennex, 2007; Roth, Patterson, & Mumaw, 2002). Hence, it is important to develop information systems which provide crucial information rapidly to help make vital decisions accurately, from the onset of an emergency (Endsley, Bolte, & Jones, 2011; Jennex, 2007).

* Corresponding author. PO Box 756, Wellington 6140, New Zealand.
E-mail address: r.prasanna@massey.ac.nz (R. Prasanna).

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1.1. The issue of end user acceptance

Despite substantial investments made to purchase and implement EOCISs, many of these systems have been struggling to gain the trust of end users (May, Mitchell, & Piper, 2014). Many systems appear to have faced rejections or replacements within a few years of implementation (Van de Walle, Turoff, & Hiltz, 2010). A seminal information system implementation model by Cooper and Zmud (1990) outlines how implementation of an information system cannot always be achieved in a single stage. Instead, it is a work in progress and implementation can be seen as an extended process, involving the six stages shown in Fig. 1: Initiation, Adoption, Adaption, Acceptance, Routinisation and Infusion.

End-users' use of a system does not necessarily mean that the system is fully implemented or accepted. Within the information system implementation model, this is not assumed to occur until the system reaches the highest-level of implementation: *infusion*, where end-users are fully satisfied with the system (Cooper & Zmud, 1990). Implementation of any type of information system therefore requires careful support and guidance, with responsive and focused improvements which will help achieve the infusion stage through progressively higher levels of end-user satisfaction. There is a growing body of research examining the determinants of information technology acceptance and utilization among end-users (Chau & Jen-Hwa Hu, 2002; Taylor & Todd, 1995). Such research enthusiasm has resulted in a number of theoretical models that attempt to explain the relationship between user attitudes, perceptions, beliefs, and eventual system use, including: the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980); the theory of planned behaviour (TPB) (Ajzen & Madden, 1986); the technology acceptance model (TAM) (Davis, 1986); and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003).

A large body of research informing the use and adaptions of the TRA, TPB, TAM and UTAUT models has included research into end-user acceptance of systems and technologies for: public services (for example, Moores, 2012), business management (for example, Zhou, Lu, & Wang, 2010) and organisational management (for example, Nah, Tan, & Teh, 2004). Other research literature has examined end-user acceptance of generic information systems such as Enterprise Resource Planning (ERP) (Ekanayake, Prasanna, & Kuruppu, 2012).

In terms of emergency response, notable studies have explored technologies for supporting frontline first responders (see for example: Manoj & Baker, 2007; Van de Walle & Turoff, 2007). Widely disseminated research by Turoff et al (2004) and Chen, Sharman, Rao, and Upadhyaya (2007) have introduced design guidelines, for information systems supporting crisis management. There has also been numerous studies into the design and development of a variety of emergency management information systems such as the knowledge management system used to support disaster planning and response (Dorasamy & Raman, 2011), emergency response system supporting firefighters (Prasanna, 2010); information management system for Hurricane Disasters - IMASH (Iakovou & Douligeris, 2001); information system to provide information for typhoon (Kitamato (2005) and PeopleFinder (Murphy & Jennex, 2006). As illustrated by these examples, most of the information systems research conducted in the emergency domain has focused on the design and development of technology based systems. There has still been comparatively little research into end users' acceptance of information systems in the emergency management domain. Haataja, Häkkinen, and Sullivan (2011) used a refined version of TAM to investigate the acceptance of emergency alerting systems in a university context. Wu (2009) used TAM driven mix method research to explore the acceptance of the use of SMS based alerting system among secondary school students. Lindsay, Jackson, and Cooke (2011) conducted a mixed-methods, longitudinal evaluation of the implementation of mobile data terminals within one of the UK police force branches to develop a revised TAM model, M-TAM. They conducted a second, qualitative study to validate the ability of M-TAM to explain the acceptance of police mobile data terminals (Lindsay, Jackson, & Cooke, 2014). There are also several notable technology acceptance studies conducted in other emergency related domains such as healthcare and telemedicine. Moores (2012) conducted an information technology acceptance study in the healthcare industry. This study proposed a revised model based on the TAM model. Similarly Lai, Huang, and Yang (2012) also adapted TAM to study the acceptance of a tele-healthcare technology product. Sun, Wang, Guo, and Peng (2013) used a variant of UTAUT to explore the patience acceptance of mobile health technology. However, there is very little research evidence related to the acceptance of information system in the EOC environment.

Information system acceptance remains a crucial challenge for emergency management organizations that are either starting an implementation or are starting to use these systems for responding to actual incidents. There is therefore a significant need for research into technical, organizational and human factor aspects of EOCIS acceptance. Substantial research is needed to help address these related issues and ensure that EOICs are more widely trusted, accepted and thereby used for successful emergency management.

1.2. Technology acceptance models

Among various technology acceptance models, Agarwal and Prasad (1999) suggested that TAM had already become the technology acceptance model which was most widely used by information system researchers. Perhaps this is because TAM was the first technology acceptance model to consider a wide range of empirical support (see Amoako-Gyampah & Salam, 2004). As shown in Fig. 2 this model was first introduced by Davis (1986, 1989), as an adaptation of the theory of reasoned action (TRA).

Venkatesh et al. (2003) nonetheless outlined how information technology researchers were confronted with a multitude of models. Researchers were therefore bound to separate constructs from models or choose a particular model and ignore potentials for contributions between models. Venkatesh et al. (2003) outlined the need for synthesis in order to reach a more unified view of users' technology acceptance. They extended the traditional TAM, to help overcome a number of known limitations (see for example: Sun & Zhang, 2006; Brown, Massey, Montoya-Weiss, & Burkman, 2002) and provide an alternative model of technology acceptance called the UTAUT. This model is summarized in Fig. 3. According to Venkatesh et al. (2003), the UTAUT model can be considered both parsimonious and comprehensive because it has generally explained more variance in usage intentions than predecessor

Fig. 1. Information system implementation model, adapted from Cooper and Zmud (1990).