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Social influence on the use of Clinical Decision Support Systems: Revisiting the Unified Theory of Acceptance and Use of Technology by the fuzzy DEMATEL technique

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ABSTRACT

The aim of study is to examine whether social influence affects medical professionals' behavioral intention to use while introducing a new Clinical Decision Support System (CDSS). The series of Technology Acceptance Models (TAMs) have been widely applied to examine new technology acceptance by scholars; nevertheless, these models omit system diversity and the user's profession. On the other hand, causal analysis greatly affects the efficiency of decision-making, and it is usually analyzed by Structural Equation Modeling (SEM); however, the method is often misapplied. This research applies the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique to explore the causal relationship between the significant Unified Theory of Acceptance and Use of Technology (UTAUT) variables. Fuzzy concept is applied to illustrate human vague judgment. It is significant that, in contrary with UTAUT, this study found that social influence does not matter in the behavioral intention to use the CDSS for medical professionals.

1. Introduction

Artificial intelligence has been focused on problem solving and processing capabilities that support problem solving (Clocksin, 2003). Expert system is a computer program that performs decision-making or problem solving functions in a very specialized and narrowed problem area (Subramanian, Yaverbaum, & Brandt, 1997). In the medical field, Clinical Decision Support System (CDSS) is utilized for patient care that mimics the decision-making behavior of a human expert and allows computer power to be applied to tasks that require the processing of human knowledge. According to Newman-Toker and Pronovost (2009), the CDSS can help prevent diagnostic errors. However, research on CDSS has been limited to the area of computer science in system development and rarely seen in causal modeling analysis from a social science perspective. Technology acceptance by users in the area of medicine has received less attention in the past, and therefore, studies on the models and factors that impact CDSS adoption by medical professionals are lacking.

In social science studies, causal relationship analysis significantly affects the efficiency of decision-making. Previous studies that examine the causal model of Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) mainly adopt Structural Equation Modeling (SEM). Collected statistical data, however, allows analysts to modify the model frequently to arrive at good model fitness, and SEM is often misapplied when the data are merely fitted to an SEM. The conceptual model or theory is then extended from the analytical results based on presumed hypotheses (Wei, Huang, Tzeng, & Wu, 2010).

Based on UTAUT (Venkatesh, Morris, Davis, & Davis, 2003), an amended TAM (Davis, 1989), this study aims to identify the relationship and influence among several research constructs towards the behavioral intention to adopt the CDSS for medical professionals. Previous studies on TAM and UTAUT focus only on public technology systems, and an empirical study can hardly obtain a large number of samples. Some technology systems, for example CDSS, are highly professional and complicated, and not all the subjects will be able to completely understand the technology system. When some variables do not meet the prerequisite assumptions and are coupled with the difficulty of obtaining a large number of samples, TAM will not be able to correctly analyze the causal relationship by SEM, which results in the insufficient conclusion (Lee, Li, Yen, & Huang, 2010).

In recent years, a number of scholars have proposed Multiple Criteria Decision-Making (MCDM) methods to strengthen the comprehensiveness and reasonableness of the decision-making process (Ali Khatami Firouzabad, Henson, & Barnes, 2008; Liao, 2011; Liou & Tzeng, 2010; Tseng, Lee, & Wu, 2010; Tzeng, Ou Yang, Lin, &

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Chen, 2005; Yang, Chiu, Tzeng, & Yeh, 2008), and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique is one of the methods that supports MCDM in analyzing the impact relations within a framework. In many cases, however, the judgments of decision-making are often given as crisp values, which these values are an inadequate reflection of the vagueness of the real world (Bellman & Zadeh, 1970; Zadeh, 1975). Human judgment about preferences are often unclear and hard to estimate by exact numerical values, thus fuzzy concept is necessary for handling problems characterized by vagueness and imprecision (Zadeh, 1975). Hence, there is a need to extend the DEMATEL technique with fuzzy concept for making better decisions in fuzzy environments. To improve the above-mentioned drawbacks, the partial UTAUT variables are treated as MCDM criteria to address dependent relationships, and the fuzzy DEMATEL technique is applied to find the core variables that affect the intention of medical professionals to use the CDSS.

The rest of this paper is organized as follows. In Section 2, previous literature is reviewed to form the framework of this study. In Section 3, the conventional and fuzzy DEMATEL techniques are described. In Section 4, an empirical study is presented. In Section 5, the research findings are discussed, and their practical implications are drawn. Finally, concluding remarks are presented in Section 6.

2. Theoretical foundation and literature review

TAM is an adaptation of the Theory of Reasoned Action (TRA) proposed by Fishbein and Ajzen (1975) chiefly designed for modeling user acceptance of information technology (Davis, Bagozzi, & Warshaw, 1989). TRA explains behavior based on an individual's expectations of outcomes (Fishbein & Ajzen, 1975). In TRA, attitude and subjective norm jointly determine behavioral intention, which leads to the performance of actual behavior. TRA is valuable in predicting behavior, where the behavior in question is completely under the individual's volitional control. The inclusion of the subjective norm in TRA represents an important addition when compared to TAM. With this addition, TRA takes account of the elements of the social influence that are found in the social explanation of the use of technology. Mathieson (1991) and Ajzen (1991) later expanded TRA, which includes the control belief and perceived behavioral constructs that made the Theory of Planned Behavior (TPB).

The TAM excludes the subjective norm included in the TRA and TPB and adds two constructs, perceived usefulness and perceived ease of use, that refer to specific beliefs influencing attitude towards the intention of use. The TAM initiative was to examine psychological factors that impact new technology acceptance. Moreover, TAM offers a link between technology acceptance and utilization behavior. Davis (1989) further adopted the belief–attitude–intention behavior causal chain to predict users' acceptance of technology. Various scholars, for instance, Bajaj and Nidumolu (1998), Chau (1996), and Lee (2006) have demonstrated the validity of TAM across a wide range of information technology adoptions.

TAM2 (Venkatesh & Davis, 2000) is an extension of TAM with the purpose of measuring several social influence dimensions (*i.e.*, subjective norm and image). Venkatesh and Davis (2000) showed that subjective norm exerts a great impact on usage intentions and perceived usefulness. They concluded that subjective norm directly influences through internalization. People incorporate social influence into their usefulness perceptions and identification in that an individual uses the system to gain social status and improve job performance. TAM and TAM2 have become solid models for predicting the intentions of information technology usage.

Venkatesh et al. (2003) further proposed a unified model after TAM and TAM2 named UTAUT, which aims to explain user intentions to use an information system and subsequent usage behavior. The theory holds four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions, which are direct determinants of usage intention and behavior. In addition, gender, age, experience, and voluntariness of use, are four moderating constructs that are posited to moderate the impact of the four key constructs on usage intention and behavior. The theory was developed through a review and consolidation of the constructs of eight theories that earlier research had employed to explain information systems usage behavior. The eight theories include TRA, TPB, TAM, motivational model, a combined TPB/TAM, the model of personal computer utilization, innovation diffusion theory, and social cognitive theory. The key constructs adopted in this research are detailed in the following sub-sections.

2.1. Performance expectancy

According to Agarwal and Prasad (1997), Compeau and Higgins (1995), Davis, Bagozzi, and Warshaw (1992), Thompson, Higgins, and Howell (1991), and Venkatesh and Davis (2000), performance expectancy is defined as the degree to which an individual believes that using the system will benefit him or her in terms of improving job performance. Three factors that pertain to performance expectancy are the following: perceived usefulness, extrinsic motivation, and job fit. Perceived usefulness is defined by Davis (1989), Renaud and Biljon (2008), and Venkatesh et al. (2003) as the degree to which an individual believes that using the system would improve his or her job performance. Davis et al. (1992) and Teo, Lim, and Lai (1999) stated that extrinsic motivation is the perception that users will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions. Thompson et al. (1991) articulated that job fit is how the capabilities of a system can enhance an individual's job performance.

In general, performance expectancy is the strongest predictor of attitude toward use, and behavioral intentions. In addition, it remains significant at all points of measurement in both voluntary and mandatory settings and is consistent with previous tests (Agarwal & Prasad, 1999; Compeau & Higgins, 1995; Thompson et al., 1991; Venkatesh & Davis, 2000). As previously mentioned, the system performance needs to be evaluated in order to check and measure the attitude toward the usage of the CDSS. Information systems normally used by individuals need maintenance in order to avoid suffering technical problems. Snead and Harrell (1994) stated that this is the evidence which may explain why users often fail to accept and use the new systems that potentially offer significant performance gains. Bates et al. (2001) and Bates et al. (2003) reported that for the past decades, CDSSs have been used more frequently and as an aid in clinical diagnosis, which is delivered by using information systems ideally for storing electronic medical records and providing specialists a tool that enables improvements in professional performance and patient safety.

2.2. Effort expectancy

According to Venkatesh et al. (2003), effort expectancy is defined as the degree of ease associated with the system use. Its conceptualization can be traced back to the concept of "ease of use," which indicates the extent to which an individual believes that using the system is effortless (Davis et al., 1989). Effort expectancy is critical in the introduction of a new technology. The adoption process of a new technology can be constrained and can even fail when factors related to ease of use are not taken into account by