A Model for E-healthcare Adoption and Patient Safety

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Abstract – Information technology (IT) and information systems (IS) were often associated with improved outcomes. Generally, when IT or IS including internet were thoughtfully selected and properly implemented, vulnerability to human fallibility can be reduced. Studies related to adoption of IT and IS in healthcare sector were essential, and this study aimed to explore factors that are crucial to the adoption of electronic healthcare (e-healthcare) and their impacts on patient safety. The secondary data retrieved from past articles were employed and analyzed in this study. The findings of this study were the research model and hypotheses which were developed based on adoption of IT and IS theories, and essential elements of patient safety. A direction for future research was then described.

Keywords – *adoption; information technology; information systems; e- healthcare; behavior; patient safety*

I. INTRODUCTION

Information technology (IT) is the application of computer hardware, software, telecommunications equipment, and internet to store, process, manipulate, transmit and retrieve data or information. The adoption and use of IT has transformed traditional healthcare into digital format healthcare that is referred to as electronic healthcare or e-healthcare. The term e-healthcare came into use in the year 2000, and it also has been used as a synonym for telemedicine, health informatics, consumer health informatics and e-business [1]. According to Omary, Lupiana, Mtenzi and Wu, e-healthcare is related to computerisation of electronic healthcare services. It refers to the organisation and delivery of health services and information using IT [2].

It is believed that the presence of IT improve the quality of care [1]. Adoption of IT is often associated with desirable performance such as reduction of errors; improvement of the quality of care, and more efficient delivery of care. Among the advantages of adopting IT in healthcare are preventing medical errors, improving patient safety, improving physician-patient relationship and cost involved in delivering care [1, 3]. In order to be a care standard, patient safety requires health information infrastructure that includes electronic healthcare record systems with decision support, a secure platform for the exchange of patient information across health care settings, and data standards to make that information understandable to all users.

Information technology systems can produce better outcomes by improving various aspect of care delivery such as clinical decision support system, computerized physician order entry with decision support, electronic medical records, automated computer reminders, and computer generated alerts to physicians from a laboratory information system [1, 4, 5]. All of these IT systems can decrease time spent on administrative duties and can increase time spent on direct patient care [2]. In addition, integrated IT systems including computerized physician order entry, laboratory results reporting, pharmacy systems with alert drug interactions and allergies, and 'smart pumps' for infusion therapy can improve patient safety [14]. Furthermore, appropriate use of IT can serve as a key component of improving quality of care [17].

Despite the growing body of literature that relates IT adoption to improve outcomes, there is still lack of study to relate IT adoption with patient safety. Also, due to healthcare cost and quality assurance taking central roles in the healthcare agenda, increasing attention is being directed towards the potential of IT to lower healthcare spending and to improve efficiency and safety of medical care. The following research question is posed for this study:

Is there a significant relationship between factors (such as attitude, perceived behavioral control and subjective norms) and patient's safety?

The aim of this study is to explore factors that are crucial to the adoption of e-healthcare and their impacts on patient safety. The specific objectives of the study are as follows:

i. To investigate factors that influence adoption of e-healthcare based on adoption theories.
ii. To examine the concept of patient safety.
iii. To develop research model for examining the relationship between e-healthcare adoption and patient safety.

This paper is organized as follows. The next section provides a literature review, followed by individual sections that describe methodology, research model and hypotheses. The last section concludes the study and suggests some future work directions.

II. LITERATURE REVIEW

A. Adoption of e-healthcare

There are various perceived benefits to individuals and organizations related with e-healthcare adoption include reduction in medical errors, improvement on physician efficiency, physician-patient relationship and cost involved in delivering care [2, 3]. Ten promissory e's in e-healthcare have been highlighted by Eysenbach, that is, efficiency, enhancing quality of care, evidenced-based, empowerment, encouragement, education, enabling, extending, ethics and equity [23].

Adoption of e-healthcare in healthcare sector has significant potential to improve patient safety, organizational efficiency, and patient satisfaction. However, little is known about the adoption and use of e-healthcare among healthcare providers or professionals [22]. Table 1 shows the summary of past studies related to e-healthcare adoption.

Table 1. Summary of past studies of e-healthcare adoption

Researcher (s)	Year	Information Technology / Information System	Adoption Theories Used
Pare, Sicote, and Jacques [7]	2006	Clinical Information System	Technology Acceptance Model (TAM)
Schaper and Pervan [8]	2007	Health Information System	Theory of Planned Behaviour (TPB)
Hoving, Mudde, and Vries [9]	2007	Health Behaviour System	Theory of Reasoned Action (TRA)
Chang et al. [10]	2007	Emergency Medical Supporting System	Technology Acceptance Model (TAM)
Xue, Yen, Choolani, and Chan [11]	2009	Female-Focused Health System	Technology Acceptance Model (TAM)
Li, Talaei-Khoei, Seale, Ray & Maclatyre [14]	2013	Electronic Health Records / Electronic Medical Records	Unified Theory of Acceptance and Use of Technology (UTAUT)

A brief explanation about the adoption theories that have been used in healthcare setting is as follows.

Theory of Reasoned Action

The theory of reasoned action (TRA) is based on behavioural intention as the main predictor of actual behaviour [27]. An individual will develop a positive or negative attitude towards a behaviour and will also respond to social pressures about the behaviour. The social pressures are called 'subjective norms', and these pressures are taken together with an individual's attitude to determine intention and ultimately change behaviour.

Theory of Planned Behaviour

Theory of planned behaviour (TPB) posits that a person's performance of a specified behaviour (for example, use of electronic health record (EHR)) is primarily determined by the person's attitudes, subjective norms and perceptions of behavioural control concerning the behaviour in question [26].

Technology Acceptance Model

Technology acceptance model (TAM) is a model of behavioural intention of using information systems (IS) or information technologies (ITs). In this model, adoption and acceptance are explained by the influence of a person's attitude towards technology and the perceived usefulness of the technology [30].

Unified Theory of Acceptance and Use of Technology

The unified theory of acceptance and use of technology (UTAUT) was developed by Venkatesh, Morris, Davis and Davis to present an integrated view of user acceptance and usage of new technology [29].

There are many benefits which can be obtained from the use of IT, for example, improvement in work quality, productivity, and educational tools for both staff of healthcare centres and patients [13]. IT also helps in decision making and improving patient's safety. It can be used to improve efficiency and timely access to clinical information, enhance the clinical decision-making process, and improve communication between providers [1, 4]. Further, greater efficiency can be translated into improved outcomes because it enables clinicians to spend more time with patients. The benefit of adopting IT in healthcare is becoming more important where the Malaysian population growth rate is expected will remain high in the next 20 years [6].

B. Patient safety

According to the research conducted by Kohn, Corrigan and Donaldson, patient safety is defined as freedom from accidental injury during medical care or from medical errors [15]. Meanwhile Emanuel, Berwick, Conway, Combes, Hatlie and Leape defined patient safety as following,

'*Patient safety is a discipline in the health care sector that applies safety science methods toward the goal of achieving a trustworthy system of health care delivery. Patient safety is also an attribute of health care systems; it minimizes the incidence and impact of, and maximizes recovery from, adverse events*' [29, p. 6].

Patient safety is essential healthcare factor in all developing and developed countries. There is growing evidence that IT improves patient safety [6]. Patient safety is a topic that has been discussed widely especially within hospital community whereby a topic nursing also has focused on for years, but with a different slant [12]. According to Sensmeier [12] despite big efforts, patients still die from medical errors, and IT has becoming the expected solution. In this context, the challenge is to adopt the IT for enhancing patient safety while optimizing clinical workflow and transforming data into information when and where it is needed.

Nowadays more attention needs to be allocated on patients during the medical interaction. The major expectation from the patients especially those who are technology savvy are effective appointments scheduling

system, individual electronic access to personal medical health records, shorter waiting time and prolonged interaction time. As such, patient's safety can be enhanced through integrating information systems in healthcare [6]. It is secured through speedy retrieval of records, immediate availability of results, and reduced treatment errors. Thus, better management of health information is a pre-requisite in achieving patient safety. Table 2 reveals several concepts of patient safety in primary care [13].

Table 2. Concepts of patient safety [13]

Concepts	Definition / Scope
Medication safety	Including organizational aspects: repeat prescribing and computerized medication monitoring systems.
Practice communication and agreements	Communicating medical records among employees in the practice and the lab results to patients.
Telephonic accessibility	Involving the number of telephone lines. A telephonic many with an option to declare an emergency.
Practice nurses	Recording advices given by the practice nurse in the medical record of the patient.
Incident reporting	Incident reporting is reviewed only with the involving employees, and some practices apply incident reporting in a structural meeting within the practice.
Patient responsibilities	The information of lab results, self-management of chronic diseases, and showing up at appointment are the responsibilities of the patient.
Knowledge and training	Specific training (e.g. in hygiene, triage, communication) and good medical knowledge.

Below are some of patient safety measures or indicators that have been used in past studies [16].

1. Medical staff members receive continuous education about patient safety.
2. My supervisor's behaviour reflects that patient safety is a top priority.
3. The quality department in this hospital cooperates with staff regarding patient safety.
4. This hospital has a reward system for reporting errors.
5. Information obtained from reported errors is used to improve patient safety.
6. Patient electronic medical records are used to improve patient safety.
7. Senior manager behaviour demonstrates that patient safety is a top priority.
8. Medical staff takes care to achieve high standards of patient safety in their work.
9. The workload is appropriate for the available staff.

One example of IT system in healthcare environment that can improve patient safety and increase practice efficiency is electronic health records (EHR) [18]. EHR is the core application as it provides electronic patients records which are input to other healthcare units.

In general, among information included in this system are patient profile, past medical history, progress reports, patient problems, laboratory data and radiology reports and medication.

A patient safety model of healthcare

Emanuel et al. proposed a model with which to view patient safety [29]. It divides healthcare systems into four main domains: (i) those who work in healthcare (Workers); (ii) those who receive health care or have a stake in its availability (Recipients of care); (iii) the infrastructure of systems for health care delivery processes (Systems for therapeutic action); and (iv) the methods for feedback and continuous improvement (Methods). These four domains are represented graphically in Figure 1.
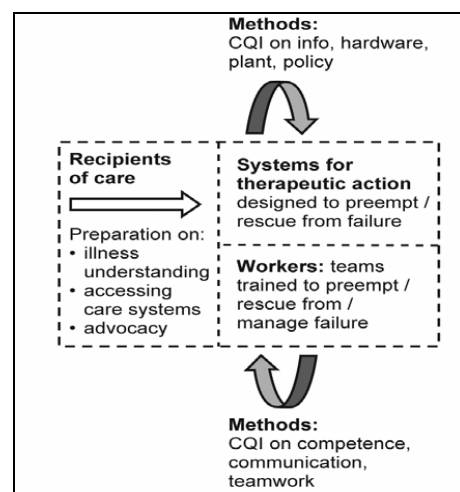

Figure 1. A Patient Safety Model of Health Care

Donabedian divided healthcare into structure, process, and outcomes for the purpose of measurement. It is also a way of categorizing the health system for the purposes of understanding how elements of the system interact [24]. For this reason, the categories can be thought of as cutting across all four domains in the patient safety model. Vincent identified seven elements that influence safety, namely (i) organization and management factors; (ii) work environment factors; (iii) team factors; (iv) task factors; (v) individual factors; (vi) patient characteristic; and (vii) external environment factors [25]. These factors distribute among the three domains: systems for therapeutic action, the people who work in health care, and the people who receive it or have a stake in its availability.

This model is consistent with existing frameworks of thinking that underpin patient safety. Each framework defines categories or elements that fall coherently within one or more of the four domains, as displayed in Table 3.

Table 3. The relation of domains and elements in the patient safety model

Domain	Systems for therapeutic action	People who work in the health care system	People who receive health care or have a stake in its availability	Methods
	1.Structure 2.Process 3.Outcome			
Content areas	1.Organization & management 2.Work environment 3.Task factors 4.External environment	1.Team factors 2.Individual factors	Patient characteristics	1.System knowledge 2.Understanding of variation 3.Understanding of how change yields knowledge 4.Psychology

The relationship between IT adoption and patient safety

Menachemi, Saunders, Chukmaitov, Matthews and Brooks [4] have explored the relationship between IT adoption and performance on set of widely used patient safety indicators in a relatively large sample hospitals. They hypothesized that hospitals with greater IT adoption would perform better on patient safety measures, and their findings support the hypothesis. The patient safety indicators (PSIs) used in their study were developed by AHRQ [31]. In this regard, the PSIs are algorithms that are applied to routinely collected hospital inpatient discharge data that screen for adverse events patients experience as a result of exposure to the system of care.

The PSIs focused on provider-level indicators that provide a measure of the potentially preventable complications for patients who received their initial care and experienced a complication of care within the same hospitalization. They provide an important perspective on patient safety events that occur at a given healthcare sector, and they have been used etensively by researchers [4, 31].

III. METHODOLOGY

This research employed qualitative method whereby the data were gathered through literature survey (i.e. using document analysis technique). We reviewed studies in healthcare that used and discussed adoption theories and models such as TRA, TAM and TPB, and the related theories and models of patient safety. The secondary data retrieved from past articles using online databases like EBSCOHost, Emerald, MEDLINE and others which can be accessible through Universiti Teknologi Malaysia (UTM) library databases. The review covered IT adoption and patient safety in healthcare sectors in Malaysia and other countries. This approach assisted us in providing an exploratory understanding of IT adoption and its' impact on patient safety.

IV. RESEARCH MODEL AND HYPOTHESES

Patient safety has become a major concern throughout the world. It is the absence of preventable harm to a patient during the process of health care; ensuring safer care is a big call and task, and psychosocial variables influences behaviours of human. The theory of planned behaviour (TPB) is a well-validated behavioural decision-making model that has been used in identifying predictor of social and health behaviour [6].

Based on the literature review, the proposed research model is shown in Figure 1. The model consisted of five major variables, that is attitude, perceived behavioural control, subjective norms, behavioural intention and patient's safety. Attitude, perceived behavioural control, subjective norms and behavioural intention (IT adoption variables) were independent variables that adopted from TPB. This research introduced the patient safety variable into the TPB as the dependent variable.

Attitude : The positive or negative evaluative affect about using the technology.

Perceived behavioural control : Proper training, technology access, and in-house technology expertise.

Subjective norms : The healthcare provider's perception that most people who are important to him or her thinks he or she should not adopt the e-health system in question.

Behavioural intention : The behavioural intention is a function of an individual's attitude toward the behaviour.

Patient safety : Patient safety is an attribute of healthcare systems whereby it minimizes the incidence and impact of, and maximizes recovery from adverse events.
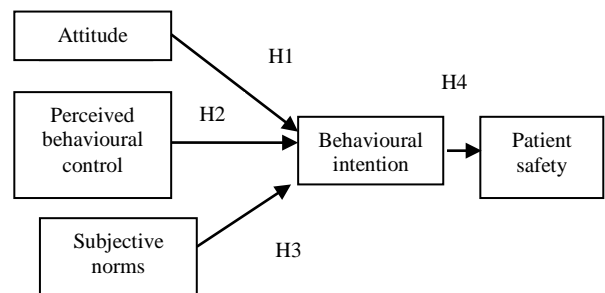

Figure 2. Research model and hypotheses

Based on Figure 2, the research hypotheses were as follows:

H1: There is a relationship between attitude and behavioural intention of healthcare staff.

H2: There is a relationship between perceived behavioural control and behavioural intention of healthcare staff.

H3: There is a relationship between subjective norms and behavioural intention of healthcare staff.

H4: There is a relationship between behavioural

intention and patient safety.

V. LIMITATIONS

This study has two major limitations. First, the patient safety measures are crucial to a variety of stakeholders, scientifically sound, feasible and usable [33]. All of these measures are difficult to achieve in one measure. For example, consumers or patients or employers may perceive outcome measures as important, whereas clinicians who are often concerned with the validity of outcome measures, may prefer process measures.

Second, when evaluating whether measures are scientifically sound, it is important to consider validity of a measure at two levels. The first level involves the patient safety domain. Since patient safety is an outcome, does it represent an important aspect of quality? The second level of validity must consider how we measure the patient safety domain. To minimize bias, efforts should follow the measurement principles for clinical research such as well-defined research protocols, explicit data collection tools, well-designed databases, clear quality control plans, and detailed analytic plans [34].

Thus, for this study, these two limitations need to be considered when examining the relationship between e-healthcare adoption and patient safety.

VI. CONCLUSION AND FUTURE WORK

In conclusion, based on literature, this study provides some evidences regarding the impact of IT adoption on patient's safety in hospital. The study proposes research model which encompassed five major variables, namely attitude, perceived behavioural control, subjective norms, behavioural intention and patient's safety. The model focuses on the influence of behavioural intention to adopt e-healthcare on patient's safety. Therefore, it provides a research novelty for examining the potential relationship between behavioural intention to adopt e-healthcare and patient's safety. The hypotheses will be tested empirically in future work. It is imperative to examine the relationship between behavioural intention and patient's safety in order to make better informed decisions by healthcare staff or clinical staff (e.g. physicians, pharmacists, nurses, specialists and IT technicians) and to offer healthcare patients better quality care.

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