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Review on security and privacy issues in health information systems adoption and usage

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Abstract

Health information systems (HIS) are major applications in the field of Information and Communication Technology (ICT). Lots of benefits and advantages can be obtained if we are to apply HIS systems in real world and this would serve healthcare providers, professionals and health population as a whole. However, these advantages of EMR, EHR and PHR cannot be accomplished if users do not adopt health information system in their healthcare dealing. Recent publication highlighted on the lack of adopting EMR, EHR and PHR in healthcare field. There, this paper aims to review the privacy and security factors effect on health information system acceptance and usage. The Results indicated that empirical studies that examined privacy and security factors in healthcare context are limited, particularly in health information system acceptance and usage; in addition to that very limited studies have applied UTAUT2 in healthcare domain including health information system acceptance.

Keywords: Healthcare, privacy and security, health information system

Introduction

E-health topic raised in early the 21st century era, it includes any electronic Information and Communication Technology (ICT) applied in the health sector. This term comprises every form of technology used for clinical, research, educational, and clerical purposes, in geographic areas as well as local sites. E-health applications are believed to enhance networking in healthcare sector, activate universal thinking and improve healthcare in regional and worldwide ^[1]. Advantages of e-health applications can be touched in the efficiency and quality of patients' operational healthcare. A vital example is medical doctors who are good key driving concept to push e-health wheel, however if these e-health advantages do not be accepted and applied to the real world, they are unlikely to be reaped ^[2]. It is worth nothing to mention that electronic medical records (EMR), electronic health records (EHR) and Personal Health Record (PHR) are used independently, this is due to patient related information that stored in EMR, EHR and PHR which form the core of e-health systems ^[3]. EMR, EHR and PHR can be used by many healthcare operators such as pharmacists, nurses, and physicians. On the other hand EMR and EHR can also be used interchangeably; however, the mentioned terms describe totally different concepts. The two terms are considered critical to achieve acceptance in local, regional, and worldwide targets to enhance the safety of patients, rise up quality to higher level, increase the efficiency, and reduce healthcare delivery costs ^[4]. The EMR can be defined as a licit record generated or initiated in hospitals and ambulatory sectors which is in same time considered a main source of data that forms the EHR. The ability to share medical information and distribute them with efficiency to stakeholders is what EHR all about. Stakeholders represented with healthcare suppliers, patients/consumers, employers, or might be payers/insurers and government ^[5]. This review study focused on HIS, acceptance systems.

HIS is an encapsulating record of care at healthcare site ^[6]. This data is a legal record owned and established by the hospital or ambulatory care provider. Many varieties of systems are sold by vendors to hospitals and health care providers.

Backgrounds

Information technology considered as a hot topic nowadays ^[66, 67, 68, 69]. In 2005, the RAND team of researchers expected that a quick adoption of health information technology (HIT)

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would save tens of billions of United States of America treasury as annual rate. The disbursements of health have grown in the United States by \$800 billion [7] the adoption of HIS systems worldwide could open the way to achieve more than \$81 billion in annual savings [8]. However, a very limited hospitals have HIS solutions that can effectively decrease medical problems or enhance the quality and effectiveness of patient care, and the worldwide adoption of EMR in US is slow due to low HIS adoption rate [9]. According to [9] one of critical challenges in the health care sector is the tardy adoption of EMR. While [10] says in Malaysia there are only few public hospitals have applied the HIS system, that means the adoption in Malaysia is still gradual slow, adding to that, there are lack of empirical studies as well as limited work found in literature related to the field HIS adoption in Malaysia.

The benefits of his adoption

HIS is touted to enhance the goodness of care, reduce medication errors, minimize paperwork, increase efficiency, reduce costs, streamline clinical workflow, improve data tracking, and support collaboration in complex health care providing organizations [11]. The systems that adopt HIS will improve the availability, readability, and data quality. Structured data entry can induce for fullness to offer better accuracy and organizing the search and retrieval [12].

Privacy and security issues in health information system adoption

Despite the many benefits of having HIS in place, there are still several downsides, especially in privacy and security context for example the issue patient confidential data. This issue certainly occurs when neglecting of HIS adoption, as a great deal of medical information retrieved from paper-based records stays in electronic warehouses. Well-Recognized experts in field of medical information privacy have reported the threats of misusing this information on personal privacy [13].

It is agreed upon that security, privacy, as well as confidentiality are the most potential issues in adopting the health information system [10]. According to these issues, physicians are worried about exploiting patient information from unauthorized persons [14], and hence, which may causes them to encounter a serious legal issues [14] since the patient information are considered as confidential record. According to [15], physicians are more concerned about this issue than the patients themselves. Furthermore, even among the physicians who do use HIS, most of them believe that paper records are more secure and confidential than health information system; this clearly demonstrates how concerns about privacy and security considered as an issue to HIS acceptance. Moreover, in case of neglecting privacy assurance, patients may face problems of whether they should expose some complains or historical information to health care providers to enhance the diagnostic procedure as well health care or holding that information to avoid inappropriate use [16]. The previous studies mentioned that privacy and security issues in health information system still needs for further investigation [10]. That means previous studies tend to focus more on privacy and security issues, including confidentiality, integrity and availability, which are considered the major concerns in HIS adoption [17, 18]. Stated that the trust

effect on HIS acceptance [19]. Stated that access controls are likely to increase the barrier to acceptance, since their design and implementation are very complex, and their purpose is to deny access to unauthorized people, thus the access control effect on health information system acceptance [20], stated that perceived threat as the key inhibitor of technology acceptance such as EMR, thus the threat affect health information system acceptance. Based on the previous research, many privacy and security issues have to be resolved [9]. Thus there are limited empirical studies have been tested privacy and security factors in HIS context.

Method

Search strategy

Many articles in health information system include EMR, EHR and PHR system field were searched and only related articles were selected. In order to achieve searching and selection of studies, two processes were defined, named with, Information sources, search and selection process.

Information source process

The main databases were used are PubMed, Science Direct, IEEE Explore, Emerald, Springer Link and Google scholar with predefined search keywords “privacy”, “security”, and “EMR” OR “EHR” OR “PHR” OR “E-health” OR “HIS” In this paper, we categorized the search key term into three categorizations. The first investigates HIS concepts and common factors of HIS. The second explores the HIS acceptance, adoption, and use. The third category reviews the relative “Empirical Study” or “Review” or “Overview” studies in field of HIS adoption. The categories of search strategy are depicted in Table 1.

Table 1: Search key term categorization

First category	Electronic Medical Record Electronic Health Record Electronic Personal Record E-health health information system
Second category	Acceptance, adoption, use and behavioral Intention
third category	Empirical study, review, overview

Search and selection process

Our inclusion criteria were:

- Full articles dealing with HIS systems published between 2008 and 2019
- Published in english language
- Articles that investigates the factors effects of privacy and security on HIS acceptance and usage. Our exclusion criteria were reports, and books

Existing model

This paper reviews empirical studies in healthcare related to HIS concept. In result we found that there are 30 studies related to HIS concept and most of them done in developed country. Our review found that there are only a few empirical studies done on HIS acceptance and Usage. Previous studies stated that there is a need to focus more on acceptance level for HIS systems [10, 21], especially in Malaysia context [10].

Author	Description: Goal of study	Factors	Theories	Method	Field
[22]	To examines rural–urban differences in the use of various information technologies (IT) applications by physicians in the ambulatory setting	Privacy confidentiality concerns	-	Empirical study	EHR
[23]	To provide the E-health application developers with the necessary information about the security issues by means of security prototypes in each context.	Data integrity, availability, authenticity and confidentiality and privacy,	-	L.R.	e-health
[24]	Integrate an individual’s concern for information privacy (CFIP) with the elaboration likelihood model (ELM) to examine attitude change and likelihood of opting-in to an EHR system.	collection data, unauthorized secondary use error	-	Empirical study	EHR
[25]	Extend applicability of the Technology Acceptance Model (TAM) to test user acceptance of EMR in the hospital context in Thailand	security/confidentiality	TAM	Conceptual framework	EMR
[26]	to highlight the importance of considering Information privacy concerns when implementing eHRs	IPC Cfip Ipc	-	Review	EHR
[27]	To identify, categorize, and analyze barriers perceived by physicians to the adoption of Electronic Medical Records (EMRs) in order to provide implementers with beneficial intervention options.	privacy security confidentiality authorized	-	systematic review	EMR
[28]	EMR system is discussed in general and Theories related to technology adoption are also discussed in general. Moreover, issues concerning the adoption of EMR system in previous studies are also discussed.	security, privacy, confidentiality unauthorised	-	Conceptual framework	EMR
[29]	Reviewed the literature on PHRs including design, functionality, implementation, applications, outcomes, and benefits	Privacy, integrity, and confidentiality of the data, and the authentication	-	Review	PHR
[30]	A comprehensive synthesis of EHR users' perceptions is key to successful future implementation.	security confidentiality of patient information privacy	-	Systematic review	EHR
[31]	To extends existing technology acceptance models (TAM) for electronic health (e-health) in ambulatory care settings and elaborates on determinants of importance to physicians in their decision to use e-health applications	Important of data security	TAM	Empirical study	EHR
[32]	To express barriers perceived by physicians to the adoption of the EHRs.	privacy, confidentiality security	-	unsystematic-review	EHR
[33]	To propose a privacy enhanced HIS framework and investigate the role of privacy protection in HISs adoption	Perceived Security Information Security Literacy	UTAUT	Empirical study	EHR
[34]	To Enhancing e-Health Security for patient and providers healthcare.	Conditionality Integrity Availability	contingency theory	Conceptual framework	E-health
[35]	To explore physicians, attitude and perceptions of the impact on EMRs	compliance, privacy, security. confidentiality	-	Literature review	EMR
[36]	To proposes a theoretical model on PHR adoption and validates that model using the view s of 389 Canadian patients	Privacy, security and Access to data sources	TAM UTAUT	Empirical study	PHR
[37]	To provides a comprehensive taxonomy of the factors influencing the user adoption of EMR and classifies these factors into meaningful categories	Privacy, Security, confidentiality, integrity and availability	-	Taxonomy	EMR
[38]	To understand the factors influencing physicians’ acceptance of EHR systems, the presented research examines the effects of social influence, health IT (HIT) experience, and privacy concerns using a modified Technology Acceptance Model (TAM)	Privacy concern,	TAM	Empirical study	EHR
[39]	To identify a set of determinants of adoption of electronic health records (EHR) portals by health care consumers	CFIP	UTAUT2	Conceptual framework	EHR
[40]	Study developed a conceptual framework on the basis of Technology Organization Environment (TOE) framework for the adoption of THIS by Malaysian hospitals	Security Concern	TOE framework	Conceptual framework	e-health
[41]	To investigated the level of adoption of Health Information Technologies (HIT) services, and the factors that influence this, amongst specialised and primary care physicians; in Andalusia, Spain	Lack of security and confidentiality	-	Literature review	EHR
[42]	To examine the extent to which the factors influence acceptance levels among Austrian physicians, the presented research uses a modified Technology Acceptance Model (TAM) approach.	Privacy concerns	TAM	Empirical study	EHR
[43]	To review the status of open-source in healthcare and discuss the potential of open-source to resolve some of the challenges surrounding the wide adoption of Health IT in North America	Privacy Security confidentiality	-	Review	EMR
[44]	To analyzed the healthcare sector as a complex system, and applied systems thinking tools to identify causal relationships across the system	Privacy and Security concern	-	Review	EMR
[45]	To investigates the differences between occupational groups within a teaching hospital	Data Security	TAM	Empirical study	EHR
[46]	To proposes a decision support examination framework on how individual, security and privacy determinants influence the acceptance and use of EMR	Authentication integrity confidentiality authorization non-repudiation availability CFIP	UTAUT2	Empirical study	EMR
[47]	To review and synthesize international literature on the attitudes of primary care physician to EMR adoption using the Clinical Adoption (CA) Framework.	Privacy confidentiality	-	Review studies	EMR
[48]	To statistically measure (quantify) how a sample of Canadians perceives the usability of electronic personal health records (PHRs)	Privacy and security	TAM	Empirical study	PHR
[49]	To provide an in-depth exploration of the patient privacy perspective toward HIE, its antecedents, and its outcomes.	Privacy	-	Review studies	HIS

[50]	To extend an individual-level information technology adoption model by incorporating three additional variables to investigate whether the individual characteristics of a physician affect EMR adoption.	Privacy	-	Empirical study	EMR
[51]	to explore the different factors that affect the EMR acceptance and use, and provides recommendations regarding the development of EMR in the context of privacy and security	CFIP Authentication Confidentiality Integrity Availability Non-repudiation	-	Review	EMR

Results and Discussion

There were some results found in HIS field of research. Even though, it is clear that there are lack of studies regarding EMR especially in acceptance context and most of the studies used TAM model which is Depending on the theory of reasoned action model. On the other hand [52, 64, 65], suggested that TAM is appropriate to examine the adoption of information technology in work process. TAM theory claimed that perceived usefulness (PU) and perceived ease of use (PEOU) are the most factors and role player in technology adoption. PU is defined as the extent of adoption technology would improve task achievement as well as job performance. On the other side, PEOU is defined as the level of thought that the technology should be simple. In consequence, PU and PEOU effect on individual attitudes toward the use of a particular technology. Moreover, PU is affected also by PEOU; since it could affects indirectly on technology acceptance. TAM theory indicates that external variables are linked indirectly, affecting both PU and PEOU. Attitude is deleted from the model by [52], because of weakness correlation with BI and PU. While there are only a few studies used UTAUT2 model in healthcare context especially in EMR acceptance, thus future work need to apply the UTAUT2 model in healthcare especially EMR system [24]. The UTAUT attempts to explain intention to use, as well as subsequent usage behavior. The theory suggests that four key constructs: 1. Performance expectancy, 2. Effort expectancy, 3. Social influence, and 4. Facilitating conditions are direct determinants of usage intention and behavior [53]. Gender, age, experience, and voluntariness of use will mediate the impact of the four constructs on intention to use and usage behavior [53].

Table above confirm that the studies on HIS acceptance are limited, especially in the privacy and security context from multi-perspective. Moreover, most of existing studies addressed privacy and security as one dimensional from single perspective, thus there is a lack of existing studies addressing privacy and security as multiple dimensional especially from multi-perspective in context of health systems. Privacy and security issues remain major concerns of healthcare workers [54, 55]. Strongly believed that the understanding of these barriers and the utilization of correct strategies to address them will lead to successful implementation and improved usage of HIS [56, 57, 58]. Attested that security and privacy aspects play an important role in the acceptance and usage of assistive medical technologies. Although HIS provide numerous benefits, they are not employed sufficiently to realize their full potential while maintaining the privacy of patients. Several components must be incorporated by medical IT solutions into system security policies and procedures. These components are authentication, availability, confidentiality, data integrity, and nonrepudiation. Moreover, the concerns of healthcare professionals about sufficient security for protecting patient privacy decelerate the implementation of IT infrastructure, such as EMR, EHR and PHR. Further research is necessary to clarify the role of trust perceptions in the IT

acceptance of healthcare professionals [59, 60, 61, 62, 63], because the role of trust in user acceptance has been studied in other context such as in e-learning and e-government. However, there are no other existing work that have examined the role of trust in the context of health system acceptance and usage. Moreover, three models exist for privacy concern, namely, concern for information privacy (CFIP), Internet users' information privacy concerns (IUIPC), and Internet privacy concerns (IPC). Among them, CFIP is the most widely applied because it focuses on the practices of one organization. This study concentrates on the privacy and security issues in the EMR acceptance and use context.

Future work

The study found that there are limited empirical studies in healthcare, especially HIS context in developing county. Moreover, the privacy and security factors play important role to increase the level of acceptance, thus these issues need to be address in this regard such as confidentiality, integrity, availability, trust, control access, human error, threats, and disclosure private data. TAM and UTAUT model have been applied in healthcare. However, there is limited studies applied these models in health information system acceptance especially UTAUT2 model.

Conclusion

This study focused on privacy and security factors that could have effect on health information system acceptance. It also reviewed other related work to show the gap in previous studies, as health information system acceptance faced with many privacy and security issues. Because there are very limited studies applied UTAUT2 model in healthcare especially health information system, as well as the lack of adopting EMR in developing countries such as Malaysia, there was a crucial need for this study.

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