

Blockchain Adoption Readiness Assessment Framework for Health Professionals of Malaysian Public Hospitals

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Abstract

Healthcare professionals are the primary user of health information technology, therefore, before introducing blockchain as an underlying mechanism to Electronic Health Record (EHR), it is vital to understand their readiness to adopt it. The most influential factors of health professionals blockchain technology adoption are largely unknown from the existing literature. A limited number of studies provides a conceptual framework that can be further extended, empirically tested to develop understating in this regard particularly in developing country context like Malaysia. To fill such gaps current study, conducts a literature review to provide an compressive framework compiling the influential factors. The finding hypothesizes that the Unified Theory of Acceptance and Use of Technology (UTAUT), the Norm Activation Model (NAM), and the initial trust factors directly influences the adoption intention while, trust also plays a mediating role between those relationships. A future study will be conducted to empirically test and validate the conceptual framework that has been proposed. The framework can be extended and tasted in other developing country context.

Keywords: Blockchain Technology, Conceptual Framework, Electronic Health Record, Malaysia, NAM, Technology Adoption, UTAUT

Introduction

The usage of blockchain technology (BcT) as the underlying mechanism for Electronic Health Records (EHR) is a potential solution for Malaysia's existing EHR limitations and difficulties. Medical data breaches and medical errors are among the issues. The use of BcT as the underlying technology for EHRs can significantly increase data exchange efficiency; as a result,

nationwide health information exchange, MyHIX coverage, can be formed. The adoption of Health Information Technology (HIT) in Malaysia's healthcare industry is moving slowly and has remained low for three decades. EHR coverage is 60% in developed nations and 60% and 50% in high-income developing countries such as Botswana and China, respectively (Hummel *et al.*, 2020). Even though EHRs have a considerable impact on enhancing care quality and overall quality of life, the developing world's healthcare industry suffers due to a lack of EHR adoption. Malaysia is one of these countries. Malaysia has the lowest EHR coverage of the countries on the chart, as illustrated in Figure 1.

Malaysia's low adoption rate is problematic given the government's significant involvement in digitalizing the country's healthcare sector. Malaysia has just approximately 25% coverage of EHRs, which raises concerns for BcT uptake as an HIT. Malaysia intends to be the world's first country to build a single hospital information system (HIS) that encompasses all aspects of hospital operations, clinical and non-clinical (Ahmadi *et al.*, 2017). Since a result, the low rate of EHR adoption is a cause for worry, as it is expected to impede the adoption of BcT-based EHRs in the country's healthcare industry.

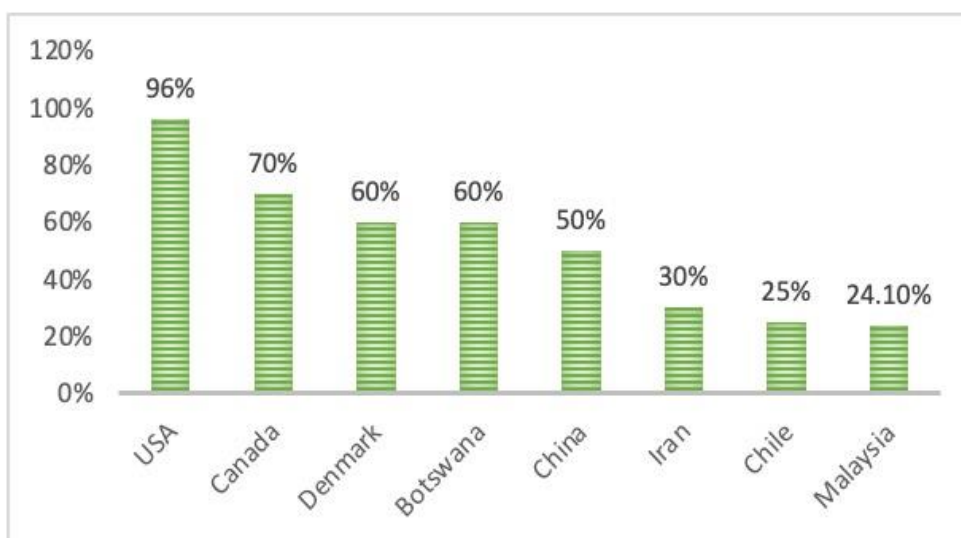


Figure.1 EHR coverage in selected developing and developed countries.

HIT projects, on the other hand, have a high failure rate. Half of all health information technology projects worldwide failed to meet their targets (Hummel *et al.*, 2020). Even if it survives, the progress is can be less than ideal. In both circumstances, the project's goal remains unachieved. One of the primary causes of failure and slow adoption has previously been investigated. As a result, assessing the readiness of health professionals during the pre-implementation phase is critical for rapid technology uptake and diffusion. The success of HIT projects cannot be guaranteed, but by understanding the factors that can impact their adoption, the risk of failure can be reduced (Sweis, 2015). As a result, policymakers' top priority is HIT diffusion (Ricciardi *et al.*, 2013). Consequently, users' readiness evaluation must identify elements that influence BcT technology adoption before system implementation. Moreover, the lower the barrier, the faster technology innovation is likely to spread.

Health professions' nature of behaving prosaically is also likely to influence their intention to adopt technology at the workplace. Besides, the socio-technical variables are critical for successful HIT adoption (Handayani *et al.*, 2020). Because end users are motivated by self-interest, they seek the benefit of utilizing technology to facilitate their daily tasks. From the user's standpoint, a better fit between technology and user increases the likelihood of the HIT

being implemented successfully. Thus, a lack of awareness of individual (user) requirements will inevitably fail in the HIT endeavor. To minimize the risk of technology initiative failure or slow technology deployment, it is vital to understand health professionals' motivations for incorporating BcT for EHR into their daily job, as they are the key users of any HIT. Additionally, researchers underline the importance of building a socio-technical framework for analyzing users' technology adoption intentions (Handayani *et al.*, 2020; Turner *et al.*, 2017). The literature lacks a framework for health professionals' use of BcT for EHR to the author's knowledge.

BCT is still in its early stages of development, and many Malaysian public hospital staff members have never heard of it before. For this reason, understanding the elements that influence adoption of BcT for EHR must be completed prior to integrating the technology into the EHR system. Additionally, there is a distinct divide between qualitative novel architecture-based system development research and BcT adoption studies. This knowledge gap necessitating BcT adoption study. This study aims to unearth the most relevant factors influencing health professionals' intention to adopt BcT for EHRs in Malaysian public hospitals. The purpose of this study is to identify the most relevant elements in health professionals' adoption of BcT-enabled EHRs in Malaysian public hospitals, as well as to propose an adoption framework that may be tested and validated in the future.

Literature Review

Barriers to Medical Professionals' Blockchain Technology Adoption

The successful implementation of technological solutions the adoption of new technologies by medical practitioners is required for innovation in hospitals. These experts are involved in the creation and deployment of new technologies on a day-to-day basis (Safi *et al.*, 2018). Psychological indicators of gaining acceptance in medical settings should also be considered while introducing innovative HIT, promoting a win-win situation. Recognize medical professionals' aversion to new technology to overcome it and plan appropriate treatments properly (Enaizan *et al.*, 2020; Safi, Thiessen & Schmailzl, 2018). Enaizan *et al.* (2020) investigated the adoption of Electronic Medical Record (EMR) by medical personnel in a Malaysian public hospital setting. According to them, the primary impediment to successful HIT implementation is physician embrace of health information technology. Medical practitioners are concerned that unauthorized individuals may gain access to the data they manage in EHRs and that legal concerns may arise from personal data exploitation. They are much more concerned about this risk since they act pro-socially and prioritize the welfare of patients while also considering their interests (Dinev *et al.*, 2016, Enaizan *et al.*, 2020).

Health professionals' decision to embrace technology is significantly influenced by privacy and security issues. Most medical professionals (physicians, nurses, pharmacists, and laboratory employees) believe that the HIT does not effectively protect patient confidentiality and privacy (Enaizan *et al.*, 2020). As a result, they oppose HIT in the workplace, persuaded that paper-based records provide a higher level of security than digitalized systems. Self-interest and normative reasons are the berries that drive the adoption of HIT. Existing HIT research demonstrates that self-interest factors play a vital role in technology adoption. However, self-interest factors have not been examined in the context of medical professionals' BcT technology adoption. Thus, need to investigate the case of BcT technology adoption. However, to the best of the researchers' knowledge, norm-activating elements associated with pro-social behavior have not been evaluated in the context of medical professionals adopting HIT. Medical practitioners' concerns about patient data security contribute to a lack of trust in BcT

technology (Lam, 2016). As a result, medical professionals' trust in BcT technology will likely remain a key obstacle to its implementation in public hospitals.

Related Work

BcT is a new technology and has yet to meet the maturity level. Therefore, although many studies focus on the technological aspect of BcT in terms of architecture development, not much attention has been paid to BcT adoption or users readiness assessment. Table 1 presents significant relevant studies that the researcher has reviewed. In Malaysia context, Hira et al. (2022) explored the potential, need and challenges towards blockchain technology implementation in the healthcare industry. The study suggests conducting pre-implementation phase research to overcome the user's individual-level barrier to BcT adoption.

BcT adoption models are currently very few. However, the increasing number of studies in this phenomenon of interest shows a promising research area. The studies presented in the table above demonstrates that BcT adoption studies are predominantly focusing on technological attributes such as quality of the system (Shrestha & Vassileva, 2019), security (Dwivedi *et al.*, 2020; Kumar *et al.*, 2021), compatibility (Dwivedi *et al.*, 2020), etc. The most relevant work close to the present study has been conducted by Wanitcharakkhakul and Rotchanakitumnui (2017) regarding BcT EMR adoption. However, the study considered the influence of ability, integrity, security, privacy on trust. Furthermore, the study measured the influence of perceived usefulness and relative advantage on performance expectancy. The BcT EMR was income-generating, and 149 respondents were physicians, nurses, pharmacists, officers. Other than the impact of integrity on trust, all the hypothesizes has been established.

Table.1

Reviewed Technology Adoption Studies

Study	Country	Industry	Respondent, Study level	Theor y	Conclusion/ Variables
Wanitcharakkha kul & Rotchanakitumn uai (2017);	Thailand	Healthca re	149, Health professionals	–	The most crucial element influencing performance was discovered to be performance expectancy. Perceived low risk and trust in BcT influence adoption intention.
Shrestha & Vassileva (2019)	–	Healthca re	–	TAM	Only perceived ease of use, quality of the system, and perceived enjoyment influence behavioral intention. Perceived enjoyment also

Khazaei (2020)	Malaysia	SMEs	156, individual	UTAU T	influences perceived usefulness. Personal innovativeness, trust, security, effort expectancy, performance expectancy, and social influence on intention to use BcT. However, technology awareness does not influence the intention to accept BcT.
Wong <i>et al</i> (2020)	Malaysia	SCM	157 firm, organization	UTAU T	Technology readiness, technology affinity influences BI. Effort expectancy, technology readiness, trust has no impact on BI. Regulatory support moderates the relationship between facilitating conditions and BI only.
Yusof (2018)	Malaysia	Banking	149 respondents, individual	UTAU T	Performance expectancy, facilitating condition, social influence, influence BI; effort expectancy has no influence.
Kumar <i>et al</i> (2021)	India	SMEs	Individual	TAM, TOE, DOI	Highlighted decentralization, immutability, trust, transparency, disintermediation, data integrity, traceability, auditability, privacy, shareability, authorization, efficiency, and security as variables.

Nuryyev <i>et al</i> (2020)	Taiwan	Tourism and hospitality SMEs	101 15,831 individual	SMEs, people, individual	TAM	Strategic orientation, social influence, SME owner/manager's characteristics, IT characteristics, cryptocurrency payments influence BI. Perceived usefulness, perceived ease of use mediates all hypothesized relationships other than the relationship between social influence and BI.
Knauer & Mann (2020)	Germany	–	157, Individual	consumer, Individual	TRA	Perceived usefulness, trialability influences positively and perceived risk influences BI negatively. Other variables are perceived ease of use, level of principles, perceived improvement, knowledge, felt independence from institutions.
Gupta <i>et al</i> (2020)	Turkey	–	fuzzy analytical framework, individual	analytical framework, individual	UTAU T, TAM, Social support theory	Social influence, financial literacy, effort expectancy, facilitating conditions, social support, performance expectancy, perceived trust, usefulness have been hypothesized to influence intention.
Yang (2019)	Taiwan	Maritime	Survey, 121		TAM	Customs clearance, digitalizing and ease paperwork, business model and

						regulation, tracking and tracing, standardization and platform, development of a business model and effective regulations, Intention to use.
Kabir (2020)	Bangladesh	Taxing	Survey, Organization	215,	TAM, SDT	Perceived usefulness, perceived trust, autonomous motivation has influences on BI. perceived ease of use was no influence on BI.
Arias-Oliva et al (2019)	Spain	Finance	The user,	survey,	UTAU T	The hypothesis regarding performance expectancy, social influence, facilitating conditions were supported, but perceived risk, financial literacy, effort expectancy was unsupported.
Jung et al (2019)	Korea, China, Vietnam	Finance	The Korea, China, Vietnam Individual	survey, (125), (43), (40),	UTAU T	Economic feasibility, payment convenience, government regulation, risk, performance expectancy, effort expectancy, social influence, facilitating conditions have been tested and found to have mixed results.
Dwivedi et al (2020)	–	–	Meta-analysis		UTAU T	Variables propose to include performance expectancy, social influence, attitude, use behavior, compatibility, resistance, effort

Kamble, Gunasekaran & Arha (2019)	India	SCM	Survey, supply chain practitioners	181	TAM, TRI, TPB	expectancy, perceived enjoyment, perceived social pressure, perceived Information security, resistance to change, personal Innovativeness in IT. Discomfort, insecurity, perceived usefulness, perceived ease of use, attitude, subjective norms, behavioral intention, perceived behavioral control. The relationship between influence perceived ease of use and attitude, subjective norms, and BI were unestablished. Hypotheses on discomfort, insecurity were rejected.
Heidari (2019)	–	Finance	222, individual		UTAUT, ITM, TTF	Task features, technological features, task-technology fit, performance expectation, personal propensity to technology trust, structural assurances, initial trust, influence behavioral intention.
Lee et al (2019)	US	Education	127, individual		UTAUT	A framework consists of ease of use, trust, cost, facilitating, usefulness, privacy, intention, experience as variables and

Alazab <i>et al</i> (2019)	US	SCM	104 firms, organization	UTAU T, TTF, ISS	obtained a mixed finding. Performance expectancy, efforts expectancy, social influence, facilitating conditions, BcT efficiency, intention to adopt BcT, system quality, information quality, service quality, user satisfaction, technology trust, inter-organizational trust, task characteristics, technology characteristics, task technology fit has been hypothesized and empirically tested.
Caldarelli <i>et al</i> (2020)	Italy	SMEs	Firms, Organization	UTAU T	Performance expectancy, social influence positively, facilitating conditions, experience influences BI.
Nawaz & Thowfeek (2020)	Sri Lanka	SCM	Individual	UTAU T	Performance expectancy, effort expectancy, trust, BcT transparency, influence BI. Besides, facilitating conditions influence behavioral expectations.
Francisco & Swanson (2018)	-	-	-	UTAU T	Performance expectancy, effort expectancy, social influence, facilitating condition influence behavioral expectation. Technology trust,

Queiroz & Wamba (2019)	India, US	SCM	Professionals, India -344; USA -394, Individual	UTAU, TAM	inter-organizational trust has a moderating impact. Social influence, facilitating conditions, performance expectancy, BcT transparency, trust of supply chain stakeholders has been hypothesized to influence BI and behavioral expectation.
Wamba & Queiroz (2019)	Brazil	SCM	138, senior supply chain specialists, individual	UTAU, T	Performance expectancy, effort expectancy, social influence, facilitating condition influences BI. Facilitating condition, performance expectancy effort expectancy plays mediating role between the relationship of social influence and BI. Performance expectancy has a non-significant influence on BI and the same for mediating effect. Other hypotheses have been established.
Choi <i>et al.</i> (2020)	–	SCM	83 respondents, organization	TAM, TOE, DOI	Maturity, compatibility, scalability, complexity, cost, security and privacy concerns, technological knowledge and awareness of top managers, expertise

Salem & Ali (2019)								UTAU	T						<p>and technical knowledge, perceived effort in collaboration and communication between firms, perceived risk of vendor lock-in, perceived constraint on government support, perceived constraint on existing regulations and legal framework within the BcT, perceived constraint on technological infrastructure, resistance to BcT factors at the organizational level.</p> <p>Performance expectancy, effort expectancy, social influence, trust, facilitating condition, perceived risk influences BI in proposed model.</p>

Underpinning Theory

Based on a survey of pertinent theories in the literature UTAUT for self-interest factors and NAM for pro-social behavior has been chosen to support the proposed BcT technology adoption framework.

UTAUT

UTAUT is a well-known and widely used theory to assess individual-level technology adoption, thus appropriate to this research. Venkatesh *et al* (2003) spotted an inadequacy of a unidimensional approach to understanding individuals' technology adoption intentions (AI) and use behavior (UB). The technology acceptance studies utilize a single theoretical perspective of the established acceptance model in explaining the BI (Taylor & Todd, 1995; Venkatesh *et al.*, 2003). Thus, based on the strength and weakness in terms of the explanatory power of eight theories, Venkatesh *et al* (2003) developed this model as in Table 2 (Lee, Kriscenski & Lim, 2019). A systematic review, 32 constructs of those theories, four new constructs were derived which are, performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) (Hsieh, 2017; Lee, Tsai & Ruangkanjanases, 2020).

Table.2

Formation of UTAUT

UTAUT determinant	The sub-determinant	The source of the integrated model
Performance Expectancy (PE)	Perceived usefulness Extrinsic motivation Job-fit Relative advantage Outcome expectations	TAM, TAM2, C-TAM-TPB MM MPCU IDT SCT
Effort Expectancy (EE)	Perceived ease of use Complexity Ease of use	TAM, TAM2 MPCU IDT
Social Influence (SI)	Subjective norm Social factors Image	TRA, TAM2, TPB, DTPB, C-TAM, TPB MPCU IDT
Facilitating Conditions (FC)	Perceived behavioral control Facilitating conditions Compatibility	TPB, DTPB, C-TAM-TPB MPCU IDT

According to Figure 2, in UTAUT, behavioral intention (BI) and use behavior (UB) are dependent variables (DV). These individual variables (IV) affect BI and UB together with the moderating effects of gender, age, experience, and voluntariness of use (Lee, Tsai & Ruangkanjanases, 2020; Venkatesh *et al.*, 2003). The four constructs of the UTAUT model are individually oriented, which are self-interest or personal utility factors (Venkatesh *et al.*, 2003).

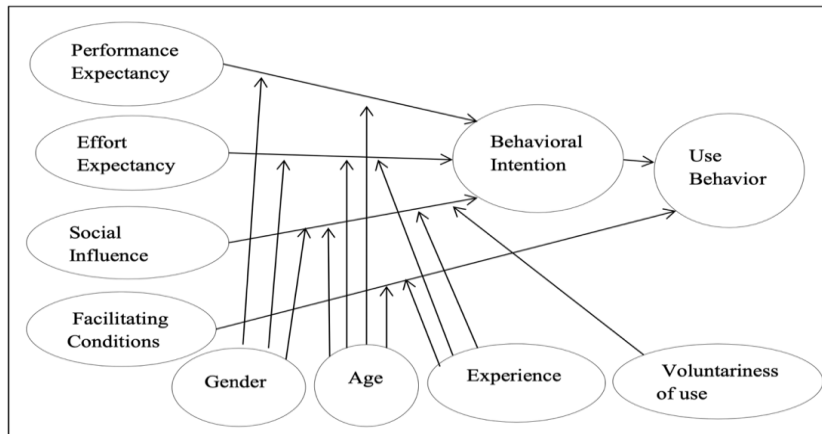


Figure.2 The UTAUT model.

NAM

NAM (Norm activation model) is mainly used to explain pro-environmental behavior. However, pro-environmental behavior is pro-social behavior since health professionals serve the community beyond duty, thus likely to behave pro-socially. NAM is also known as Norm Activation Theory (NAT). This theory has three constructs to predict pro-social behavior, namely, awareness of consequence (AC), ascription of responsibility (AR), personal norms (PNs). This aims to research pro-social behavior and to ascertain how individuals forego their interests to benefit others. The NAM comprises three components and is frequently viewed as a sequential paradigm in which AC impacts AR and subsequently triggers PNs. PNs are the significant determinants of adoption intention. The three precursors of the NAM are depicted in Figure 3 (Lee et al., 2020). The critical basis of NAM is PNs which means "feelings of moral obligation to perform or refrain from certain actions" (Schwartz, 1977).



Figure.3 The Norm Activation Model.

According to the theory, the determinants of PNs include the AC, AR of a particular behavior. AC is defined as "the understanding that performance (or non-performance) of certain behavior will lead to outcomes/consequences that the individual will have to deal with." AR refers to "the feeling of responsibility an individual has for his/her behavior." The AR, AC influences PNs, and PNs influence pro-social intention and behavior. As a result, PNs activate whenever an individual recognizes the implications of their actions and is willing to take responsibility for that act. The given interpretation of NAM explains why this theory has been chosen as an underpinning theory for explaining BcT-enabled EHR. For BcT adoption, PNs of health professionals activates by their sense of responsibility toward the patient as they serve the community beyond duty (Hyde et al., 2013; Liebe et al., 2019); thus, they are likely to act towards harm reduction by themselves to patients. The awareness of consequence (AC) that if they do not adopt BcT, if patient information is not readily available at the point of service, medical errors and adverse treatment events will continue to occur. Thus, this sense of responsibility toward the community further triggers them to uptake this technology. The core concept of NAM is derived from pro-social behavior (Udo et al., 2016b). Therefore, the researcher adopts the idea of pro-social behavior" in explaining NAM, although the theory has

been widely used in explaining "pro-environmental" behavior. However, the present study captures the concept of pro-social behavior" and argue that since the health professionals serve the community beyond duty (pro-socially) (Hyde et al., 2013; Liebe et al., 2019), therefore, the NAM theory is applicable in healthcare technology adoption study.

NAM-UTAUT integrated models could explain the variance better than a single theory (Maity *et al.*, 2019; Udo et al., 2016b). The basic BcT acceptance studies are predominantly using TAM, TPB, UTAUT to understand user AI. Although NAM can explain an individual's "inner self" influences decision-making for technology adoption, very few studies attempted to examine TA from the NAM perspective. Furthermore, none of these theories (TAM, TPB, UTAUT) fully incorporates emotional or motivational (PN, AC, AR) and functional appeals (EE, PE) together (Udo et al., 2016b). Selflessness is the foundation of medicine. According to the Accreditation Council for Graduate Medical Education, clinicians are required to show compassion, honesty, respect for others, and responsiveness to patients (Waisel *et al.*, 2020). Thus, this study considers NAM as one of the underpinning theories to close this gap. This research argues that We propose that health professionals adopt BcT if they positively influence the patients or society. Thus, this research integrates NAM with UTAUT, optimistic that the framework will better explain NAM in the technology adoption research domain. Depending on the summary of NAM-based studies of Table 3, technology adoption studies utilizing NAM explain behavior other than pro-environmental behavior. NAM is a widely used theory in explaining the pro-environmental behavior of individuals. Thus, this study argues that NAM is applicable in explaining pro-social behavior as prior studies mentioned that "pro-environmental behavior" is a kind of pro-social behavior" (Shin *et al.*, 2018; Udo et al., 2016a; Udo et al., 2016b). The NAM-based studies on the technology have been reviewed in Table 3 to highlight the research gap.

Table.3

Reviewed NAM-based Technology adoption studies

Technology	Country	Type of study	Theory	Conclusion	Source
Smart Grid technology	Europe	Model development	NAM, TAM	Personal norms to the independent variables significantly increased the explanation.	Toft, Schuitema & Thøgersen (2014);
Biogas technology	Pakistan	Empirical study	NAM extension	47.8 % variance explained, thus, suggested to integrate with other models.	Wang et al (2020)
Drone technology	Korea	Empirical study	NAM, TPB	All hypothesis supported	Kim & Hwang (2020)
Sustainable energy technology		Model development		Hypothesis proposed	Huijts et al (2012)
Green IT	Malaysia	Model development	NAM, TPB	A proposed model considering Malaysia as a research context	Asadi et al (2016)
Electric vehicles technology	Malaysia	Empirical study	NAM, TPB	The study explained 78% of the variance in adoption intention. Self-interest and altruistic aspects increased the explanatory power of the model.	Asadi et al (2021)
Digital piracy	India and US	Empirical study	NAM, UTAUT, culture	NAM-UTAUT model has been proven to be more comprehensive and robust in explaining BI	Udo et al (2016b)
Information technology	–	Empirical study	NAM, UTAUT	Model better explained green information technology (all hypotheses supported other than EE, PE) and digital piracy (All hypotheses supported other than SI, AR).	Maity et al (2019)

All the above studies integrated with either TPB, TAM, UTAUT theory, or additional contextual construct. Although NAM-based research is lacking in the healthcare context during the last decade, it has been utilized in several technology contexts such as green IT (Asadi et al., 2016), biogas technology (Wang *et al.*, 2020), IT and digital piracy (Maity *et al.*, 2019; Udo et al., 2016b) are few. There are very few NAM-based studies on technology acceptance available in the Malaysian context (Asadi et al., 2016; Asadi *et al.*, 2021), but none considered empirically testing electronic health (eHealth) adoption intention utilizing NAM-UTAUT integrated mode. Also, the summary of studies demonstrates that NAM is applicable in the organizational context as Lei and Ngai (2014) applied it to test employees' intention to adopt green IT. Asadi *et al.* (2021) integrated TAM-NAM, and the result demonstrated that the integration of self-interest factors (from TAM) and altruistic aspects (from NAM) enhanced the model's ability to explain phenomena in the Malaysian context. Since UTAUT is upgraded TAM the thus the constructs represent self-interest aspects.

Consequently, the researcher of this study argues that NAM, UTAUT integration is likely to explain a higher percentage in variance than only UTAUT of NAM. NAM-UTAUT frameworks have been developed and empirically tested in prior studies, but the number of studies is minimal, thus creates a research gap. Also, due to a lack of study in the technology domain utilizing NAM, the influence of normative factors derived from this theory remains underexplored in the technology adoption research domain. Using NAM for this research helps to understand the health professionals' behavior towards BcT. Likewise, it contributes to the body of knowledge providing justification and empirical validation of the suitability of NAM in the technology adoption domain where some form of moral obligation is involved.

Result and Discussion

Hypothesis Development

Based on the literature and with the support of underpinning theories, this study proposes below hypothesizes.

Perceived Autonomy

Perceived Autonomy (PA) refers to "the degree to which an individual believes that using a particular system would increase his/her control over the patients' medical conditions, decision-making processes or increased control over his or her work." In other words, in blockchain EHR context PA becomes a "capacity" no more "threat" to professional autonomy. Thus, this study proposes that medical professionals will desire the blockchain EHR if they have strong perceptions of autonomy. Based on the discussion, the following hypothesis has been developed.

H1: Perceived autonomy positively impacts the adaption intention.

Performance Expectancy

Performance Expectancy (PE) means the extent to which technological usage gives users efficiency in carrying out activities (Venkatesh *et al.*, 2003). In this study, PE refers to the extent to which BcT is useful in performing healthcare professionals' tasks and service delivery at the workplace. Thus, PE denotes the degree to which medical professionals think technology can improve their healthcare service delivery efficiency. PE has a positive impact on users' intention to adopt new technology (Hoque & Sorwar, 2017). However, prior BcT acceptance research found inconsistent results, such as Heidari *et al.* (2019) found positive impacts of PE on BI. Ben Arfi *et al.* (2021) found IoT for healthcare positively impacts BI but is

not significant. Wong *et al* (2020) reported there was no relationship between PE and BI. Thus, PE is hypothesized to positively influence the user's behavioral intention towards accepting the BcT technology. Based on the discussion, the below hypothesis is formulated.

H2: Performance expectancy positively impacts the adaption intention.

Effort Expectancy

Effort Expectancy (EE) means the degree of ease related to using the system" (Venkatesh *et al.*, 2003). The importance of EE is it works as a tool to develop a sense of the usefulness of a particular technology. Therefore, the users tend to consider technology for easy task accomplishment (Pal *et al.*, 2018). Moreover, in BcT enabled EHR, EE is linked to the users' perception that the BcT will not require much effort (easy to use) be more beneficial for health service delivery outcomes. The description of EE for this study is, the easier it is to utilize BcT, the more likely health professionals are to use it. Previous HIT studies empirically tested EE and BI relationship and yielded a mixed or inconsistent result (ben Arfi *et al.*, 2021; Fan *et al.*, 2020; Jang, Kim & Lee, 2016). Consequently, the following hypothesis is developed.

H3: Effort Expectancy positively impacts the adoption intention.

Social Influence

Social Influence (SI) is defined as the extent to which a person sees the importance of peer opinions on whether they should utilize the technology (Venkatesh *et al.*, 2003). The opinion of the affiliated others will influence an individuals' behavior towards technology. The influence can be positive or negative. However, the SI will affect an individual's decision to adopt a technology. Studies found a significant contribution of SI to influence Individual' technology adoption (ben Arfi *et al.*, 2021; Fan *et al.*, 2020; Jang *et al.*, 2016). In BcT-based EHR, the SI is predicted to impact health professionals' adoption intention positively. Furthermore, it is essential to note that social and psychological frameworks encompass social and personal norms (PN). PN (in NAM) is not the same as social norms (Udo, Bagchi & Maity, 2016a). Maity *et al* (2019) assert that SI (or subjective norm) influences an Individual's attitudes and beliefs (Venkatesh *et al.*, 2003), and in their study context, PN is an attitude. Thus, they further anticipated that SI shapes PNs regardless of whether they are normative (green information technology) or non-normative (digital piracy). They hypothesized that a high SI would result in this more positive PN. The findings for both cases, green information technology, and digital piracy, were positive and significant. In line with their study, the following hypothesis has been developed.

H4: Social Influence positively impacts adaption intention.

H5: Social Influence positively impacts personal norms.

Personal Norms

Personal norm (PN) is "feelings of moral obligation to perform or refrain from specific actions" (Schwartz, 1977). Feelings morally obliged towards society play an essential role in reflecting individuals' pro-social behavior (Toft *et al.*, 2014). Empirical studies that tested NAM in the realm of pro-environmental behavior (e.g., Vining and Ebreo, 1992) indicate it can explain individuals' pro-social behavior. The theory has been tested in a pro-social behavior

context (Maity *et al.*, 2019). Thus, PNs can affect pro-social behavior. Health professionals behave pro-socially due to their job nature. BcT implementation can erase significant public health issues like medical errors. Therefore, health professionals' pro-social behavior can play an essential role in triggering PNs. As a result, PN is expected to positively associate with a health professionals' intention to adopt BcT.

H6: Personal norm positively impacts the adaption intention.

Ascription of Responsibility

Ascription of responsibility (AR) is also called outcome efficacy. AR is one of the three factors of NAM that influences individuals' pro-social behavior. AR or outcome efficacy is a concept that describes a sense of responsibility while conducting a particular task (Udo *et al.*, 2016a). Groot and Steg (2009) convey pro-social ownership attitudes for the adverse repercussions of inaction. According to NAM, the AR affects individuals' pro-social behavior and catalyzes their moral imperative to behave accordingly (Schwartz, 1977). Thus, consistent with the NAM, it is anticipated that if health professionals accept the duty to act in mitigating medical data management related issues (i.e., medical error, data breach risk reduction), they will have a greater desire to embrace BcT-based EHR and will also feel more obligated to behave pro-socially. Consequently, the following hypothesis is developed.

H7: Ascription of responsibility positively impacts adaption intention.

H8: Ascription of responsibility positively impacts personal norms.

Awareness of Consequence

Awareness of consequence (AC) means being conscious that engaging in (or refraining from engaging) a particular act can result in specific outcomes (Udo *et al.*, 2016a). According to this definition, if the health professionals understand that BcT adoption has positive effects such as reducing medical error, effective data management, and improved quality of patient care, they will adopt the technology. Also, this AC will activate their AR. According to Maity *et al.* (2019), considerable research that already has utilized NAM in various pro-social scenarios shows that users' awareness of their actions has distinct effects that affect their sense of accountability and moral duty for that activity. These studies indicate that AC positively influences PN, a relationship that we expect in our research. According to the researcher, using BcT-based EHR is a socially desirable activity. The user is also aware of the implications, which could lead to the establishment of PN. As a result, BcT is expected to have a favorable effect on PN.

Individuals' PN are also engaged when perceiving that a specific event constitutes harm to others (Schwartz, 1992). Therefore, AC (problem awareness) should activate a PN or a "perceived moral" need to preserve the patient's health and wellbeing. As mentioned by Dalvi-Esfahani *et al.* (2017), according to Nordlund and Garvill (2003; p. 341), individuals who are conscious about the harmful impact of their act on environmental damage develop moral obligation thus, behave environmentally friendly. Similarly, health professionals aware of the adverse effects of lack of medical data availability are more likely to create a moral imperative to act in a socially friendly manner. In BcT-based EHR, the more health professionals are

obliged to behave pro-socially and the more they intend to adopt BcT. Therefore, the following hypothesis is developed.

H9: awareness of consequence positively impacts adaption intention.

H10: awareness of consequence positively impacts ascription of responsibility.

Initial Trust

Trust has been proved to be vital in developing relationships among individuals or organizations (Zavolokina et al., 2020). However, technology trust is different from those (individual to Individual or Individual to organizational) trust as it is between individuals and technology. This study's focus is trust between individuals and technology. There are two types of technology trust, namely, initial trust and continuance trust. Also, trust formation has three stages: initial trust-building, trust maintaining, and trust recession. BcT is still at a nascent stage of development, likely to face difficulty in initial trust-building (Gu & Wei, 2020). Initial technology trust develops before interacting with it. In other words, Initial trust is created before first-hand contact with the technology. At this point, the technology trust begins at zero (Lewicki et al., 2006). User's trust in the initial phase goes through stages and based on Initial trust later; they determine whether they want to use the technology (McKnight, Cummings & Chervany, 1998). There is a pre-conceived principle in the case of technology trust - "no trust, no use" (Zhang *et al.*, 2018). That means the potential users will only adopt the technology (in this case, BcT for EHR) when they have a positive initial trust in the technology (Ofori *et al.*, 2018). The Initial trust develops the desire to rely on variables that cause an individual to accept the risk and uncertainty associated with the technology adoption (Lewicki et al., 2006). Health professionals' concern about patient's privacy may cause a delay in technology uptake and diffusion, particularly for BcT as it will be directly involved with patient's information. Therefore, initial trust in BcT-based EHR may play a vital role in health professionals' BcT adoption intention. These study hypotheses are mentioned below.

- H11 Initial trust mediates the relationship between self-interest factors and adoption intention
- H11a Initial trust mediates the relationship between performance expectancy and adoption intention
- H11b Initial trust mediates the relationship between effort expectancy and adoption intention
- H11c Initial trust mediates the relationship between social influence and adoption intention
- H12 Initial trust mediates the relationship between normative factors and adoption intention
- H12a Initial trust mediates the relationship between personal norm and adoption intention
- H12b Initial trust mediates the relationship between ascription of responsibility and adoption intention
- H12c Initial trust mediates the relationship between awareness of consequence and adoption intention

- H13. Initial trust mediates the relationship between perceived autonomy and adoption intention
- H14. Initial trust has a positive effect on adoption intention

This study's objective is to propose the research framework depicted in Figure 4. The UTAUT and NAM have endorsed the framework.

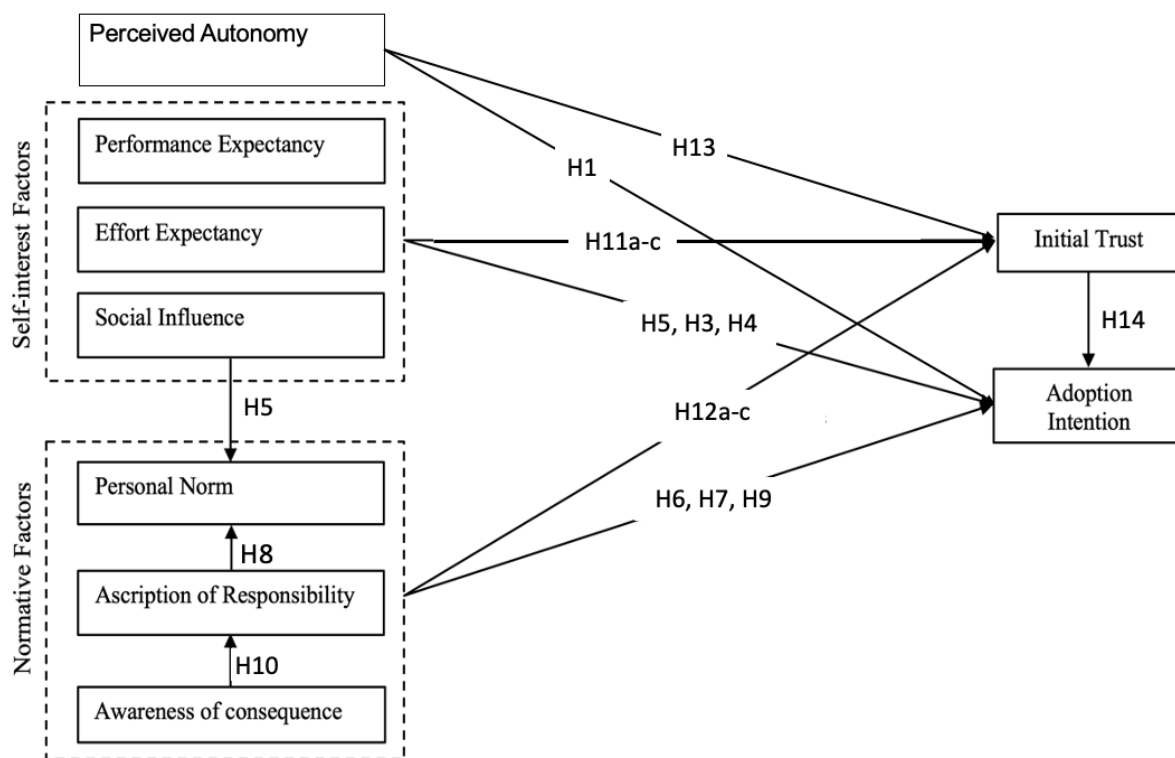


Figure.4 Conceptual framework.

Research Methodology and Data Analysis

To accomplish the research objective, the study will employ a quantitative research approach. A quantitative analysis, in its ideal form, provides objective data and is used to include programs in an aspect-oriented approach. Additionally, this analysis technique ensures the validity of conclusions through robust systems of justification and definition. The suggested model will be empirically validated using the Statistical Package for the Social Sciences (SPSS) collected from a questionnaire survey. Health professionals from 36 public IT hospitals in Malaysia will respond to this individual-level study to generalize the finding. The sample size is 384 people, according to the chart created by (Krejcie & Morgan, 1970). The likelihood that all questionnaires distributed will be useable is low. As a result, an additional 10% of questionnaires will be circulated for 422 participants. The fundamental research will be carried out in accordance with the phases depicted in Figure 5.

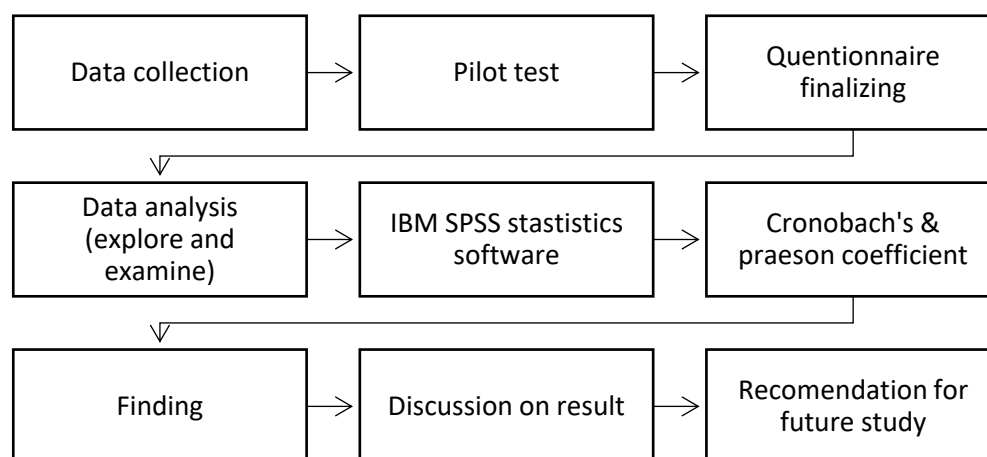


Figure.5 Research phases from data collection to recommendation.

Limitation and Future Research Direction

This study proposes a conceptual framework that needs further empirical validation, thus can be tested in developing country context like Malaysia. The limited number of factors has been included in the framework. Future research can extend the framework through theory integration, IV, moderator and mediator inclusion. The present study overlooks the mediators of original UTAUT model - gender, age, experience, and voluntariness of use that can be added in future research.

Conclusion

Technology adoption studies are being conducted for the last three decades. The more we are getting into technologies, the more technology adoption is gaining importance. The technology ought to be accepted by the end-users to be successfully implemented; thus, assessing users' readiness is a crucial undertaking. In this study, we propose a conceptual model that will be further empirically tested to assess health professionals' readiness to adopt BcT technology for EHR. The conceptual model incorporates self-interest and normative factors, initial trust to investigate clinical and non-clinical medical professionals' intention to adopt BcT technology in Malaysian public hospitals. UTAUT and NAM theory has been used as underpinning theory to develop the proposed model.

It is expected that better understanding of the acceptance and usage intention of the BcT-based EHR system by health care providers will have significant implications for the future sustainability of the healthcare system, which will benefit from more efficient resource utilization. This study also provides a foundation for further research. The contribution to the knowledge of this study is the use of NAM theory that remained unexplored in the HIT adoption study context. Currently, there is an extreme lack of conceptualizing factors influencing health professionals' technology adoption. This study also fills this research gap.

Furthermore, the framework is expected to bring meaningful insight to support the ministry of health, public hospital management in decision-making, and planning BcT intervention in the hospitals of Malaysia. BcT technology implementation has the potential to establish a sustainable, safer, and patient-centric healthcare delivery system. User readiness to adopt this technology is one of the primary concerns that may hinder this novel

technology's implementation and diffusion. Therefore, pre-implementation phase user readiness assessment is advisable to mitigate the risk of project failure, low adoption, or slow implementation of BcT technology in the Malaysian healthcare industry.

Nomenclature

AC	Awareness of consequence
AI	Adoption intentions
AR	Ascription of responsibility
BI	Behavioral intention
BcT	Blockchain technology
DTPB	Decomposed theory of planned behaviour
DV	Dependent variables
EE	Effort Expectancy
EHR	Carbon intensity indicator
EMR	Electronic Medical Record
eHealth	Electronic health
FC	Facilitating conditions
HIS	Hospital information system
HIT	Health information technology
IDT	Innovation Diffusion Theory
IT	Information technology
IV	Individual variables
MM	The motivational model
MPCU	The Model of PC Utilization
NAM	Norm activation model
NAT	Norm activation theory
PE	Performance expectancy
PN	Personal norm
SCT	Social cognitive theory
SI	Social Influence
SPSS	Statistical package for the social sciences
TAM	Technology adoption model
TPB	The theory of planned behavior
TRA	Theory of reasoned action
UB	Use behavior
UTAUT	Data collection system

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