BLOCKCHAIN-BASED ELECTRONIC HEALTH RECORDS: REVOLUTIONIZING HEALTHCARE IN MALAYSIA

Fariha Anjum Hira[1]*, Haliyana Khalid[1], Alam Md Moshiul[2]

1. Azman Hashim International Business School, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia

2. Razak Faculty of Technology and Informatics, Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia

Correspondence: hirafa92@gmail.com

ABSTRACT

INTRODUCTION:

Despite the government's continuous efforts since the 1990s, the public healthcare sector of Malaysia still faces issues related to system deployment and technology adoption. As a result, the nationwide health information exchange remains as not fully established, hampering the Malaysian aspirations of health service provision for citizens. The government long to establish health information exchange, enabling blockchain technology-based applications. This paper aims to review the government's digitalization initiatives and describe the provision of blockchain Electronic Health Records for healthcare services in Malaysia.

METHODOLOGY:

A review of the scholarly databases Scopus, Web of Science, and Google Scholar, along with the grey literature from the Malaysian government, was conducted. In addition, health-related government websites have been searched for information until the end of March 2023.

RESULTS:

There were 55 documents yielded from the database, and a grey literature search was retained for content analysis.

DISCUSSION:

The major barrier that could push back governments' efforts is user resistance, particularly from medical professionals. Besides, Regulatory reform is needed to facilitate blockchain provision for healthcare data management. Technical issues directly associated with the system and vendor are worth addressing.

CONCLUSION:

Malaysia has a progressive vision towards healthcare digitalization aimed at 2030. To be able to successfully achieve this target then it is essential to implement appropriate strategies. User readiness assessment calls for research, while system-related issues regarding; hardware, software, and vendor needs to be properly planned. Patients' ownership of medical data is to be allowed by law. Currently this information strictly belongs to hospitals and health partitioners therefore data management is physician centric.

KEYWORDS

blockchain technology, electronic health records, healthcare digitalization, hospital information system; Malaysia.

INTRODUCTION

Malaysia's Ministry of Health (MOH) strives to achieve "A Nation Working Together For Better Health," serving 28 million Malaysians. The MOH administered public healthcare facilities play a significant role, accounting for around 74% of the healthcare service sector share [1] and providing extensive healthcare services to citizens. Hospitals play a crucial role in ensuring quality healthcare delivery. However, the government has been slow in developing robust health information technology (health IT) in general hospital settings, with only 25% coverage for the Hospital Information System (HIS) as of 2023. There is an urgent need for a healthcare system revolution, and users must be ready to embrace new technologies such as blockchain Electronic Health Records (EHR). Therefore, it is essential to acknowledge that a health technology adoption strategy is no longer an option but a necessity for the Malaysian healthcare industry.

The government has set the vision for 2030 to utilize blockchain technology to streamline medical data management in the public healthcare sector. However, the overall understanding of issues associated with the digital revolution in the health industry is marginal and dispersed from review of the present literature. Particularly, more research on blockchain technology's healthcare application in Malaysia has been urged by Anjum et al. [2]. Therefore, this study aims to answer the questions; (a) what is the health IT initiative undertaken, and what is the HIS status quo in Malaysian general hospitals? (b) how is blockchain EHR linked to the digital economy blueprint 2030, and what benefit can it bring regarding healthcare service delivery? (c) why rethinking about the regulatory framework and end users' preparedness is required to move forward?

The findings of this study are helpful for policymakers and researchers to grasp the complexity of deploying blockchain EHR in the Malaysian healthcare industry. Besides, to realize the importance of human factors and policy reform as the prerequisite of project success hence can design and develop the system deployment strategies accordingly.

The remainder of this article is as follows; the subsequent section presents the study's methodology. Next is the chronological representation of the health IT initiative, followed by the HIS status quo. The adjacent section illustrates the link of blockchain EHR with Malaysia's digital economy blueprint for 2030 and healthcare service delivery. Following these are the need to rethink policy measures and end users' preparedness in moving forward. The study then concludes by highlighting the study's contribution, limitations, and future research direction.

METHODS

A narrative literature review method was used to undertake this study. A review of scientific databases (Scopus, Web of Science, Google Scholar), medical related electronic databases, Malaysia Government and MOH websites, World Health Organization (WHO), and the World Bank publication on Malaysia from the websites. The literature review was conducted by following the PRISMA protocol for guidance (as illustrated in Figure 1) following the pattern of Anjum et al. [2]. The literature search included terms related to healthcare digitalization on telemedicine flagship project under Multimedia Super Corridor (MSC), Electronic Medical Record (EMR), EHR, HIS, and cloud computing in Malaysia which yielded 153 documents. After screening, 55 papers met the inclusion criteria and were retained for content analysis.

FINDINGS: HEALTH IT DIGITALIZATION INITIATIVES AND THE STATUS QUO OF HIS

In the 1990s, the Malaysian Government, through MOH, initiated several health IT projects. In 1991, the government introduced Vision 2020 [2, 3], which identified health IT as a critical component of the plan. The HIS initiative began to take shape during the Sixth Malaysian Plan (MP) [4] from 1990 to 1995, and in 1993, Hospital Selayang became the first hospital in the country to implement HIS. The telehealth project was launched on August 1st, 1996. The Seventh MP [3] (1996-2000) aimed to establish 33 IT hospitals, including eight HIS hospitals and 25 intermediate and basic HIS hospitals [3,4].

However, due to the economic crisis in 1998, the Government could not meet its targets. Despite the setback, the Government remained committed to achieving its goals during the Eighth MP [3]. However, only two hospitals became IT hospitals by the Ninth MP (2006-2010) [3], and the rest remained on hold. Since 2018, the Government has focused on revitalizing the three-decades-old healthcare reform projects under MSC to enhance the use of technology in public healthcare facilities [5]. These initiatives include reviving the "Telemedicine Blueprint 1997 [3]," which proposes the

implementation of a Lifetime Health Record (LHR), Personalized Lifetime Health Plan (PLHP), Continuing Professional Development (CPD), teleconsultation, and online health services [6].

In 2018, the former Health Minister introduced the Electronic Medical Record (EMR) implementation plan for 2018-2023. The goal was to ensure that medical data and EMRs could be shared across healthcare facilities, including clinics, hospitals, and post-care practitioners [7]. This plan aimed to establish EHR in all public healthcare facilities to achieve nationwide coverage. Table 1 presents the government's healthcare facility-focused digitization initiatives chronologically [6, 8, 9].

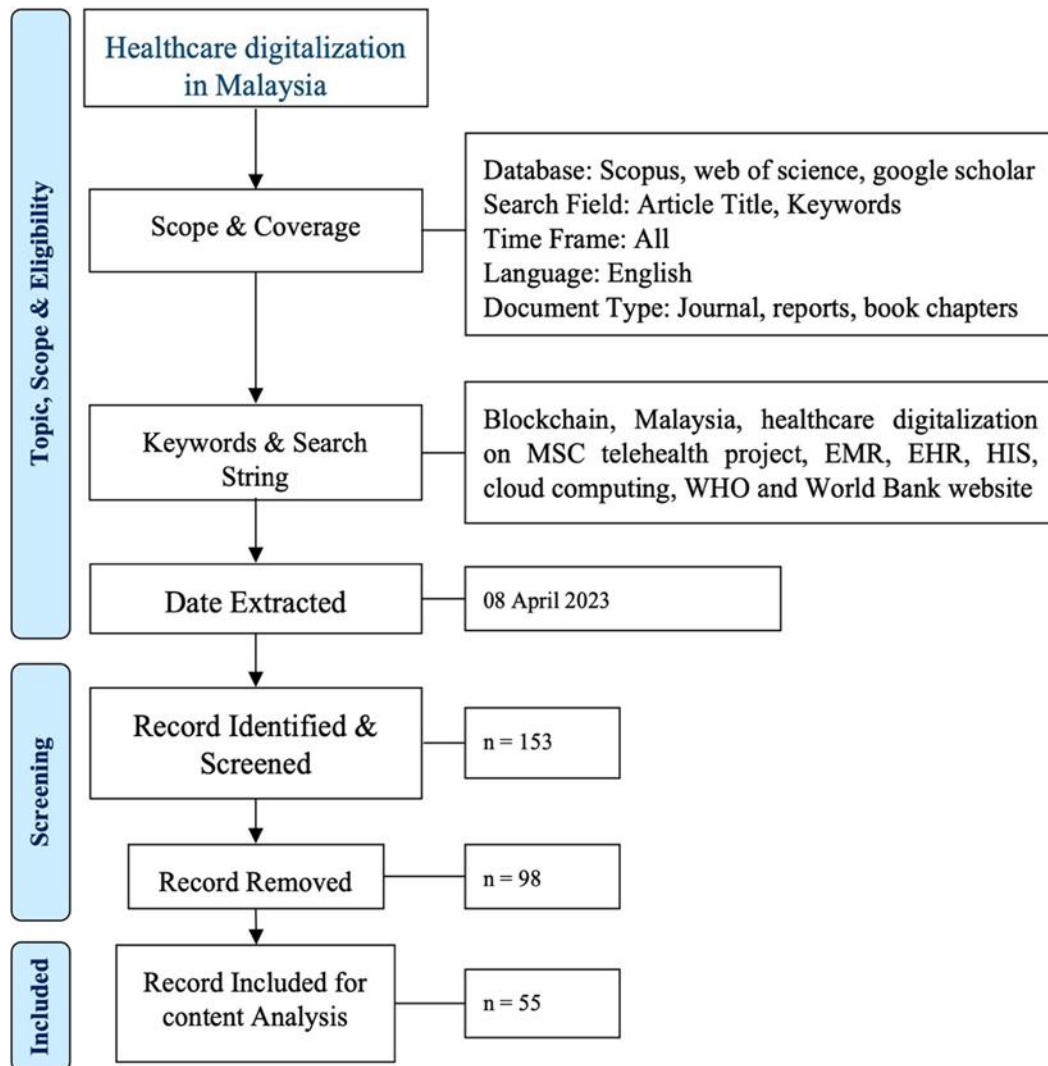**FIGURE 1. PRISMA LITERATURE SEARCH**

TABLE 1. PUBLIC HEALTHCARE SERVICE DIGITALIZATION INITIATIVES IN MALAYSIA

Timeline	Initiative/description
5th MP (1985-1990)	Computerization was introduced for efficient billing systems at selected hospitals.
6th MP (1991-1995)	Computerized health MIS for non-clinical functions, i.e., patient administration, budgeting, and performance supervising.
7th MP (1996-2000)	Widening the use of IT for patient care management and telemedicine.
	Videoconference system trial from 2 tertiary hospitals for remote patient monitoring, Deploying the MSC-telehealth flagship project.
	Development of a telemedicine roadmap and guidelines.

	The Telemedicine Act (1997) was enacted to govern clinical practice utilizing telecommunication systems for addressing client confidentiality and authorization issues.	
	Setting up of Telehealth Unit, MOH.	
	Development of the National Telehealth Policies	
	Contracting signing finalized for Pilot Project of Telehealth	
	Phase I: telehealth project completion: MCPHIE, CME, LHP	
	Deployment of Teleconsultation at 41 sites	
	Hospital Selayang and Putrajaya enabled THIS operational in 2000	
	THIS is in tertiary hospitals such as Ampang, Sungai Buloh, and Serdang. BHIS/IHIS in district hospitals such as hospitals Lahad Datu & Kepala Batas	
	Tele-primary care in selected Health Clinics	
	Proposal for THIS in Shah Alam, Cheras Rehabilitation Hospital	
8th MP (2001-2005)	Telemedicine at the Kajang and Seremban Hospitals as well as its neighbouring facilities.	
	Deployment of disease and clinical database (i.e., cancer, cataract, neonatal)	
	Completion of Telecommunication Pilot Project	
	Launching MyHealth portal (replacing non-operational MCPHIE services)	
9th MP (2006-2010)	Tele-primary care launch in Johore & Sarawak in 41 sites	
	Upgrading HIMS between national, state and district health offices	
	Re-activation of Teleconsultation services	
	Upgrading of electronic disease surveillance registries	
	Management Information System Blueprint	
	Revision of Telehealth strategies into seven components: LHR, LHP, CPD, PLHP, MPHIE, Teleconsultation, call centre/CRM, Group Data Service	
	Piloting LHR and PLHP, emphasizing interpretability and integration between healthcare providers seamlessly	
	Pilot project for Malaysia Health Information Exchange (MyHIX) in 2009	
	Tele-primary care expansion	
10th MP (2010-2015)	Utilization of tele-primary care in regional locations	
2018 onwards	All public hospitals will have EMRs with 5G technology and EHRs by 2023	
	Re-emphasis on MSC: LHR, PLHP, CPD, teleconsultation, health online	
	In 2020, 25% (35) of the 145 public hospitals were IT hospitals	
	In 2018, there were 21 IT hospitals out of 138 total public hospitals	
	EMR at all public healthcare facilities by 2023 (including 145 general hospitals).	
	EHRs will be integrated via MyHIX for the "Master Patient Index" and LHR	
	Blockchain for medical data management by 2030 in public healthcare facilities	

Abbreviations: Basic Hospital Information System (BHIS); Customer Relation Management (CRM); Lifetime Health Plan (LHP); Mass Customised Personalised Health Information and Education (MPHIE); Intermediate Hospital Information System (IHIS); Management Information System (MIS); Malaysian Plan (MP); Total Hospital Information System (THIS)

There are two sorts of public hospitals in the country: IT hospitals and non-IT hospitals. Non-IT hospitals lack information systems. Only 35 public hospitals have three levels of HIS; a total, intermediate, or basic HIS (Table 2). Tertiary hospitals with a capacity of over 400 beds have THIS. IHIS hospitals are those with 200 to 400 beds. BHIS hospitals have fewer than 200 beds. HIS components of THIS hospital covers all the hospital's departments, having EHRs. Currently, there are 12 THESE hospitals in Malaysia. BHIS and IHIS all departments' systems are not integrated and have a hybrid (both IS and paper-based) data management.

TABLE 2. DIFFERENCE BETWEEN THIS, IHIS AND BHIS HOSPITALS

Indicators	THIS	IHIS	BHIS
	12 Hospitals	23 Hospitals	
EHR component coverage	Complete	Partial	Partial
Data management	Paperless	Hybrid	Hybrid
Capacity (number of beds)	>400	200~400	<200
Tertiary Hospital	Yes	No	No

Abbreviations used are explained at Table 1

In November 2018, the Malaysian Government announced its intentions to introduce EHRs in all public hospitals by 2023, integrating them into a unified system known as MyHIX to generate a "Master Patient Index" and LHR. As of February 2023, this initiative has not been updated. According to available data, as of 2018, only 21 out of 138 public hospitals were equipped with IT infrastructure, and by 2020, only 25% or 35 of the 145 public hospitals had implemented IT systems. Despite some progress, this represents a considerable distance from achieving nationwide EHR coverage.

DIGITAL ECONOMY BLUEPRINT AND BLOCKCHAIN EHR

Blockchain is a P2P (peer-to-peer) distributed ledger containing a network of affiliates called nodes [10]. Malaysia's digital economy strategy includes integrating blockchain technology as the underlying mechanism for EHRs to streamline medical records. Phases one and two of the integration are set to be completed by 2025, with phase three scheduled for 2030. The integration of blockchain with the Malaysian Health Data Warehouse (MyHDW) is planned for 2023 since it does not hold any health-related patient information; therefore, it is irrelevant to this study.

In order to deliver the highest quality patient-centred care, public hospitals need EHRs that can generate LHR beginning at birth. In addition, data must be protected by ensuring confidentiality, and anonymity; possess a single version of the truth; have zero downtime; be accessible to approved key players (such as insurers, physicians, or advocacy groups); possess immutable integrity; be accessible in real-time and anywhere (outside the home environment); and be ubiquitous. These features are absent from EHRs as they now exist. By facilitating data protection, transparency, provenance, traceability, immutability, audit, flexible

access, confidentiality, and dependability, blockchain EHR can meet the requirements of an ideal EHR [11,12].

In 2016, health technology scientists found blockchain could be a supporting tool [2]. Blockchain technologies' use cases in healthcare clarify that it is not hype but hope. The blockchain enabled app, "The Immunity Health Passport"[13], is the first initiative in the county to exchange COVID-19 vaccination certificates for Malaysian travellers to Singapore as an exchange of health information. The Government plans to integrate blockchain with EHRs by 2030, aiming to achieve nationwide health information exchange (NHIE). Blockchain EHR benefits include;

A. It is possible to develop a seamless HIE between medical institutions. Blockchain could enhance EHR efficiency. Thus, nationwide MyHIX coverage can be achieved. MyHIX is the Malaysian Health Information Exchange [13]. MyHIX has been an EHR integration engine for HIE since November 2008 [14]. It allows connected healthcare facilities to exchange health information in the form of discharge summaries via an online virtual private network. The nationwide coverage of MyHIX will enable caregivers to access patients' medical records, thereby improving the quality of care. However, the EMR implementation and development of LHR are not yet established in line with the Government's target to achieve nationwide MyHIX coverage. To address this, the Government has undertaken the EMR implementation project to include all 145 public hospitals, but only ten hospitals and one clinic have been integrated. One of the primary reasons for the low number of healthcare facility integrations is the inefficiency of traditional EHR. Therefore, blockchain EHR can improve efficiency and support the establishment of nationwide MyHIX network coverage [13,15].

B. Patient control of their medical information can provide the caregiver with immediate access to the

data during the visit. As a result, care providers can plan informed treatment decisions personalized to each patient's needs, thus potentially mitigating the risk of medical errors.

C. The decentralized information-sharing mechanism of blockchain EHR eliminates the requirement for third-party engagement, minimizing a data breach risk.

D. This can aid the ambitious objective of "one patient, one record." Blockchain EHR can store patient information chronologically and create a chain of patient information. As the name implies, Lifetime Health Record summarizes an individual's health records throughout their life, beginning with the first use and continuing until the individual visits their healthcare provider. The concept of LHR represents a patient's life-long medical information at the point of care with reports from various facilities of healthcare settings where s/he is involved in medical care. It contains all the patient's medical information in chronological form since birth and can be facilitated through blockchain EHR. For instance, based on the idea derived from Leeming, Cunningham, and Ainsworth [16], Figure 2 presents an LHR of a woman created using blockchain EHR from birth in 1992 to death in 2020. A single patient's entire medical history is added as blocks during the patient's full lifetime, which is an LHR, thus forming "1 patient, 1 record."

FIGURE 2. A PATIENTS' LIFETIME HEALTH RECORD BLOCKCHAIN EHR
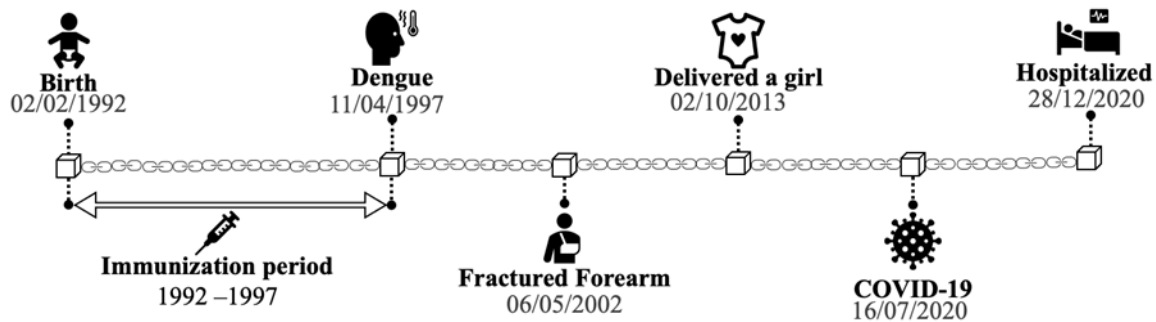
This LHR contains all medical information, such as medications, previous treatments, and disease background. If the LHR is accessible, high-risk patients, such as cancer and asthma patients, could be recognized without additional investigation. It is extremely important during infectious disease outbreaks such as COVID-19. During such a public health emergency, a well-positioned distributed HIE mechanism can facilitate decisive treatment decisions.

RETHINKING REGULATORY FRAMEWORK AND END USERS' PERCEPTION AND READINESS TOWARDS BLOCKCHAIN EHRS

Malaysia's health IT users (medical professionals and patients) are not technology ready. The unfreezing of medical professionals from the current state to prepare them to accept change in organizational settings has traditionally been identified as a major barrier. Change management strategy at the pre-implementation stage is of utmost importance. The resistance issue in every step of technology deployment needs assessment and strict continuous monitoring.

Additionally, the low adoption of health IT in public hospitals, partly due to professionals' reluctance to change from legacy systems, makes it critical to engage in a change management process that includes "unfreezing" the mindset of users to deploy health IT successfully.

Furthermore, policy implications must be reconsidered to prepare users for adopting blockchain EHRs, particularly concerning regulatory reforms allowing users to own their medical data. These are crucial areas that require policymakers' attention to ensure the successful adoption and implementation of blockchain EHRs in the Malaysian healthcare system.

Regulatory reform to facilitate exchangeable EHR. In THIS hospitals, the EHR data gets exchanged within the hospital. Due to data sensitivity, the Malaysian Medical Council imposed strict legislative complacency. Hence, the

country's public hospitals have deployed non-shareable EHRs managed by single or multiple approved care providers only. In non-sharable EHR, data cannot be exchanged outside the designated healthcare facility [7,17]. The restrictions are due to the concern of data breaches. Blockchain EHR allows patients access to their data, which contradicts policy as medical professionals and hospitals own the data by law. Such a law requires revision and amendment to facilitate blockchain EHR.

CONCLUSION

This contribution of this study is to provide a clear picture of the state-of-the-art technology initiatives and how endusers and regulatory mandates could potentially hinder the successful deployment of blockchain EHR in revolutionizing healthcare in Malaysia. The study is strictly limited in answering the research questions; future studies are encouraged to detail the issues outlined.

The potential advantages of blockchain technology are immense. However, utilizing it as an innovative method to integrate EHRs nationwide and programmatically manage typical medical issues can improve patient outcomes, medical experiences, and individuals' overall health and well-being [18]. As the EHRs are an initiative of the MOH, THIS hospitals would have been the most worthy candidates to revolutionize their EHRs to blockchain EHRs, allowing them to enjoy the advantages of Blockchain EHRs over traditional EHRs. The MOH initiated LHR under the MSC so that every individual would have one patient and one record. Sadly, the project was terminated in 1997. EHR based on blockchain technology can improve efficiency, eliminate the pitfalls of the current EHR, and facilitate the LHR and national health information exchange. MyHIX. To fulfil that target, blockchain EHR is needed. The study is anticipated to direct government hospital policymakers' decision-making and strategic planning processes for a safe and resilient health information exchange in the country.

Reference

1. Permarupan PY, Al Mamun A, Samy NK, Saufi RA, Hayat N. Predicting Nurses Burnout through Quality of Work Life and Psychological Empowerment: A Study Towards Sustainable Healthcare Services in Malaysia. Sustainability. 2020; 12(1):388. https://doi.org/10.3390/su12010388

2. Anjum HF, Rasid SZA, Khalid H, Alam MdM, Daud SM, Abas H, et al. Mapping Research Trends of Blockchain Technology in Healthcare. IEEE Access. 2020 Sep 18; 8:174244–54.

3. Ahmadi H, Nilashi M, Almaee A, Soltani M, Zare M, Babazadeh A. Multi-level Model for the Adoption of Hospital Information System: A Case on Malaysia. Journal of Soft Computing and Decision Support Systems. 2015;3(1):61–74.

4. Hertin RD, Al-Sanjary OI. Performance of hospital information system in Malaysian public hospital: A review. International Journal of Engineering and Technology (UAE). 2018;7(4):24–8.

5. Ahmadi H, Nilashi M, Shahmoradi L, Ibrahim O, Sadoughi F, Alizadeh M, et al. The moderating effect of hospital size on inter and intra-organizational factors of Hospital Information System adoption. Technol Forecast Soc Change [Internet]. 2018;134(March 2017):124–49. Available from: https://doi.org/10.1016/j.techfore.2018.05.021

6. Mat Som MH, Norali AN, Megat Ali MSA. Telehealth in Malaysia - An overview. ISIEA 2010 - 2010 IEEE Symposium on Industrial Electronics and Applications. 2010;(October):660–4.

7. Mudaris ISM. Electronic Health Records: Planning the Foundation for Digital Healthcare in Malaysia. KRI Discussion Paper. 2021;(August):1–18.

8. Intan Sabrina M, Defi IR. Telemedicine Guidelines in South East Asia—A Scoping Review. Front Neurol. 2021;11(January):1–13.

9. Shitu Z, Aung MMT, Tuan Kamauzaman TH, Ab Rahman AF. Prevalence and characteristics of medication errors at an emergency department of a teaching hospital in Malaysia. BMC Health Serv Res. 2020;20(1):1–7.

10. Radjenovic Z. The Cost- Saving Role of Blockchain Technology As a Data Integrity Tool: E-health Scenario. KnE Social Sciences. 2020; 2019:339–52.

11. Talukder AK, Chaitanya M, Arnold D, Sakurai K. Proof of disease: A blockchain consensus protocol for accurate medical decisions and reducing the disease burden. Proceedings - 2018 IEEE SmartWorld, Ubiquitous Intelligence and Computing, Advanced and Trusted Computing, Scalable Computing and Communications, Cloud and Big Data Computing, Internet of People and Smart City Innovations, SmartWorld/UIC/ATC/ScalCom/CBDCo. 2018;257–62.

12. Yaqoob I, Salah K, Jayaraman R, Al-Hammadi Y. Blockchain for healthcare data management: opportunities, challenges, and future

recommendations. Neural Comput Appl [Internet]. 2022;34(14):11475–90. Available from: https://doi.org/10.1007/s00521-020-05519-w

13. Hira FA, Khalid H, Rasid SZA, Baskaran S, Moshiul AM. Blockchain Technology Implementation for Medical Data Management in Malaysia: Potential, Need and Challenges. TEM Journal. 2022;11(1):64–74.

14. Ismail NI, Abdullah NH. Malaysia health information exchange: A systematic review. Business and Economic Horizons. 2017;13(5):706–21.

15. Hira FA, Khalid H, Zaleha S, Rasid A, Alam M, Hashim A. A Conceptual Framework to Investigate Health Professionals' Blockchain Technology Adoption Readiness in Malaysia. Open International Journal of Informatics (OIJI) [Internet]. 2021;9(2):58. Available from: https://oiji.utm.my/index.php/oiji/article/view/147/108

16. Leeming G, Cunningham J, Ainsworth J. A Ledger of Me: Personalizing Healthcare Using Blockchain Technology. Front Med (Lausanne). 2019;6(July):1–10.

17. Salleh MIM, Abdullah R, Zakaria N. Evaluating the effects of electronic health records system adoption on the performance of Malaysian health care providers. BMC Med Inform Decis Mak [Internet]. 2021;21(1):1–13. Available from: https://doi.org/10.1186/s12911-021-01447-4

18. Fatoum H, Hanna S, Halamka JD, Sicker DC, Spangenberg P, Hashmi SK. Blockchain Integration With Digital Technology and the Future of Health Care Ecosystems: Systematic Review. J Med Internet Res [Internet]. 2021 Nov 2;23(11): e19846. Available from: https://www.jmir.org/2021/11/e19846