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Blockchain-based adoption framework for authentic land registry system in Malaysia

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ABSTRACT

Land registration systems are very essential for property ownership management. The exited land registry systems are less efficient and time-consuming and expose to human errors. By using blockchain technology, most of the principles of good governance in land administration such as transparency and efficiency can be fulfilled. However, there is a lack of experience in developing blockchain-based land registry systems. This paper proposes a blockchain-based adoption framework for land registry management in Malaysia. It elaborates more on developing a prototype that fulfills the main functions of current land registration by using smart contract functionalities. Also, this paper illustrates the main challenges of adopting this technology such as expertise shortage of software developers, implementation difficulties due to scalability of the land transactions, data sharing with different types of blockchain and lack of security attacks resistance. Therefore, there is a need to form an agreed-upon blockchain development platform that meet such constraints.

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1. INTRODUCTION

In the direction of a safe, reliable, and tamperproof digital system for the land record, various government agencies explore and operate. The process includes multiple stakeholders, which makes the system difficult and requires various checks and balances to address different types of threats and establish an atmosphere of mutual confidence [1]. Stable and up-to-date land surveys will also aid governments in tax collection, service provision, and other governance aspects [2]. The World Bank is actively working in this direction and provides funding in many countries to develop the land registry system and to finance conferences as well as modernization programs for land registration [3], [4]. Several government agencies are researching and working on a secure, accurate, and tamper-proof digital land-recording system.

The blockchain-based approach is more suitable for applications where multiple zorganizations are interacting and conducting business and have no confidence in each other. The blockchain is useful when any information is exchanged on various networks or channels [5]. The land registry system encompasses a huge number of registration documents to be held in central databases that allow transactions for land title trade. This system is vulnerable to different forms of corruption and modification with the aid of dishonest staff in the registry office. So, land registry offices have taken steps to make use of information and communications

technology (ICT) technology to improve openness and transparency. Through distributing data from a centralized database to a distributed database, central storage is secured by copying and replicating data [6]. In Malaysia, transfer and registration of land titles are conducted by using Torrens system. This system was introduced in South Australia in 1858, generally attributed to Sir Robert Richard Torrens. As stated by Arrieta and Luis [7], "the torrens title system replaced a deeds registration system (old system) in which priority between competing interests was determined by the order in which instruments were registered and in which registration did not render effective an instrument impugned for fraud, mistake, or forgery". Arrieta and Luis found that Torrens Title system also solves the ethical problems arising from hidden taxes because all of the required fees are already part of the registration fees.

The current process of registering land in Malaysia is having some flaws, for example, the long duration to complete a title registration. The time taken to complete the registration process could be up to several months. The current system must also hire middlemen such as lawyers and property agents to handle the process of registering ownership. The buyer will have to prepare extra money to hire the related middlemen to handle advertising, documentation, and paperwork. Another concern of the current system is human error. Blockchain is a vital technology in today's context that can lead to a major shift in communication networking within the next ten years. Blockchain technology was started in 2008 [8] in the cryptocurrency industry. It offers a peer-to-peer (P2P) electronic cash exchange network with chronological, secured, and chained blocks [9].

This technology would have a significant effect on the provision of business opportunities, improving productivity, and providing job clarity and exposure [10]. Blockchain is a vaunted technology that enables effective cyber protection and high data privacy levels. It consists of a sequence of blocks connected to the previous blocks cryptographically. The data transfer system without third-party intervention has been entirely modified by such technology [10]. In the form of a multi-signature, blockchain offers high protection, and multi-keys are needed to formalize the operation or transaction. If the hacker wants to access the device or attempts to steal information and if it is hacked, then it will quickly be retrieved [11]. This means the data is stored on an integrated computer. And then, if they have to hack, they have to simultaneously hack more than 55% of the machines, which is unlikely to happen. For example, if they hacked the device by recognizing the key, they could not access it because they could not fit the particular multi-signature [12]. Blockchain can overcome such issues, this technology can reduce third party dependency as all participants in the blockchain share the same ledger. It also guarantees the integrity of the land documents by strengthening them through immutable blockchain ledger. Apart from that, it reduces possible human error in the land registry legacy system [13].

By using blockchain technology, most of the principles of good governance in land administration such as transparency and efficiency can be fulfilled. History of land registry transactions can also be tracked. This technology helps to identify land information such as parcel numbers and persons' identification numbers (legal and natural). Most land registry systems rely on conventional software such as stylesheet systems as currently practiced in the Netherlands [13]. By looking at the web-based application used in land registry systems in Malaysia, it is discovered that the incorporated business rules are similar to the transaction rules in the smart contract implemented by blockchain [13]. To ensure the applicability of smart contracts in the land registry system in Malaysia, further research is needed. Therefore, this study aims to fulfill this gap by answering the following questions: How does the land registry system operate in Malaysia?, What are the challenges and defects that exist in Malaysia's current land registry system?, How to utilize the open-source tools of blockchain technology to run a land registry system in Malaysia?, How to map the land registry system in Malaysia with smart contract technology? and How to develop a proof of concept prototype for a land registry system in Malaysia using blockchain?

This paper is divided into the following sections. The second part describes issues with the current system in Malaysia, the third section discusses the application of blockchain technology in land registry management, and the fourth section presents the research methods used in this study, the next section explains the prototype design of the land registry system in Malaysia using smart contracts. Then challenges of blockchain implementation of the land registry are presented. Afterward, findings and discussion are shown. Then, limitations and future research directions are illustrated and finally, the conclusion is presented.

2. ISSUES WITH CURRENT SYSTEM

R. Wu *et al.* [14] compared the implementation and flow of land title registration between Malaysia and Hong Kong. They found two important issues within the current system: indefeasibility and ownership. They stated that under the registration of title system, the original owner might lose his land without negligence or fault of his own when someone forged his signature and sold his land to an innocent third-party purchaser.

Figure 1 shows the comparison between manual and online systems (STPH/STAMPS). The current system requires the third-party purchaser to return the title land to its real owner. This proves the injustice of the current system judgment on the innocent purchaser. Abdullah *et al.* [15] conducted a study on indefeasibility and the concept of federalism in Malaysia's land administration system. From their study, they found an increasing number of cases regarding title registration fraud in Malaysia. The authors suggested tightening the system security to reduce fraud. The literature review has confirmed that the current system used to register land titles presents problems that could be more complicated in the future if nothing is done, discussed specific and general solutions, and concluded that blockchain technology is needed to be implemented in the land registry. According to Ease of Doing Business Survey 2017 by the annual World Bank Doing Business ranking, Malaysia ranks 42 out of 190 jurisdictions in ease of registering property [16]. In Malaysia, Special Taskforce to Facilitate Business (PEMUDAH)] is an agency that maintains property registration. It also works to improve the processes and enhance transparency in the procedures of property registration. This agency involves members from the Stamp Office Division of the Inland Revenue Board of Malaysia, the Valuation and Property Services Department of the Ministry of Finance, and the Land Office/Registry under the State Government [6]. This agency has made improvements in the current system by establishing an online stamping system (e-Stamping) that involves agents and the stamp office or revenue service centre (RSC) which comprise: (STPH). Stamp assessment and payment system (STAMPS). The valuation process by the Valuation and Property Services Department (JPPH); Computerization of the property registration system in the land office/registry. This system enables people in Malaysia to register their land within two days only [17]. By looking at the STAMPS implementation in Malaysia, it seems better than the manual system STPH. However, the current process of registering land in Malaysia has some flaws. For example, in terms of time and cost, it normally takes a long time to complete title registration (10 days maximum), while it may take only a couple of minutes in the blockchain. In the current system, it is also necessary to hire middlemen such as lawyers and property agents to handle the process of registering ownership, which is not required by blockchain technology. Moreover, the buyer will have to prepare extra money for the middlemen to handle their advertising, documentation, and paperwork, unlike blockchain which only requires the seller and buyer to be linked through the blockchain. The second issue is human error that affects data transaction accuracy. Blockchain has been proven to overcome human error. Finally, fraud issues can also be mitigated by using blockchain technology.

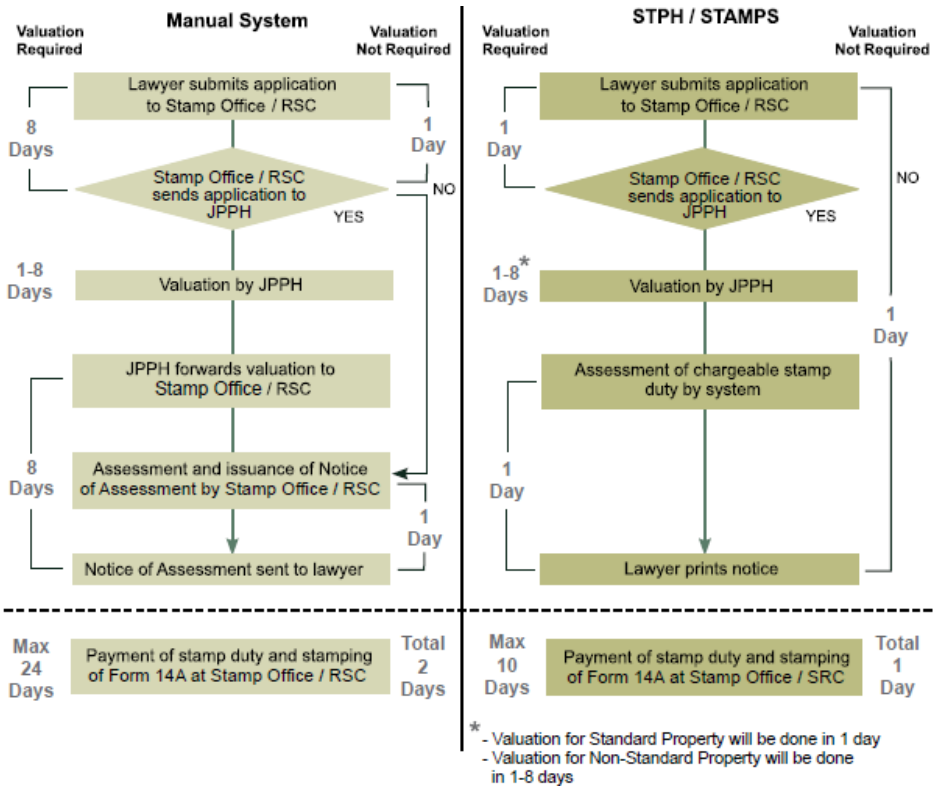

Figure 1. The comparison between manual and online systems (STPH/STAMPS)

3. APPLICATION OF BLOCKCHAIN TECHNOLOGY IN LAND REGISTRY MANAGEMEN

There are rapid interests to adopt ICT to make life easier and better in several aspects such as education, environment, business, and cyber security [18]–[21]. Within the field of digital humanities, a great deal of work has been made in the area of digital humanities to digitize papers and archives them in various formats, such as portable document format (PDF), extensible markup language (XML), plain text, and images [22].

Blockchain technology is emerging technology in the field of digitating significant documents such as land ownership documents. This technology is defined as a digital decentralized ledger distributed across a network of computers called 'nodes'. It keeps the history of transactions that have taken place between two nodes running the same protocol. Blockchain enables the participating nodes to encrypt their ledger and make it append-only, immutable, and updateable only via consensus or agreement among the peers [23]. This technology enables the peers to perform the transactions without any intervention from trusted third parties. This approach of managing data enables users to manage transactions, agreements, contracts, and anything that needs third-party verification [23].

Blockchain technology enables the transaction owners to track their transactions, obtain more information on where the transaction has taken place, and ensure that each transaction has only one owner. It keeps track of transactions, knows when a transaction takes place and ensures that there is always one single owner for each item in the ledger [24]–[26]. This technology protects block integrity by using strings of letters and numbers called "hash" which makes it extremely difficult to tamper with the data. In case someone wants to add a new block to the running ledger, all other participants in the network who have existing copies of the running blockchain need to verify the proposed change against the originating hash [12]. Only if the majority of nodes in the block approve the validity of the transaction, can it be accepted to be added into the running ledger [27]. This feature makes blockchain a trusted platform and allows users of the ledger to view the history of their transactions such as which transactions have been saved and by whom [23]. By using this technology, people can trade securely online without the need for a middleman or central authorities [28], [29].

The blockchain is classified based on public or private and peer authorization on the network. The tampering with the actual changes in the land registry record or the attempts to temper the old documents produces the audit direction on the ledger [30]. The transfer records are stored in a distributed ledger that prevents fault, isolation, and careful random modification of the record by the system. The entire blockchain record is secured by evidence of existence [31]. In which each phase of the land registry is published on the blockchain which, by stamping the entire record with notarization, provides protection and record stability [32].

There are some cases of implementing this technology, for example, the Republic of Georgia is the first government adopted blockchain technology in Land Registry Management. Citizens of Georgia can register and manage their land through blockchain. This technology has reduced conflicts in the land registration process and property exchange [33]. Another example of blockchain implementation in land registry management is by the Government of Andhra Pradesh in partnership with a Sweden-based company, Chromaway. Ethereum platform has been connected to the government's Land Registry to store property transactions [34].

For example, in India, blockchain implementation has been adopted by some of the state governments to track manufacturing and supply chain sectors. Some states, such as Haryana, Punjab, and Madhya Pradesh have started floating tenders to use blockchain in land records and registration processes [35]. A blockchain-based project has been introduced by the Japanese government to archive all land records on a single database instead of the existing system where many ministries and real estate firms have a different land record system. The new system has been introduced as a pilot test in a few cities and, once the findings are positive, it will be implemented in the next five years at the national level. In addition to the government initiative, a property company called Zweispace has already introduced a blockchain-based proprietary property appraisal and transaction framework that can dramatically reduce the cost of transfer time [5].

Russia's Ministry of Economic Development and Trade has initiated a project to document all land titles on a blockchain-based system and promote the protected transaction of land records online. In the first step, every record is transferred to a blockchain system, which allows you to verify all land records, past owners, and all property liabilities [5]. The British Columbia (BC) Land Titles and Survey Authority (LTSA) is currently working together with the Digital Identity and Authentication Council of Canada (DIACC) and Identity North North (DIACC) on a project to use blockchain technology in land transactions and record management in Canada (IDN). The project aims to explore social and legal complications, the utility of blockchain in the duties of BC Land Titles and the Survey Authority. In this respect, the University of British Columbia launched a challenge to examine the numerous issues and problems associated with the implementation of blockchain in the land registry [5].

In the United State of America (USA), a partnership agreement has been signed with the South Burlington Clerk Office by Paolo Alto based real estate company propy to provide blockchain-based real estate transactions and record-keeping to make it cost-effective, productive, and safer. It's a pilot project that will be repeated following successful implementation in other nations. Teton County, meanwhile, signed an memorandum of understanding (MoU) with Medici Land Governance in Wyoming in 2018 to transfer the current land records to a new blockchain-based network [5]. In the Netherlands, in May 2018, the Netherlands Land Registry Organization, commonly referred to as Kadaster, launched a land registry project using blockchain and AI. For proper identification, the land registry department registers the ownership details and geographical coordinates. Using blockchain and time stamping techniques, this knowledge can be precisely processed. The project is in the process of growth. This initiative is part of the blockchain pilots government programs to incorporate blockchain in all areas of e-governance [5].

3.1. Smart contract

The smart contract is a technique by which people can exchange money, property, shares, or anything valuable without human intervention. This technique can also advance a transparent and easy way of exchanging things without the need for a middleman [23]. It would contribute to facilitating asset ownership transfers between sellers and buyers with Land Department approval. It would facilitate potential integration with other government entities, such as State Municipal Department and Water Department [34]. A smart contract is an application of blockchain where its execution is enforced by the consensus protocol [13], [36]. It is an immutable digital notary that proves ownership transmission among different owners that complies with the pre-agreed property deal. Distributing the trust among a variety of nodes involved in the transaction becomes possible through the use of decentralized distributed structures. This can be executed by having a copy of every single transaction in all nodes in the network [23].

The ‘proof of work’ technique is a method that makes the transaction processes more secure and makes it more difficult to hack or tamper with nodes’ contents. Ethereum is preferred to code the contracts on blockchain [23]. In Ethereum platform, it becomes possible to store the transactions along with the smart contract (code snippets) in the blocks [37]. The hyperledger is another blockchain open development toolset that eases blockchain application development and supports the existing Hyperledger Fabric where transactions are done according to the policy cited by the business network partners. Hyperledger Fabric offers two software development kit (SDK) programming platforms to support several programming languages such as Node.js and Java [38].

4. METHOD

This study has followed the qualitative based research method. Starring with investigating the current statute of land registry systems in Malaysia by reviewing the available documentation which is available in Malaysian government websites. Then determining the main issues that are existed in the current system. Afterword study and analysis of some of the examples of implementation blockchain in land registry systems in some countries such as the USA, Netherlands, and Georgia. Next, the prototyping method [39]–[41] has been followed to design and implements a prototype for land registry systems in Malaysia. Which include determine objectives, develop, refine, demonstrate, test and implement the prototype.

5. PROPOSED FRAMEWORK FOR BLOCKCHAIN-BASED LAND REGISTRY SYSTEM

This paper has proposed, designed, and implemented a prototype for a land registry system using smart contracts called ChainMYLand. It is a web-based system using blockchain technology, developed on an architecture that focuses on the separation of functionalities between modules. In generating functions within ChainMYLand systems, end-users are required to have MetaMask online wallet to handle the transactions within Ethereum environment. For each transaction, Ethereum will record its success or failure in a block. Every user that uses the platform will be able to view the block’s information publicly.

This project will be using a web-based system interface where users interact with the system through their web browser. The web-based system also provides advantages to users in terms of user-friendliness and ease of use. Modules of this project include the functions to register lands, search for lands, request to buy land, and make payment transactions. Figure 2 shows the land ownership system architecture using blockchain.

Figure 3 describes the behavior of ChainMYLand through a use case diagram. It shows that the owner can view reports of the land sold, request to register land, sign the document of title agreement, update their land status, complete sales, and accept the request to sell their land. The buyer can pay the deposit, make a request to buy land, search for land, and view reports of the land bought. Banks can fund loans into smart contracts. Land office can can view transfer and register, reports and register land into the system.

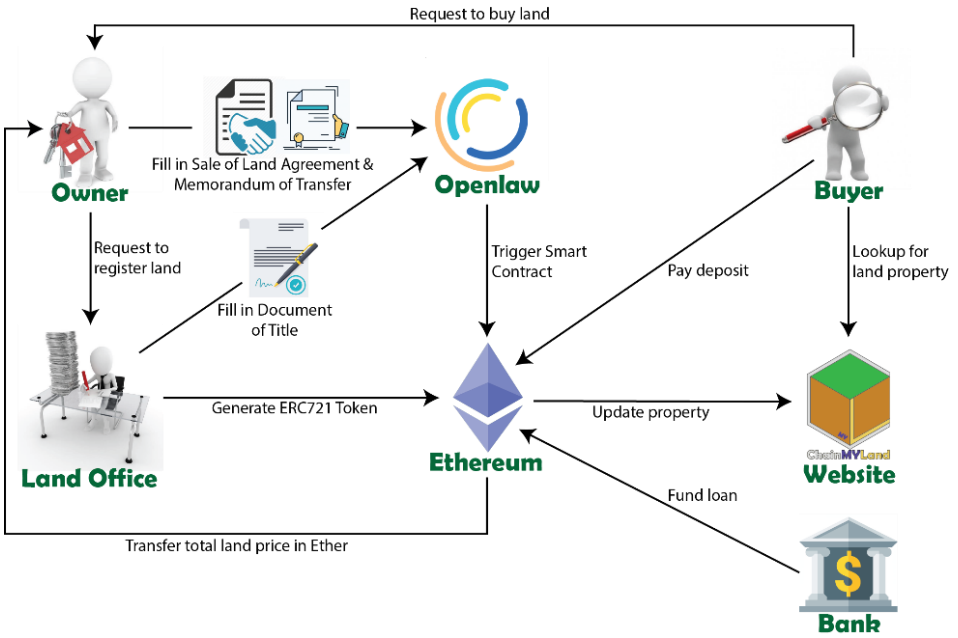

Figure 2. Land ownership's system architecture using blockchain

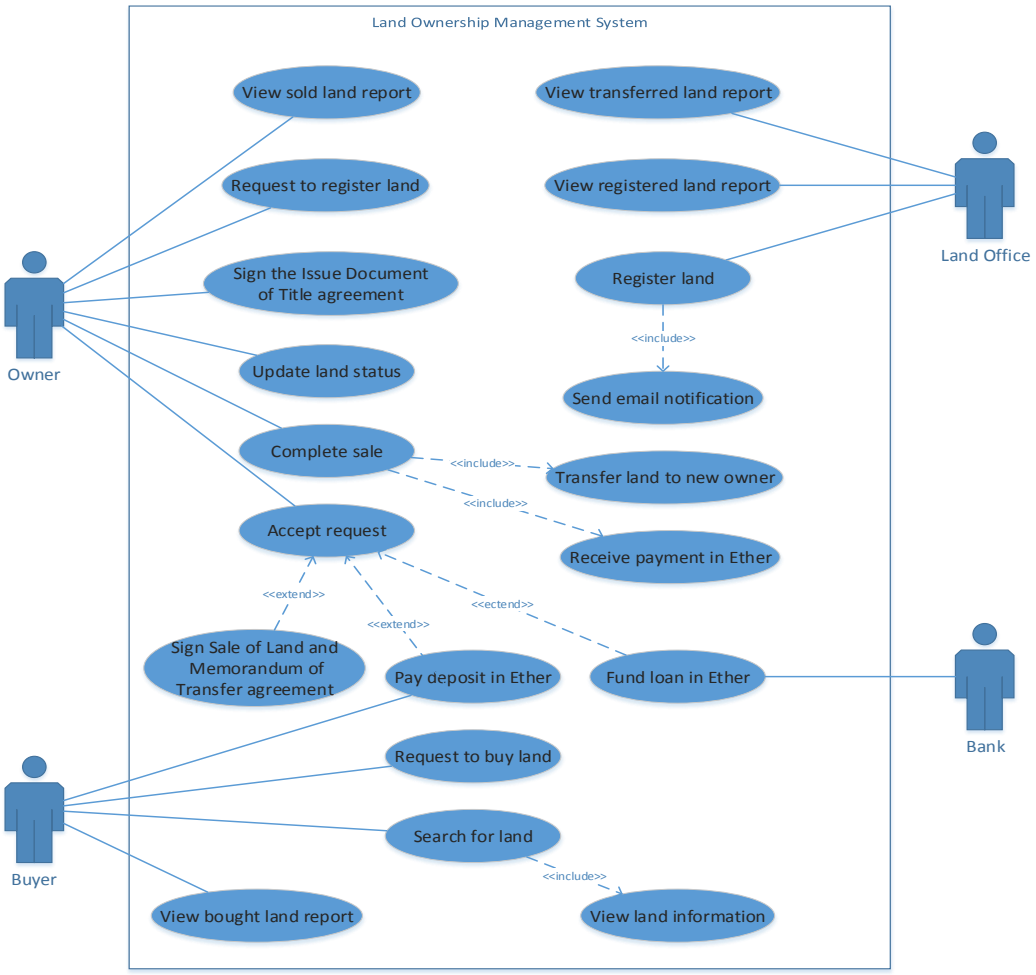

Figure 3. Use case diagram of the land records management system

6. CHALLENGES OF BLOCKCHAIN IMPLEMENTATION IN LAND REGISTRY SYSTEM

Blockchain offers an efficient and hassle-free way to handle property registration and keep the data tamper-proof. However, this technology has some shortcomings [42]–[45] For example, there is a limited number of experts and programmers/developers familiar with developing smart contracts and cryptocurrency applications by using various blockchain platforms (public, private, hybrid). Moreover, there is a shortage of organizations (private/government) with the necessary qualifications to organize training programs on blockchain technology.

In addition, due to the immutable nature of blockchain that makes it hard to modify anything at a later stage, employees often resist using it and stick with the existing systems due to the advantages they will lose. Key management especially in private blockchain also represents an issue. For example, the Indian Public Key Infrastructure (KPI) and eSign mechanism (http://cca.gov.in) is not linked with public blockchain yet, which poses a risk in key management processes. No regulations are imposed on how the transactions should be carried out in the blockchain platform. There is a necessity to have a regulatory body in India that governs the applications of blockchain and defines the rules and regulations that need to be adhered to by the blockchain technology producers. The diversity of blockchain technology codes is also vulnerable to security violations. Setting up a massive blockchain network requires high initial costs and wide bandwidth. India's network availability is still very low. Updating land records databases is still carried out under Taluka level offices which makes blockchain implementation in the land registry a challenging task. Based Malaysian industry-government group for high technology (MIGHT), report, 2019, some challenges need to be considered in implementing blockchain in Malaysia. For example, there is a necessity to solve the business and social challenges involving trust due to the blockchain technology ecosystem.

According to Malaysia's Personal Data Protection Act, blockchain technology might threaten people's privacy intentionally or unintentionally especially when involving cross-border transactions [46]. Malaysia's trading companies may face serious challenges on how to handle trade data ownership especially trade finance data that might affect their competitive advantage. Meanwhile, the Malaysian government will be greatly impacted through decentralized digital asset transactions. It will be able to track such transactions and thus, tax collection will be affected. Continuous security monitoring is a prerequisite in this sphere, both for commercial and government deployment [46].

7. RESULTS AND DISCUSSION

There are several advantages to adopt blockchain in land records management. For example, ownership can be determined easily by using blockchain. Land records department, registration department, and bank entities can be connected through the same truncation blockchain. Transfer of ownership takes lesser time and land records can be managed in a trustworthy manner with less maintenance effort. Furthermore, blockchain technology offers applicable solutions to migrate information systems transactions to blockchain nodes.

Blockchain can also play a crucial role in making land registration more transparent and integrated through the following functionalities: the participating parties can have on-demand access to records; transactions are grouped in blocks; each record in land registration system is connected with its predecessor that forms a chain of blocks; notary services do not have to verify the transactions and documents; each block has an irrefutably unique digital signature; records are incorruptible, unchallengeable, and cannot be reproduced; no human interventions required [23]; and they are held in a secure cloud [37], [47]. As stated in Malaysia's blockchain and distributed ledger technology (DLT) report in 2019 [48], the Malaysian government needs to establish strategies to manage blockchain involvement in business and society with the understanding that there s no 'one size fits all strategy. As the change within blockchain applications moves rapidly, Malaysia is demanded to initiate more agile and flexible guidelines of proper planning to adopt this technology. The Malaysian government needs to be more open by defining regulations and policies in order for industry players to access this new market. Apart from that, it needs to facilitate the association between blockchain applications' supply and demand that include infrastructure providers such as Futurise, I2M Medini in Johor Bahru, and Malaysia Digital Economy Corporation (MDEC).

There is a necessity to provide affordable access to technology such as open-source digital technologies, blockchain, and DLT for Malaysian small and medium-sized enterprises (SMEs) that form 98.5% of Malaysian business. The Malaysian regulatory framework needs to consider the preferences of open-source applications over proprietary networks. There is growing interactivity between blockchain and DLT industry community in Malaysia and ASEAN countries which requires the Malaysian government to facilitate market access for the business. The Malaysian government is encouraged to include blockchain and DLT development policy in its policy planning documents which encompass the 11th Malaysia Plan Review, Annual Budget (2019/2020), 12th Malaysia Plan 2021–2025, and the new Industrial Malaysia Plan. In

addition, Malaysia can be the main enabler for blockchain usage in key areas of strength such as shariah-compliance finance, Halal supply chain, and technology embedment. Such a movement will make Malaysia a leader of this new industry in the Muslim nation.

Open-source blockchain with its applications offers an excellent avenue for Malaysia's talents to develop more beneficial applications that ensure cost reduction in adopting this technology in the SME sector. There is a need for close collaboration between financial institutions (banks) and the industry to facilitate the adoption of this technology in local companies to enhance work efficiency and effectiveness. New investments and knowledge can be brought in Malaysia due to its great location and smart infrastructures in Cyberjaya and Labuan. Demand for talents, hackathons, talent development groups, and special programs is growing to initiate research and development (R&D) and reports, interfaces, conversions, extensions (RICE) in the blockchain research area. Local universities must strengthen students' hands-on experience in this technology. This can be achieved through the offering of new courses related to blockchain technology and collaborative programs that gather academia, industry, and government in Malaysia on the same platform.

The Malaysian government can play a main role in supporting the usage of this technology in Malaysia. This can be accomplished by providing testbeds for the industry with minimal risks. This will push the local blockchain ecosystem forward and make it ready for the next steps. Malaysia needs to encourage the scientist to produce more intellectual property (IP) that can service businesses, especially SMEs in terms of reducing the cost of accessing this technology and improving their competitiveness. Despite its powerful capability, blockchain needs to have a tamper-proof and authentic solution for storing and managing transactions. However, it is not clear yet which attributes should be taken up in transactions related to a plot, ownership, and geographic boundary coordinates of the plot [49]. Moreover, this study has successfully answered the stated questions which are as follows:

3.1. How to adopt blockchain and DLT in Malaysia?

To understand the state of readiness of the Malaysian blockchain ecosystem, MIGHT organized series of stakeholder engagements with experts from different sectors such as industry, government, academia, and the public. From these engagements, a roadmap had been suggested on how to adopt blockchain and DLT in Malaysia. It includes establishing professional training institutions that specialize in different areas of blockchain technology. There is also a need to establish academic-industry collaboration (AIC) with ASEAN countries. Furthermore, creating awareness about this technology and educating people on the impact of blockchain and DLT in real life is mandatory. The government should create a gender and family-friendly environment by offering sufficient infrastructure and housing to encourage more talents to work in this new technology. Finally, training and research centers are needed to develop common standards of learning curriculum and blockchain-based certificates [48].

3.2. What are the challenges and defects in the land registry system in Malaysia?

Land registration management in Malaysia has been experiencing weaknesses such as increasing fraudulent cases. For example, 435 cases of title fraud and forgery were reported from 2005 to April 2010, with Sabah recording the highest number of cases (86), followed by Selangor (56), Penang (47), and Kuala Lumpur (35). In 2015, the cases reached 90 with losses amounting to RM20 million. The main cause of increasing fraud cases is vulnerabilities in the current registration system at the Land Office, which can be exploited by attackers. Therefore, there is a need to ensure that the registration system is secure, safe, reliable, and fraud-proof [15].

3.3. How to utilize the open-source tools of blockchain technology to run land ownership in Malaysia?

Some open-source tools can be used to develop blockchain-based land registry systems. For example, Ethereum software platform which is an open-source blockchain-based distributed computing platform and operating system can be used to convert land registry rules and regulations of smart contract functions. In addition, open law software can be used to manage legal agreements and trigger smart contracts. Metamask, which is a browser extension allows users to interact and transact within Ethereum environment.

3.4. How to map the land registry system in Malaysia with smart contract technology?

This paper focuses on managing ownership of land in Malaysia by using blockchain technology. All of the transactions, contract signing, and ownership registration will be enhanced in the context of security, transparency, and time by applying this technology. First, the user as the buyer will be able to select and view their desired land. They may request to buy land. The requested data represented by a block is sent to every node in the blockchain network. By approving some agreement in the smart contract with the seller, the buyer can transfer money digitally to the seller. After the money has been transacted, the land ownership will

be transferred to the buyer using the smart contract. Once the transaction is verified, a new block will be added to the chain, providing a record of the transaction on the network. Table 1 shows how to map the land registry system in Malaysia with smart contract technology functions. The column at the left side of Table 1 shows the conventional land registry functions in Malaysia, which compose the following functions: register land, search for land for sale, request to buy land, payment transaction, and finalize the transfer functions. At the right column of Table 1 is the functions of the smart contract that match the conventional land registry functions.

Table 1. The mapping between the legacy land registry system process and smart contract

Conventional Land Registry Functions	Smart Contract Functions
Register land	Step 1: Seller registers their property into the blockchain network by completing all the contracts and agreements. Step 2: The information of the property is recorded, and everyone can view its basic information.
Search for land for sale	Step 1: Buyer can search for desired land by entering the land's unique string ID. Step 2: System will list down the land's physical address and its owner's Ethereum address.
Request to buy land	Step 1: Seller and buyer agree to terms of sale in the agreement of smart contracts. Step 2: Buyer fills the required data for the agreement such as their basic information, property information, and payment information. Step 3: The contract will be sent to the seller's email and both parties will be required to sign the agreement using digital signatures. Step 4: Once both parties have signed the agreement, smart contract will be triggered to initiate the land property transfer. New record will be added in the Ethereum blockchain.
Payment transaction	Step 1: Buyer transfers deposit amount to smart contract. Step 2: System will update the balance in the property details. Step 3: Buyer transfers the rest of the purchase price to smart contract.
Finalize the transfer	Step 1: Seller completes the sale using their account by confirming the transaction. Step 2: Seller receives full payment for their sold property. Step 3: Property ownership is transferred to buyer and recorded in the blockchain network.

3.5. How to develop a proof-of-concept prototype for land ownership in malaysia using blockchain?

This study provides a thorough overview of using blockchain technology in managing land ownership in Malaysia. The current system used in Malaysia for managing land ownership was also explained in this paper. Land ownership management system using blockchain technology called ChainMYLand is a system developed for websites. This system is implemented for three different types of users: land office, landowner, and buyer. All the data such as land property details, owner details, and payment details will be stored inside the blockchain with ERC721 token. This system will interact with a smart contract using .json file in Web3js. The payment transaction for this system uses Metamask wallet browser extension.

8. IMPLICATION

This paper has given clear answers on how to empower the current practices of blockchain in land registry systems in Malaysia. From the theoretical view, it has answered on main questions which are: How does the land registry system operate in Malaysia?, What are the challenges and defects that exist in Malaysia's current land registry system?, How to utilize the open-source tools of blockchain technology to run land registry system in Malaysia?, How to map the land registry system in Malaysia with smart contract technology? and How to develop a proof of concept prototype for the land registry system in Malaysia using blockchain?. Practically, this paper has described in detail how to implement blockchain in land registry systems by using open-source software. Also, it has formed a clear road map on how to match land registry systems with smart contact functions.

9. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

There is a lack of understanding of how this technology will impact the industry in Malaysia and the new opportunities that may exist from this technology. There is also insufficient information on the potential risks associated with the technology which makes its implementation more challenging. It is not clear how this technology could be associated with other technologies. This association can bring verifiability and transparency features to blockchain technology. Apart from that, the lack of collaboration between public and private entities in Malaysia makes the technology adoption in their ecosystem more challenging [48]. So, there is a need to establish centers of excellence for blockchain in Malaysia and create initiatives to enhance

hands-on blockchain experience among the Malaysian talent society. The levels of knowledge and hands-on skills in educational institutes in Malaysia are still not sufficient [48].

It would be the greatest goal if blockchain startups are supported by gathering earlier efforts in developing open-source together. This can enhance social capital and enable society to function effectively. Shariah-compliant finance, resource management, and supply chain management aspects need to be considered once this technology is adopted. The current business model is still not stable worldwide, so Malaysia needs to take the next steps in exploring ways to overcome global turbulence. The government may adopt blockchain principles to gain more governance and accountability capabilities and acquire new ways of dealing with intermediaries and trust entities. There is a need for an adaptable policy document that supports industry development and can be implemented in public and private sectors, taking into consideration the associated risks. Furthermore, having a comprehensive framework that aggregates industrial, competitive, administrative, and regulatory perspectives can transform Malaysia to become a leading country in the blockchain industry [48].

10. CONCLUSION

There is a lack of knowledge about how blockchain technology can enhance the Malaysian land registry system. Also, there is also a lack of awareness about the practical aspects of implementing this technology in the land registry. So, this study aimed to examine the existed issues of the land registration system in Malaysia. And propose a blockchain-based formwork to overcome such issues. This study has answered the presented questions which are: How does the land registry system operate in Malaysia?, What are the challenges and defects that exist in Malaysia's current land registry system?, How to utilize the open-source tools of blockchain technology to run a land registry system in Malaysia?, How to match the land registry system regulations in Malaysia with smart contract technology?, and How to develop a proof of concept prototype for a land registry system in Malaysia using blockchain?.

This paper has proposed, developed, and introduced a framework for the land registry system using smart contracts called ChainMYLand. It is a web-based framework that uses blockchain technologies, built on an architecture that focuses on the separation of functionalities between modules. When creating functions within ChainMYLand system, end-users must provide a MetaMask online wallet to manage transactions within the Ethereum setting. Ethereum will report its success or loss in a block for each transaction. Any person accessing the network would be able to access the details on the block publicly. In addition, this study explained how to use a web-based device interface where users can communicate with the system using their web browser. The web-based interface also provides users with benefits in terms of user-friendliness and ease of access. It is recommended to do more research on enhancing the implementation of blockchain in the land registry sector through initiatives that enhance hands-on blockchain experience among the Malaysian talent society. Also, there is a necessity to find a common framework that fulfills the interests of individual countries, trading blocks, and trade tariffs. Future work needs to be conducted on auditing to detect abnormalities in the current systems, to regulate access control techniques used in land administration systems.

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REFERENCES

[1] S. T. Siddiqui, R. Ahmad, M. Shuaib, and S. Alam, "Blockchain Security Threats, Attacks and Countermeasures," in *Ambient Communications and Computer Systems*, Springer, 2020, pp. 51–62, doi: 10.1007/978-981-15-1518-7_5.

[2] A. Dobhal and M. Regan, "Immutability & Auditability: The Critical Elements in Property Rights Registries," in *Annual World Bank conference on land and property.: Annual World Bank conference on land and property*, 2016, pp. 1–20.

[3] R. B.-Fich and A. Castellanos, "Digitization of land records: From paper to blockchain," *Conference: Thirty Ninth International Conference on Information SystemsAt: San Francisco 2018*, 2018.

[4] D. Domeher and R. Abdulai, "Access to Credit in the Developing World: does land registration matter?," *Third World Quarterly*, vol. 33, no. 1, pp. 161-175, 2012, doi: 10.1080/01436597.2012.627254.

[5] M. Shuaib, S. M. Daud, S. Alam, and W. Z. Khan, "Blockchain-based framework for secure and reliable land registry system," *TELKOMNIKA Telecommunication, Computing, Electronics and Control*, vol. 18, no. 5, pp. 2560–2571, 2020, doi: 10.12928/TELKOMNIKA.v18i5.15787.

[6] W. Z. Khan, M. H. Rehman, H. M. Zangoti, M. K. Afzal, N. Armi, and K. Salah, "Industrial internet of things: Recent advances, enabling technologies and open challenges," *Comput. Electr. Eng.*, vol. 81, 2020, doi: 10.1016/j.compeleceng.2019.106522.
[7] L. J. Arrieta-Sevilla, "A comparative approach to the Torrens Title system," *Australian Property Law Journal*, vol. 20, no. 3, pp. 203-223, 2012. [Online]. Available: https://www.researchgate.net/publication/277571934_A_comparative_approach_to_the_Torrens_Title_System
[8] T. M. Fernández-Caramés and P. F.-Lamas, "A review on the application of blockchain to the next generation of cybersecure industry 4.0 smart factories," *IEEE Access*, vol. 7, pp. 45201–45218, 2019, doi: 10.1109/ACCESS.2019.2908780.
[9] M. T. Çaldağ and E. Gökalp, "Exploring Critical Success Factors for Blockchain-based Intelligent Transportation Systems," *Emerg. Sci. J.*, vol. 4, pp. 27–44, 2020, doi: 10.28991/esj-2020-SP1-03.
[10] A. Iqbal, M. Amir, V. Kumar, A. Alam, and M. Umair, "Integration of Next Generation IIoT with Blockchain for the Development of Smart Industries," *Emerg. Sci. J.*, vol. 4, pp. 1–17, 2020, doi: 10.28991/ESJ-2020-SP1-01.
[11] J. He, G. Zhang, J. Zhang, and R. Zhang, "An Economic Model of Blockchain: The Interplay Between Transaction Fees and Security," *Available SSRN 3616869*, 2020, doi: 10.2139/ssrn.3616869.
[12] I. Lee, "Encyclopedia of e-commerce development, implementation, and management," *IGI Global*, 2016, doi: 10.4018/978-1-4666-9787-4.
[13] J. Vos, "Blockchain-based land registry: panacea illusion or something in between?," 2016.
[14] R. Wu and M. Y. B. Z. Kepli, "Implementation of land title registration system in Malaysia: Lessons for Hong Kong," *Malayan Law Journal Articles*, vol. 1, pp. 1-8, 2010, [Online]. Available: http://irep.iium.edu.my/29661/1/29661.pdf
[15] N. C. Abdullah, R. Ramly, and M. I. Ikhsan, "Land Registration of Titles at Stake: West and East Malaysia Compared," *Environ. Proc. J.*, vol. 2, no. 6, pp. 197–203, 2017, doi: 10.21834/e-bpj.v2i6.988
[16] World Bank Group, "Enhancing public sector performance: Malaysia's experience with transforming land administration," *The World Bank*, 2017.
[17] T. S. T. to F. B. PEMUDAH, P. P. K. P. Perniagaan, "Guidebook on Registering Property in Malaysia," 2010, [Onlone]. Available: https://www.mpc.gov.my/pemudah/wp-content/uploads/sites/21/2017/01/13-Guidebook-on-Registering-Property-in-Malaysia.pdf
[18] S. K. Kibaara, D. K. Murage, P. Musau, and M. J. Saulo, "Comparative Analysis of Implementation of Solar PV Systems Using the Advanced SPECA Modelling Tool and HOMER Software: Kenyan Scenario," *HighTech Innov. J.*, vol. 1, no. 1, pp. 8-20, 2020, doi: 10.28991/HIJ-2020-01-01-02
[19] S. Musa, A. Shahzad, and A. Aborujilah, "Simulation base implementation for placement of security services in real time environment," *ICUIMC '13: Proceedings of the 7th International Conference on Ubiquitous Information Management and Communication*, 2013, doi: 10.1145/2448556.2448587.
[20] A. Aborujilah, M. N. Ismail, and S. Musa, "Detecting TCP SYN based flooding attacks by analyzing CPU and network resources performance," *2014 3rd International Conference on Advanced Computer Science Applications and Technologies*, 2014, doi: 10.1109/ACSAT.2014.34.
[21] A. Shahzad, S. Musa, A. Aborujilah, and M. Irfan, "Secure cryptography testbed implementation for scada protocols security," in *2013 International Conference on Advanced Computer Science Applications and Technologies*, 2013, pp. 315–320, doi: 10.1109/ACSAT.2013.69.
[22] A. L. Duca and A. Marchetti, "Design and Implementation of a Web Application for Cultural Heritage," *HighTech Innov. J.*, vol. 1, no. 2, pp. 72–85, 2020, doi: 10.28991/HIJ-2020-01-02-04.
[23] V. Thakur, M. N. Doja, Y. K. Dwivedi, T. Ahmad, and G. Khadanga, "Land records on Blockchain for implementation of Land Titling in India," *International Journal of Information Management: The Journal for Information Professionals*, vol. 52, no. C, 2020, doi: 10.1016/j.ijinfomgt.2019.04.013.
[24] J. M. Graglia and C. Mellon, "Blockchain and Property in 2018: At the End of the Beginning," *Innov. Technol. Governance, Glob.*, vol. 12, no. 1–2, pp. 90–116, 2018, doi: 10.1162/inov_a_00270.
[25] A. Oprunenco and C. Akmeemana, "Using blockchain to make land registry more reliable in India," *LSE Bus. Rev.*, 2018.
[26] M. Stefanović, D. Pržulj, S. Ristic, and D. Stefanović, "Blockchain and land administration: Possible applications and limitations," In *Proceedings of the 5th International Scientific Conference on Contemporary Issues in Economics, Business and Management (EBM 2018)*, 2018.
[27] A. Baliga, "Understanding blockchain consensus models," *Persistent*, vol. 4, pp. 1–14, 2017.
[28] D. Mohanty, "Ethereum for Architects and Developers," *Apress Media LLC, Calif.*, pp. 14–15, 2018.
[29] A. Spielman, "Blockchain: digitally rebuilding the real estate industry," *Thesis: S.M. in Real Estate Development, Massachusetts Institute of Technology*, 2016.
[30] A. A. Mazlan, S. M. Daud, S. M. Sam, H. Abas, S. Z. A. Rasid, and M. F. Yusof, "Scalability Challenges in Healthcare Blockchain System—A Systematic Review," *IEEE Access*, vol. 8, pp. 23663–23673, 2020, doi: 10.1109/ACCESS.2020.2969230.
[31] V. L. Lemieux, "Trusting records: is Blockchain technology the answer?," *Rec. Manag. J.*, vol. 26, no. 2, pp. 110–139, 2016, doi: 10.1108/RMJ-12-2015-0042.
[32] S. Alam, S. T. Siddiqui, A. Ahmad, R. Ahmad, and M. Shuaib, "Internet of Things (IoT) Enabling Technologies, Requirements, and Security Challenges," in *Advances in Data and Information Sciences*, pp. 119–126, 2020, doi: 10.1007/978-981-15-0694-9_12.
[33] A. Dasgupta, "The Game Changer of Geospatial Systems—Blockchain," *Geospatial World (online)*, 2017.

[34] R. Bowden, H. P. Keeler, A. E. Krzesinski, and P. G. Taylor, "Block arrivals in the Bitcoin blockchain," *arXiv Prepr. arXiv1801.07447*, 2018.
[35] M. Swan, "Anticipating the Economic Benefits of Blockchain," *Technol. Innov. Manag. Rev.*, vol. 7, no. 10, pp. 6–13, 2017, doi: 10.22215/timreview/1109.
[36] L. Luu, D.-H. Chu, H. Olickel, P. Saxena, and A. Hobor, "Making smart contracts smarter," in *Proceedings of the 2016 ACM SIGSAC conference on computer and communications security*, 2016, pp. 254–269, doi: 10.1145/2976749.2978309.
[37] M. Mukhopadhyay, "Ethereum Smart Contract Development: Build blockchain-based decentralized applications using solidity," *Packt Publishing Ltd*., 2018.
[38] M. Valenta and P. Sandner, "Comparison of ethereum, hyperledger fabric and corda," *Frankfurt School Blockchain Center*, pp. 1–8, 2017.
[39] S. Leonov, H. Yarovenko, A. Boiko, and T. Dotsenko, "Prototyping of information system for monitoring banking transactions related to money laundering," in *SHS Web of Conferences*, 2019, vol. 65, doi: 10.1051/shsconf/20196504013.
[40] S. Saeed, N. Z. Jhanjhi, M. Naqvi, and M. Humayun, "Analysis of Software Development Methodologies," *Int. J. Comput. Digit. Syst.*, vol. 8, no. 5, pp. 446–460, 2019, doi: 10.12785/IJCDS/080502.
[41] S. Shylesh, "A study of software development life cycle process models.," In *National Conference on Reinventing Opportunities in Management, IT, and Social Sciences*, 2017, pp. 534-541.
[42] V. Chandra and B. Rangaraju, "Blockchain for Property A Roll Out Road Map for India," *India Institute*, 2017.
[43] M. Bal, "Securing property rights in India through distributed ledger technology," *Obs. Res. Found. Occas. Pap.*, no. January, pp. 1-18, 2017. [Online]. Available: http://www.orfonline.org/research/securing-property-rights-india-through-distributed-ledger-technology/
[44] E. Hughes, "Unlocking Blockchain: Embracing New Technologies to Drive Efficiency and Empower the Citizen," *The Journal of British Blockchain Association*, vol. 1, no. 2, pp. 1-15, 2018, doi: 10.31585/jbba-1-2-(1)2018.
[45] N. Kshetri, "Will blockchain emerge as a tool to break the poverty chain in the Global South?," *Third World Q.*, vol. 38, no. 8, pp. 1710–1732, 2017, doi: 10.1080/01436597.2017.1298438.
[46] T. M. F*ang, L. H. Wei, and R. Muthuveloo,* "Innovation Capability for SME Biomass Industry Performance: Perspectives of HRM, OC, KMC in Industry 4.0," In *Challenges and Opportunities for SMEs in Industry 4.0*, 2020, pp. 79-103, doi: 10.4018/978-1-7998-2577-7.ch006.
[47] W. Ying, S. Jia, and W. Du, "Digital enablement of blockchain: Evidence from HNA group," *Int. J. Inf. Manage.*, vol. 39, pp. 1–4, 2018, doi: 10.1016/j.ijinfomgt.2017.10.004.
[48] K. R. K. Mahamud, M. Omar, N. A. A. Bakar and I. D. Muraina, "Awareness, trust, and adoption of blockchain technology and cryptocurrency among blockchain communities in Malaysia," *International Journal on Advanced Science, Engineering and Information Technology*, vol. 9, no. 4, pp. 1217-1222, 2019, doi: 10.18517/ijaseit.9.4.6280.
[49] B. Adams and M. Tomko, "A Critical Look at Cryptogovernance of the Real World: Challenges for Spatial Representation and Uncertainty on the Blockchain (Short Paper)," *Conference: 10th International Conference on Geographic Information Science (GIScience 2018)*, 2018, doi: 10.4230/LIPIcs.GIScience.2018.19.