Technological Forecasting & Social Change 111 (2016) 244–264

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Determining the importance of Hospital Information System adoption factors using Fuzzy Analytic Network Process (ANP)

Mehrbakhsh Nilashi [a,b,*,1], Hossein Ahmadi [a,*,1], Ali Ahani [a,1], Ramin Ravangard [c,1], Othman bin Ibrahim [a,1]

[a] Faculty of Computing, Universiti Technologi Malaysia, Johor, Malaysia
[b] Department of Computer Engineering, Lahijan Branch, Islamic Azad University, Lahijan, Iran
[c] Department of Health Services Management, School of Management and Medical Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

ARTICLE INFO

Article history:
Received 24 September 2015
Received in revised form 29 June 2016
Accepted 2 July 2016
Available online 15 July 2016

Keywords:
HIS adoption
DOI theory
TOE framework
Institutional theory
HOT-fit model
Fuzzy ANP

ABSTRACT

The Hospital Information System (HIS) is a computer system aimed at providing a paperless environment that covers all aspects of the hospital's operation such as clinical, administrative, and financial systems. The aim of this study is to provide more insight within the context of Malaysia to understand the potential factors that importantly driving or inhibiting the decision of HIS adoption from non-adopters' perspective. This study mainly integrates the diffusion of innovation theory, technology-organization-environment framework, institutional theory along with human-organization-technology fit model that can be tailored in understanding of the HIS adoption by Malaysian public hospitals. In this regard, the initial model is designed by considering four main dimensions (Technology, Environment, Human, Organization) with seventeen variables based on reviewing of the existing extensive literature of information system in particular information technology adoption in line with prior HIS adoption studies. Accordingly, a Fuzzy Analytic Network Process (ANP), one of the Multi-Criteria Decision Making (MCDM) techniques, model is developed to determine the most important factors among the four categories for the HIS adoption in the context of Malaysian public hospitals. These factors are identified and compared by 20 hospital experts and decision makers, who are fully familiar of HIS technology with also professional management and decision-making experience in hospitals. Then fuzzy ANP is applied to compute the weights of incorporated factors in the HIS adoption. The results reveal that hospitals with compatibility, complexity, mimetic pressure and vendor support are more likely to adopt HIS. Hence, the decision to adopt HIS is mainly determined by technological and environmental context. The study and its findings have resulted in theoretical contributions and research implications where the integrated theoretical model serves as a tool for healthcare industry to gain insight into the process of HIS adoption.

1. Introduction

1.1. Malaysian health informatics context

In Malaysia, people can acquire a broad range of healthcare services at low prices. However, according to Lee et al. (2012), "factors like changing pattern of death causing diseases from infectious diseases to chronic diseases, population structure, lifestyle, and healthcare service expectation from the people have distorted the status quo". Furthermore, this is compounded by an increasing rate of healthcare expenses in Malaysia annually. Hence, the Malaysian government faces an imposing pressure to enhance the healthcare quality and reduce patients' medical costs (Ahmadi et al., 2015b, 2016; Lee et al., 2012). In order to overcome these two major issues, the Malaysian government has embarked on several projects with the aim of promoting and maintaining the citizens' wellbeing, apart from providing additional access to healthcare information. Consequently, in the quest to overcome and solve recent aforementioned challenges, the Malaysian government has initiated several medical care projects. One of the projects is the National Telehealth Policy (NTP) (Abdullah, 2008). This project comprises four attractive schemes namely, Telemedicine, Mass Customised/Personalised Health Information and Education (MCPHIE), Lifetime Health Plan (LHP), and Continuing Medical Education (CME) (Abdullah, 2008; Li, 2010) which ultimately aim to promote Information System (IS) in the healthcare industry. Telemedicine is one of the domains that has been targeted for radical improvement (Abdullah, 2008; Lee et al., 2012). Known as the Telemedicine Blueprint under the renowned Multimedia Super Corridor (MSC) Telehealth project, telemedicine is a healthcare-reform initiative launched to reform the Malaysian healthcare system. Abidi et al. (1998) concur that "MSC began in 1996 to emphasize on the national vision of 2020 which can assist Malaysia toward becoming a developed country

* Corresponding authors.
E-mail addresses: nilashidotnet@hotmail.com (M. Nilashi), hosseinis3007@gmail.com (H. Ahmadi).
[1] Authors had the equal contribution and participation as the first author.

http://dx.doi.org/10.1016/j.techfore.2016.07.008
0040-1625/

in the year 2020 through particular objectives". In addition, the LHP is among the four key projects that concentrates on fostering a healthcare platform, whereby general hospitals can provide personal lifetime health plan to the general public. According to some authors (Abidi et al., 1998; Ismail et al., 2013; Mohd and Syed Mohamad, 2005), under the LHP project, Hospital Information System (HIS) is introduced as an impetus to the healthcare industry's digitalization process. The HIS is a computer system aimed at providing a paperless environment that covers all aspects of the hospital's operation such as clinical, administrative, and financial systems. According to some authors (Ahmadi et al., 2014, 2015b, c; Ismail et al., 2010, 2013; Lee et al., 2012; Masrom and Rahimly, 2015; MOH-Malaysia, 2014; Sulaiman and Wickramasinghe, 2014), only 15.2% of the Malaysian public hospitals are referral hospitals equipped with either fully integrated or partially integrated HIS since the Telehealth project was launched more than a decade ago and almost 85% of public hospitals are delaying in adopting the HIS. Hence, this shows a very slow progress among Malaysian public hospitals on the trend of HIS innovation adoption.

This study aimed to examine the influence of technological context (relative advantage, compatibility, complexity and security concern), organizational context (presence of champions, IS infrastructure, top management support, hospital size and financial resources), environmental context (mimetic pressure-competitors, coercive pressure-government, vendor support and intensity of competition) and human context (perceived technical competence, employees' IS knowledge, clinical IT experts and CIO innovativeness) on HIS adoption. The research framework are tested by data collected from 20 hospital experts and decision makers, who are fully familiar of HIS technology with also professional management and decision-making experience in Malaysia. Furthermore, the findings of this study contribute to empirical research on identifying contextual factors by applying a hybrid Multi-Criteria Decision-Making (MCDM) model using Fuzzy Analytic Network Process (ANP) approach that influence the decision of HIS adoption. The findings of this study can result at fostering the uptake of HIS and facilitating its reluctant trend by improving the decision of hospitals towards HIS adoption in Malaysia, however not limited to other countries.

1.2. Research questions and research objectives

The questions in this study are shaped as: (a) what is the current situation of HIS adoption in Malaysia? (b) what is the suitable theoretical model that can be proposed to facilitate the trend of HIS adoption in Malaysia? (c) what factors significantly influence the organizational adoption of HIS in Malaysia? and (d) What Multi-Criteria Decision-Making (MCDM) model is suitable to weight the factors for HIS adoption in Malaysian public hospitals?

Hence, this study discussed an integrated theoretical model for HIS adoption decision with adopting a Fuzzy ANP approach. The main objectives of this research are four-fold: (a) to identify the current situation of HIS adoption in Malaysia (b) to identify an integrated theoretical model that can be proposed to facilitate the trend of HIS adoption in Malaysia (c) to identify the significant factors that influence the organizational adoption of HIS in Malaysia and (d) to develop and validate an integrated theoretical model using an evaluation method of Fuzzy ANP that aims in fostering the adoption of HIS by Malaysian public hospitals.

The Technology Organization Environment (TOE) framework has been empirically tested by many studies and has been found useful in understanding the adoption of technological innovations (Wu and Chen, 2014). In particular, TOE perspective is suggested as a comprehensive lens to identify the imperative factors on HIS in the early stage of diffusion at the organization level by encompassing and focusing on the characteristics of technology, organization, and environment (Ahmadi et al., 2015b; Chang et al., 2006, 2007; Hsiao et al., 2009; Hung et al., 2009; Lian et al., 2014; Liu, 2011).

Furthermore, institutional theory is seen as a supplement for TOE which would help potentially in better explaining organizational innovation adoption. Moreover, institutional theory discusses the environmental pressures that exist in the institutional environment which force organizations to follow the new action as others (isomorphism). This is more emphasized by Mohr (1992) and Sherer et al. (2016) in which the healthcare industry is a very institutionalized environment.

Finally, with respect to Human Organization Technology (HOT) fit model in the healthcare domain, Yusof et al. (2008a) recently developed a new model based on Human, Organization and Technology after having conducted a critical appraisal of the findings of existing health information system evaluation studies. This framework has great overlap with the TOE framework, except that it does not take into account the environmental context. On the other hand, the TOE framework does not have an explicit category "Human".

Oliveira and Martins (2011) suggested for more complex new technology adoption in the organizational level, it is important to combine more than one theoretical model to achieve a better understanding of the IT adoption phenomenon. Hence, it can be concluded that organizational innovation adoption theories provide a strong theoretical foundation of new model for the current study to see in a valuable way, how HIS innovation can be adopted with respect to the early stages of innovation adoption process throughout the entire hospital organization.

According to the above discussion, there are reasonable motivations for this study in developing a suitable incorporated view of theoretical model. This can be built on the basis of relevant aforementioned theories for public hospitals to foster the adoption of HIS technology which can provide plenty of benefits to both parties including hospitals and more importantly to the patients community.

2. Literature review

2.1. Hospital Information System (HIS) in Malaysia

Malaysia is an example of a developing country that is progressing in its electronic health (e-health) initiative with the HIS being placed under the government's vision of 2020 plan (Ahmadi et al., 2015b; Mohan and Razali Raja Yaacob, 2004; Nilashi et al., 2015; Sulaiman and Wickramasinghe, 2014). Three types of HIS was introduced including Total Hospital Information System (THIS), Intermediate Hospital Information System (IHIS), and Basic Hospital Information System (BHIS) (Ahmadi et al., 2015a; Hassan, 2004; Ismail et al., 2013; Lee et al., 2012; Mohan and Razali Raja Yaacob, 2004). HIS decision applications are according to the number of beds that the particular hospital has. THIS gives an integrated system whereas BHIS is the lowest and limited system. Moreover, THIS implementation is for tertiary hospitals with over 400 beds. According to Kensing et al. (2007) and Ismail et al. (2010), in Malaysia the intention of the Ministry of Health on implementation of HIS is proven to be beneficial; even though, the task could be risky but the overall advantage of having extensive system is priceless. THIS has more complete set of HIS than IHIS and BHIS. The central objective of having HIS is to provide an integrated care delivery system capable of information sharing, automation of work processes, provide greater efficiency, and better storage and use of data (Abdullah, 2008; Pai and Huang, 2011; Sulaiman and Wickramasinghe, 2014).

An integrated HIS project was first launched in Malaysia in late 1999 as a direct result of the Prime Minister's vision for Malaysia becoming a developed country by the year 2020 (Salleh, 2003; Sulaiman, 2011). Hospital Selayang was the first hospital in the country to integrate HIS in the year 1999 (Dwivedi, 2011; Lee et al., 2012). The hospital implemented integrated HIS to improve their service delivery by focusing on patient, enterprise-wide information and management system in order to maximize the efficiency and utilization of their staff (Lee et al., 2012; Triantaphyllou et al., 1998). Furthermore, hospital Putrajaya was the second hospital integrating HIS into the daily operations in the year 2000. In addition, the hospital integrated HIS into their medication administration (Lee et al., 2012).