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Behavioral Intentions of Radio Frequency Identification Users at Hospitals in Thailand: An Application of the Unified Theory of Acceptance

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Abstract

The aims of this study were to investigate the behavioral intentions of hospital staff in using Radio Frequency Identification by applying the Unified Theory of Acceptance and Use of Technology 2. Data were collected from 404 respondents who worked in the hospitals and had experience using Radio Frequency Identification. Confirmatory Factor Analysis and the Structure Equation Modelling technique, based on the Unified Theory of Acceptance and Use of Technology 2 model, were used to test among seven hypotheses (performance expectancy, effort expectancy, social influence, facilitating condition, hedonic motivation, price value, and habit) affecting Radio Frequency Identification users' behavioral intentions. The results revealed that perceived utility and hedonic motivation had a strong positive influence over behavioral intention. The current findings could help hospital management teams understand the use of Radio Frequency Identification in healthcare.

Keywords: *Behavioral intention, motivation, utility, Radio Frequency Identification*

Introduction

The utilization of health information technology, such as Radio Frequency Identification (RFID), is well-known as a standardized technology for patient and information traceability, crucial for implementation of desired healthcare services. Though in use for more than a decade, RFID technology remains one of the key technologies due to its sophisticated applications and comprehensive adaptability (Duroc & Tedjini, 2018). Besides healthcare, RFID is also used in related areas such as social services. Other industries, for example telecommunications (Saafein & Shaykhian, 2014; He & Mu, 2012), automobile (He & Mu, 2012), and electronics (Lu & Weng, 2018) also have applied technological tools into their management system.

While the use of management systems is valuable to assist in the organization of a vast amount of information, it is still necessary for stakeholders to understand how such systems or tools are being used. One approach is to understand the behavioral intentions of those employing such technological systems. This approach may contribute to the maturity of such information systems (e.g., Carvalho et al., 2019). Hence, the purposes of the present study were:

1. To explore hospital staff behavioral intentions in using RFID by applying the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2); and
2. To study the relationships among different constructs by using Structure Equation Modelling (SEM), so as to provide hospital managers with suggestions for more effective management of RFID technology systems.

Literature Review

Use of RFID in Hospitals

Public hospitals in Thailand are large, and unfortunately, chaotic. Many hundreds of medical cases are handled daily. In a report published by the World Health Organization on the accessibility of medical services to outpatients in Thailand, the figures showed that there was a dramatic increase from 111.9 million in 2003, to 184.3 million in 2017 (National Health Security Office, 2017, as cited by Patcharanarumol et al., 2018). Considering the increasing number of patients, information supporting systems in Thai hospitals are evidently very important. Compounding the issues created by a large number of patients are critical situations. These include information-sharing among surgeons for

urgent cases, which contributes to the safety of patients, as well as to the control of operational costs (Yao et al., 2011). Identification using RFID can also be extended to follow-up care after an operation or a medical procedure involving groups of people. A significant aspect is the correct identification of patients and allocation of their prescribed medicine, and even the monitoring and regulation of medicines (Cheng & Kuo, 2016; Yazici, 2014).

Given the ability to process large amounts of information and subsequently to support healthcare management, RFID technology is seen as the next disruptive innovation (Haddara & Staaby, 2018). Despite its value, there are still challenges faced prior to or during the implementation of RFID, such as patient privacy and information security (Hadara & Staaby, 2018; Gulcharan et al., 2013; Cheng & Kuo, 2016). These challenges may be addressed by higher management in a hospital, by cultivating support from all levels of the institution, raising awareness to the value of RFID, and also customizing RFID to suit the contextualized needs of a hospital (Hadara & Staaby, 2018; Yao et al., 2011; Lai et al., 2014). Recognizing the potential challenge faced in the use or implementation of RFID, this study aimed to examine the behavioral intentions of hospital staff. Specifically, this study employed the Unified Theory of Acceptance and Use of Technology 2 as its primary tool for analyzing technology acceptance. The analysis of behavioral intentions has several potential advantages. It will allow insights to be gained into attitudes towards RFID, which serve as useful data for hospital management in their endeavors to create efficient work processes. It may also inform researchers and others how RFID, as an information management tool, is localized in the study setting.

Unified Theory of Acceptance and Use of Technology 2 (UTAUT2)

Macedo (2017) claimed that the main goal of applying UTAUT2 was to predict technology acceptance and use determined by behavioral intention. Several other theoretical models also have been introduced in recent decades, such as the Technology Acceptance Model (TAM) by Davis (1989), and the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al., (2003). Macedo (2017) revealed that these technology acceptance frameworks were operationalized to apply to workplace contexts to predict people's behavioral intentions and actual usages. Venkatesh and colleagues (2012) developed and formulated UTAUT2 from UTAUT by incorporating three additional constructs in the context of consumer use. These were hedonic motivation, price value, and habit. The original determinants of UTAUT were performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). The UTAUT2 scheme generally was applied to investigate the influence of behavioral intention in using technology. For example, Rabaa'i (2017) used the UTAUT model to examine the effect of e-government services in Jordan. The framework that will be adopted in this paper is shown in Figure 1.

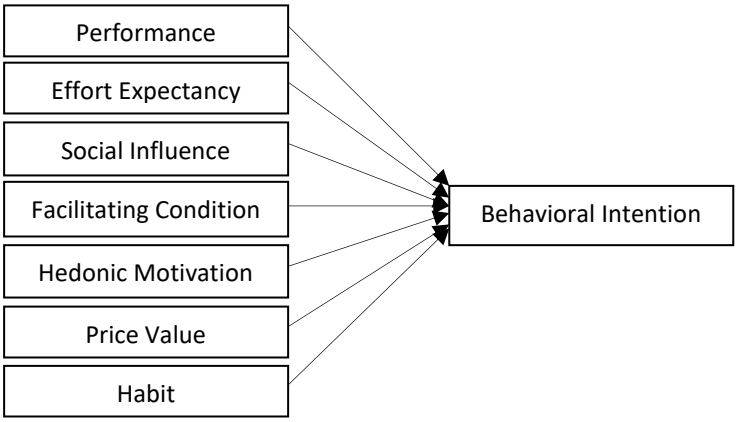

Figure 1. The UTAUT2 Model (Venkatesh et al., 2012)

Behavioral Intention can be identified as an individual's intention that they could perform a predicted act analogously (Islam et al., 2013). Cheung and Vogel (2013) suggested that behavioral

intention might also be identified as an assessor of the strength of one's intention to act or show specific behaviors in an information system context. Davis and colleagues (1989) emphasized that behavioral intention is correlated with an individual's usage of an information system, and this indicates that the user's behavior is a primary determinant. Mafe et al. (2010) studied how motivational factors influenced short messaging service (SMS) users to participate in watching TV programs in Spain. They found that perceived value, attitude, and affinity were key influencers of SMS users' acceptance of programs. This contrasted with the situation in Colombia, where perceived value and attitude were the key elements in SMS user's responses. Behavioral intention needs to be considered as a factor related to the use of technology, for the use of technology is dependent on the decision of the management team, and also on acceptance of the technology by the operators.

In UTAUT2, Performance Expectancy is a variable showing the degree to which technology users receive advantages from adopting a technology while they are performing activities (Venkatesh et al., 2012). Jambulingam (2013) claimed that performance expectancy is similar to the factor of 'Perceived usefulness' from the technology acceptance model (TAM).

> ***Hypothesis One:*** 'Performance Expectancy' will positively influence behavioral intention to use RFID in hospitals.

Effort Expectancy is defined as the degree of ease the users find in using the technology (Jambulingam, 2013). Research conducted by Teo and Noyes (2014) indicated that effort expectancy affects individual behavioral intentions about using information technology.

> ***Hypothesis Two:*** 'Effort Expectancy' will positively influence behavioral intention to use RFID in hospitals.

Social Influence is the influence of others on an individual's perception of the use of technology, such as family members or peers (Leong et al., 2013). The study conducted by Taylor and partners (2011) supported the idea that friends strongly affected students' use behaviors of mobile applications.

> ***Hypothesis Three:*** 'Social Influence' will positively influence behavioral intention to use RFID in hospitals.

Facilitating conditions refers to an individual's perception of existing infrastructure that supports the use of technology (Venkatesh et al., 2003). Many facilitating conditions will be available for technology users–for example, organizational environment, supporting systems provided, and training courses (Venkatesh et al., 2012).

> ***Hypothesis Four:*** 'Facilitating Conditions' will positively influence behavioral intention to use RFID in hospitals.

Hedonic motivation refers to pleasure that RFID users experience from using RFID in hospitals. It shows the important role of enjoyment and/or satisfaction in defining technology acceptance in terms of technology usage (Venkatesh et al., 2012). Brown and Venkatesh (2005) defined hedonic motivation as an experience of pleasure and amusement while adopting a technology. Daim and colleagues (2010) mentioned the psychological processes linked with behaviors by considering core components such as attitudes, intention, and behavior.

> ***Hypothesis Five:*** 'Hedonic Motivation' will positively influence behavioral intention to use RFID in hospitals.

Price Value is defined as the part played by the cost or price on the perceived benefits of products and/or services (Zeithamal, 1988). A price value will be positive if the perceived benefit of using technology is more than a cost or price spent. Thus, a positive price value will drive a behavioral intention (Venkatesh et al., 2012).

Hypothesis Six: 'Price Value' will positively influence behavioral intention to use RFID in hospitals.

Habit is a natural behavior typically functionalized at the time when use of a technology is initiated (Kim & Malhotra, 2005). Habits can be separated into two categories: an earlier behavior, and an automatic behavior (Kim & Malhotra, 2005).

Hypothesis Seven: 'Habit' will positively influence behavioral intention to use RFID in hospitals.

Research Objectives

The aims of this study were to investigate the behavioral intentions of hospital personnel in using Radio Frequency Identification (RFID) by applying Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), and to study the relationships among different constructs, which can be used to give hospital managers suggestions for more effective management in using RFID technology.

Methodology

Sampling Design and Data Collection

Data for this study was gathered through a paper-based survey at selected hospitals in each part of Thailand. The respondents worked in different departments of various hospitals. The study was conducted in three parts of Thailand and eight hospitals, both public and private, where RFID was used. The first part was in Northern Thailand, consisting of three hospitals. The second part was in Central Thailand, consisting of three hospitals, and the last part was in Eastern of Thailand, consisting of two hospitals. From 600 questionnaires distributed, 404 questionnaires were returned. Paper-based questionnaires were distributed face-to-face to RFID users at different hospitals in Thailand. Purposive sampling was used by asking people who were working at hospitals that use RFID technology. Each respondent took approximately 15–20 minutes to complete the questions, and every survey was collected immediately after it was answered.

Questions on demographic aspects such as gender, age, marital status, educational background, RFID knowledge, and the perception of the usefulness of RFID were collected. The demographic data are shown in Table 1.

Table 1. Demographic Profile of Respondents (*N* = 404)

Variables	Category	Number	Percentage
Gender	Male	204	50.5
	Female	200	49.5
Age	25–30	184	45.5
	31–35	126	31.2
	36–40	63	15.6
	Above 40	31	7.7
Education	Lower than a bachelor's degree	104	25.7
	Bachelor's degree	165	40.8
	Higher than a bachelor's degree	135	33.4
RFID Knowledge	Yes	296	73.3
	No	108	26.7
RFID Usefulness	Yes	363	89.9
	No	41	10.1

Research Design and Measurement

The survey was designed in two parts. Part 1 dealt with the demographic aspects of the respondents such as gender, age educational background, knowledge about RFID technology, and the perception of RFID technology's benefits. Part 2 of the survey consisted of 25 items (seven constructs)

selected to investigate the opinion of RFID users, and to show how RFID technology encouraged RFID users' behavioral intention. All items of each construct were measured by a 5-point Likert scale ranging from 1 to 5 where 5 was *strongly agree*, 4 was *agree*, 3 was *neutral*, 2 was *disagree*, and 1 was *strongly disagree*.

A quantitative survey was implemented to investigate RFID users' behavioral intentions in applying RFID in their workplaces by using the UTAUT2 constructs (Venkatesh et al., 2012). These were Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Condition (FC), Hedonic Motivation (HM), Price Value (PV), and Habit (HT). The survey was divided into two parts and adopted to quantitatively describe the relationship among the variables. The pre-test of the proposed construct scales, using 30 respondents, gave Cronbach's alpha values of reliability for the 25-item scales of .93, which exceeded the threshold of .70, and hence was considered acceptable (Hair et al., 2006).

Findings and Discussion

Exploratory Factor Analysis (EFA) was used to conduct a preliminary analysis of the UTAUT2 framework of RFID users in the hospitals. There were seven original constructs derived from the framework; however, five poor-performing items were removed from original 25 items. The 20 remaining items were resolved into elements in new constructs and renamed under five constructs, which were 'Perceived Utility', 'Hedonic Motivation', Perceived Value', 'Performance Expectancy', and 'External Influence'. The new construct of 'Perceived Utility' asked about the perception of ease and reliability of using RFID in the hospitals. The construct of 'Perceived Value' was mainly focused on the worthiness and reasonability of using RFID in the hospitals. Questions were asked about the accomplishments of others to increase efficiency in the hospitals by using RFID for items under the 'External Influence' construct.

Confirmatory Factor Analysis (CFA) exposed the measurement of each property assessed by RFID users in the hospitals. The model fit summary of the measurement model showed an acceptable fit to data [x^2 (n = 404) = 681.70, (p < .001) 2/df = 2.84, NFI = .88, CFI = .92, RMSEA = .07].

Table 2 displays the factor loadings and composite reliability of each construct. Some constructs were deleted, while some were combined from the original model construct. Each construct's composite reliability was greater than .70.

Table 2. Principle Component Analysis Factor Loadings and Composite Reliability of Individual Constructs

Constructs and Items	Standardized Loadings	Composite Reliability
Perceived Utility		.84
1. Staff are interested in using RFID at the hospitals	.60	
2. I have become familiar with using RFID	.74	
3. Using RFID makes hospitals more reliable	.81	
4. I find RFID is easy to use	.72	
5. I have knowledge about the necessity of using RFID	.67	
Hedonic Motivation		.81
1. Using RFID is useful	.61	
2. Using RFID is interesting	.72	
3. Using RFID is challenging	.72	
4. Using RFID has become my habit	.65	
5. I can get help from others when I have difficulties in using RFID	.71	
Perceived Value		.80
1. I find RFID makes me more comfortable at work	.65	
2. The cost of RFID is reasonable	.62	
3. RFID is worthwhile	.64	

Constructs and Items	Standardized Loadings	Composite Reliability
4. I must use RFID	.66	
5. RFID helps facilitating patients' needs	.71	
Performance Expectancy		.72
1. My colleagues think I should use RFID	.58	
2. RFID is a technology that responds to organizational needs and changes	.61	
3. Using RFID is convenient for staffs	.68	
External Influence		.71
1. Staff can accomplish things more efficiently by using RFID	.64	
2. Staff are using RFID	.86	
Behavioral Intention		.85
1. I will continue using RFID	.77	
2. I am trying to use RFID more often	.70	
3. I have a plan to use RFID more in the hospitals	.71	
4. I am going to use RFID more in the future	.75	
5. I will recommend RFID to others	.70	

The correlation coefficients are shown in Table 3 and present the matrix for the new relationship among reconstructed model variables by Pearson's correlation. It was found that all correlations among the proposed reconstructed model were significantly positive at the .01 two-tailed level.

Table 3. Correlation Coefficients of Reconstructed Variables

Factors	1 PU	2 HM	3 PV	4 PE
1. Perceived Utility (PU)				
2. Hedonic Motivation (HM)	.69**			
3. Perceived Value (PV)	.60**	.71**		
4. Performance Expectancy (PE)	.48**	.70**	.87**	
5. External Influence (EI)	.71**	.71**	.80**	.84**

Notes: **Correlation is significant at the .01 level (two-tailed).

The structural model was tested by using the Structural Equation Modelling (SEM) approach. Hypothesis five was supported in that 'Hedonic Motivation' had a significantly positive influence on 'Behavioral Intention' for using RFID in hospitals ($\beta = .81$, $p < .05$). Based on this study, Exploratory Factor Analysis (EFA) was applied to the preliminary analysis of the UTAUT2 model scale of RFID users' behavioral intentions. Five poor-performing items were removed from 25 items. The remaining items were grouped and renamed to five constructs, which were 'Perceived Utility', 'Hedonic Motivation', Perceived Value', 'Performance Expectancy', and 'External Influence'. This means that new hypotheses can be assumed. The results are shown in Table 4.

Table 4. Hypotheses Testing Results of the New Model after Using EFA and CFA

Hypothesis	Coefficients (*SE*) *N* = 404	Result
Perceived Utility → Behavioral Intention	.23*	Supported
Hedonic Motivation → Behavioral Intention	.81*	Supported
Perceived Value → Behavioral Intention	-.09	Not Supported
Performance Expectancy → Behavioral Intention	.08	Not Supported
External Influence → Behavioral Intention	-.06	Not Supported

Note: $p <$ *.05

It can be noted in Table 4 that of the three new constructs, 'Perceived Utility' had a significantly positive effect on 'Behavioral Intention' (β = .23, $p < .05$). However, the hypotheses relating to 'Perceived Value', 'Performance Expectancy', and 'External Influence' affecting 'Behavioral Intention' were not supported (with β = -.09, β = .08, and β = -.06, respectively).

The results from Confirmatory Factor Analysis (CFA), and Structural Equation Model (SEM) are displayed under five constructs in Figure 2. According to the concept underlying SEM, it checks linear relationships between the independent and dependent variables in making decisions (Sin et al., 2015).

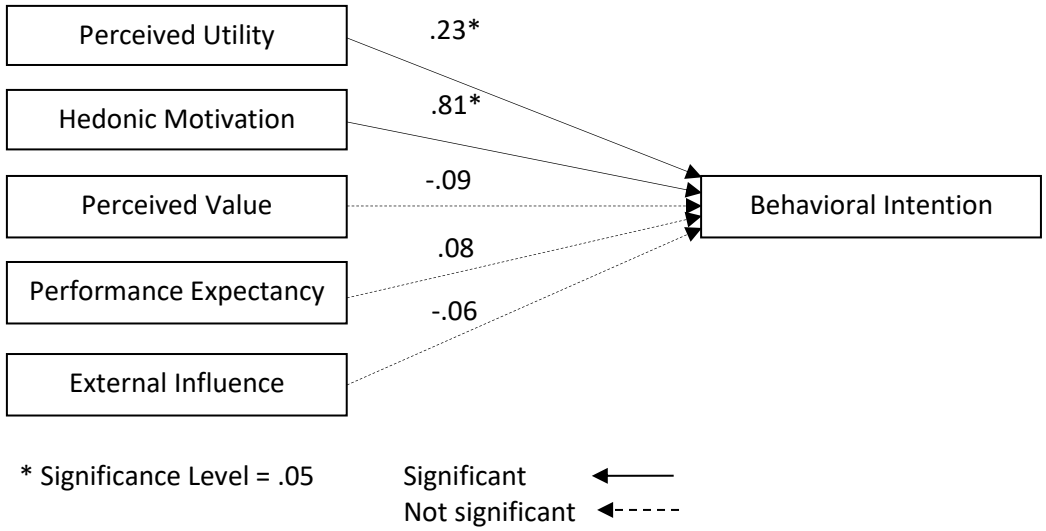

Figure 2. Standardized Total Effects of Reconstructed Model

Perceived utility represents people's evaluation of the merits of technology usage and their abilities to meet people's needs and expectations. Perceived utility was reconstructed and had a high positive influence on behavioral intention. The modified construct of perceived utility was both extrinsic and intrinsic benefits from functional and utilitarian attributes. Perceived utility of RFID can help healthcare services improve the efficiency of using RFID by introducing RFID performance to users in the working environment (Van der Togt et al., 2011). For this study, it indicates how RFID users considered the benefits they would get from RFID, and whether it would meet their expectations. Benefits of RFID technology in the hospitals include the ability for real-time traceability of people and equipment, better monitoring critical systems, and quality control (Roper et al., 2015).

The results indicated that hedonic motivation positively affected RFID adoption, and could be seen as a crucial factor influencing RFID users. Hatz and colleagues (2017) studied technology users' motivation by using hedonic motivation (passion, fun, emotions, and excitement). Such motivation

was a significant driver for adopting technology. Hence, RFID users, in particular doctors, nurses, and other hospital staff, should be willing to adopt this new technology, by focusing on the convenience that it brings.

Woodruff and Gardial (1996) defined perceived value as a perception of attributes that are received and given. External Influence is defined as an aspect and a concern of individuals with the judgments of others–for example, family, peers, and colleagues (Tonglet et al., 2004). For example, they can even increase the convenience and minimize time effort in searching for information related to patients, medicines, or equipment, through this one-click or scanning technology.

The statistical findings failed to indicate that 'performance expectancy,' 'perceived value,' and 'external influence' were important to the behavioral intentions for using RFID in hospitals. Nevertheless, RFID users who perceived it as a beneficial technology would recognize advantages such as convenience and efficiency.

In our study, variables affecting the behavioral intention of using RFID were derived from the values perceived by users themselves. Thus, the results indicate that RFID users' were focused on fulfillment of their expectations and their experiences. Nonetheless, to have a more comprehensive overview, hospital administrative teams should also obtain input from various departments using RFID technology, including clinical services, information technology, human resources, and others. By having a comprehensive overview, hospital management would have a better understanding of how to best integrate RFID technology use into the various hospital departments' existing workflow. Furthermore, personalized design could be achieved through the combination of usefulness and enjoyment. This would not only benefit workflows, but also facilitate users' technology adoption processes (Namahoot & Laohavichien, 2018).

Hospital administrators can be one of the most important stakeholder groups to shape users' perspectives towards the use of RFID technologies. However, Fisher and Monahan (2008) cautioned that a problem for using RFID in hospitals was its quality and extent of use. To ensure that RFID is used to its full potential, vendors also have the responsibility to educate both hospital administrators and RFID end-users. Another worry is that RFID users may feel like they are being watched (Fisher & Monahan, 2008).

Conclusions

This study proposed a novel research model that included five hypotheses regarding the relationships between perceived utility, hedonic motivation, perceived value, performance expectancy, and external influences affecting behavioral intention to use RFID, based on the UTAUT2 model analyzed via SEM. The results showed that perceived utility and hedonic motivation had the strongest positive influence on RFID users' behavioral intention. Perceived utility and hedonic motivation should be taken seriously in the consideration of adopting RFID in hospitals or healthcare services. Besides creating a valued utility for users, management should encourage adopting RFID technology from the point of view of bringing enjoyment. RFID adoption in healthcare services can enhance the productivity of the healthcare sector. It is important to understand the capabilities and limitations that are involved in adopting RFID.

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