IMPACTS OF BLOCKCHAIN IN THE MEDICAL INDUSTRY FROM THE MALAYSIAN PERSPRECTIVE

BY

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DECLARATION

We hereby declare that:

(1) This undergraduate FYP is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this FYP has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the FYP.

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LIST OF ABBREVATIONS

BNM	Bank Negara Malaysia
ESMA	European Securities and Markets Authority
UTAR	Universiti Tunku Abdul Rahman
UM	Universiti Malaya
UKM	Universiti Kebangsaan Malaysia
TARUC	Universiti Tunku Abdul Rahman College
PDPA 2010	Personal Data Protection Act 2010
CCA 1997	Computer Crime Act 1997

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PREFACE

We are from University Tunku Abdul Rahman. As it is our last year pursuing our studies, we are required to conduct a research entitled “The Impact of Blockchain Technology in the Medical Industry from the Malaysian Perspective”. The reason for conducting this case study research was because of the scarce of similar research that could provide further understanding about the impacts of Blockchain Technology to the society. Due to time and resources constraint for the research, we only manage to collect limited data that could contribute to our research.

Our research writes out includes the following components:

- Chapter 1: Introduction
- Chapter 2: Literature Review
- Chapter 3: Research Methodology
- Chapter 4: Qualitative Data Analysis
- Chapter 5: Recommendation and Conclusion

ABSTRACT

The objective of this paper is to study the impacts of blockchain technology in the medical industry from the Malaysian Perspective. Blockchain is considered as something new in Malaysia and some developed countries. Thus, people often have the wrong perception and misrepresentation. They focus on the negative impacts of blockchain technology and overlook the advantages that blockchain technology might bring to mankind. Hence, this paper will be including the contributions of blockchain technology to our society, the limitations and application of blockchain technology.

In order to comprehend the current awareness level of Malaysians towards blockchain technology, four respondents were interviewed. They had pinpointed several issues of the implementation of blokchain in the Malaysian medical industry. This includes the challenges faced by Malaysia, the insufficient of knowledge on blockchain technology and the need of support from top level management. The results obtained from the respondents will be a reference to the future researchers in providing deeper understanding about blockchain technology and enhance the findings in the future.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

This chapter contains a proposal on blockchain technology in the medical field from the Malaysian perspective. The background of the research will be briefly explained. In addition, the problem in regards to the blockchain technology will also be included in the discussion. The problems mentioned will then be explained further in the next chapter. Not only that, the objectives of carrying out this research will also be included in the proposal. Furthermore, research questions, significance of study, chapter layout will also be written in this topic.

1.1 Research Background

Acoording to Lin & Liao (September, 2017), bitcoin is the first application of blockchain. It is used as money in the trading of goods online like in the real world. After the success of bitcoin, people started to use blockchain technology in many sectors such as financial market, medical treatment, storage and supply chain.

In general, blockchain technology is a peer-to-peer transaction which is digitalised. The transactions may be made distributed privately or publicly to all users. It provides a transparency and eliminates the need of intermediaries and third party (Rennock, Cohn & Butcher, 2018).

Advait, Katherine, Louise and Salil (May, 2017) stated that blockchain is divided into a few categories. This mainly includes cryptocurrency, virtual currency and distributed ledger technology (DLT). Many countries have started to recognise blockchain technology as one of the ways to store users' information. This technology had been widely used in many industries such as finance, agriculture, and healthcare.

This technology is also slowly being applied in the medical field recently. Many countries such as Malaysia, Korea, United States and some other developing countries have come to realise the importance of blockchain in the medical industry. It is also used to store medical records of the patients. This technology is unlike the traditional way of storing information which requires hard copy of the medical records.

A party who uses blockchain technology in their operation must ensure their compliance with the domestic rules. Organisations must guarantee that their clients' personal information is well protected. Users' information may be important to certain people as they can steal the information in exchange for money. Companies like Maxis, Digi and other service provider companies had also seen in its proliferation of data and privacy leakage issue (Rozanna & Jeremy, Nov 1, 2017).

In order to overcome the concern of the users, a list of law sections have been used to protect them when such problem arises. This includes the Act on the Personal Data

Protection Act 2010 (PDPA 2010), Digital Signature Act 1997 and the Computer Crime Act 1997. The list of laws is disclosed in **Appendix 1.1**

Governmental organisation such as Information Security Certification Body (ISCB) is established to ensure that the organisations comply with the current rules. This body offers various services in protecting the information and privacy of the government and commercial activities ("CyberSecurity Malaysia", 2018).

Under the guideline in Malaysia known as the Good Medical Practice, the practitioners are obliged to protect the patients' data. They are not allowed to disclose the information unless with the consent of the patients. Under proviso 3 of Good Medical Practice,

When disclosing information about a patient, the practitioner shall:

(a) Use anonymised or coded information if practicable and if it will serve the purpose

(b) Be satisfied that the patient:

(i) Has ready access to information that explains that their personal information might be disclosed for the sake of their own care, or for clinical audit, and that they can object;

(ii) Has not objected

(c) Get the patient's expressed consent if identifiable information is to be disclosed for purposes other than their care or clinical audit, unless the disclosure is required by law or can be justified in the public interest

(d) Keep disclosures to the minimum necessary, and

(e) Keep up to date with, and observe, all relevant legal requirements, including the common law and data protection legislation.

2. A practitioner shall respect, and help patients to exercise, their rights to:

(a) Be informed about how their information will be used, and

(b) Have access to, or copies of, their health records.

3. When a practitioner is responsible for personal information about patients, the practitioner shall ensure that the information and any documentation about it are effectively protected against improper disclosure at all times. Professional expertise should be used when selecting and developing systems to record, access and send electronic data. The practitioner shall ensure that administrative information, such as names and addresses, can be accessed separately from clinical information so that sensitive information is not displayed automatically.

21. A practitioner may release confidential information in strict accordance with the patient's consent, or the consent of a person authorised to act on the patient's behalf. Seeking patient's consent to disclosure of information is part of good medical practice.

1.2 Problem Statement

There are many governmental and non-governmental institutions that have underlined their responsibilities to ensure that each organisation in the industry is complying with the regulations. Every organisation has the responsibility to ensure that the information of the users is not leaked to a third party. Even so, many cases regarding to privacy and information leakage can still be seen. It had become a common phenomenon in the technology industry nowadays.

Based on Tan & Nair (2017), there were 46.2 million mobile number subscribers in Malaysia had suffered from data breaches. Their personal information has fallen into the wrong hand. Besides, Malaysian Medical Council, Malaysian Medical Association (MMA) and Malaysian Dental Association had also come through the same leakage issue.

In addition, Qishin (2018) mentioned that the case that happened in the year 2018 had caught the attention of the public and has breached records in Asian. The statistics had proven that Asian had the lowest breach records as compared to India and Middle East. Asian had 21,045 incidents while in India and Middle East was 33,167 and 33,125 respectively. The seriousness of data breaching are supported by the statistics

Based on "Data security in the limelight" (2017), security issue is said to be the root of data leakage. Cyber attacks are becoming more critical to the extend whereby data leakage issue is also happening in the banking industry. A few cases occurred in the year 2017. These include the loss of magnetic tapes that consist of customers' personal information. The information is considered as the asset of an organisation. Customers provide their information to the organisation with the expectation of shielding their information well in return.

According to "Malaysia's data breaches stem from weak security, say experts" (2018), the experts in the cyber and technology industry had given feedback that the current tools used in guarding the data from being breached are insufficient. The current tools are only used to protect against the threats that happened in the past, not the recent

one. They also further explained that by relying only the PDPA 2010, it is not enough to solve the breach problem. Individuals cannot only depend on government to curb such problem. They must also take on their responsibility as a consumer to ensure their personal information is well protected.

Sanjay (2018), the Managing Director of BlackTrace, an Artificial Intelligence cyber security company mentioned that the data breach issue has become the main concern for organisations and individuals. The large service providers companies such as Yahoo, Google and Uber have been severely affected by the issue. The users of these companies had taken preventive steps to solve the issue. However, the outcome is not up to their expectation. The issue is still threatening these companies nowadays.

1.3 Research Objectives

Research Objectives are developed from the problem statement. It can be divided into two types, which are General Objectives and Specific Objectives respectively.

1.3.1 General Objectives

In doing this research, we will need to define the concept of Blockchain in the medical field. Throughout the research, we will also be able to determine the good impacts of blockchain in the medical field. In contrast, the bad impacts of Blockchain that occurs in the medical field that draws concern amongst the users. We will also provide suggestions on how to curb with issues surrounding blockchain technology in the medical industry.

1.3.2 Specific Objectives

We will carry out a research to have a deeper understanding on what blockchain is and the relevancy of it in the medical field. Next, the benefits and limitations of Blockchain technology will be defined in this research. A list of suggestions will be provided to the relevant institutions in order to improve on blockchain technology in the Malaysian medical field. This will be detailed out in Chapter 5.

1.4 Research Questions

(a) What is blockchain technology?

(b) How is blockchain technology relevant in the medical field?

(c) What are the benefits of blockchain to the medical field?

(d) What are the limitations of blockchain to the medical field?

(e) What are the suggestions to improve blockchain in the medical field?

1.5 Significance of Study

The recognition of blockchain technology is still weak amongst Malaysia's population. Therefore, by carrying out this research, it acts as a guide to the government and Ministry of Health on the relevance of blockchain technology in the medical field. This can help the government organisation to have a deeper understanding on the importance of blockchain that results in the ease of implementation of its application.

From the perspective of the society, it is significant to provide a better understanding and enhance the level of awareness among the society of what is blockchain technology. Level of awareness amongst the society determines the willingness to accept the implementation of blockchain in related field.

Other than that, it also acts as a guideline for the future researchers. The research done can be a reference to them so that blockchain can be better implemented and bring convenience for the future generation.

1.6 Chapter Layout

In this report, it is broken down into 5 chapters. Chapter 1 is the proposal on the blockchain technology while Chapter 2 mainly discusses about the literature review of the blockchain technology in the medical field. For Chapter 3, interviews will be conducted involving experts in the particular field to find out more information and have a better insight on blockchain technology. The results of interview will then be transcribed in Chapter 4. Meanwhile, Chapter 5 is in regards to providing suggestions to overcome the problems found in the blockchain technology. A conclusion will also be written up in this chapter.

1.7 Conclusion

In a nutshell, there are good impacts on the Blockchain technology in the medical field. The good impacts are the integration of database between medical centres and the maintenance of a good system. However, there are also some negative impacts of Blockchain technology. The main concerns on the Blockchain technology are the privacy and security issues. Both good and bad implications of Blockchain technology will be discussed in discussed in the upcoming chapters.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Literature review is the fundamental to a research study. In a research study, literature review is required to allow the readers to further understand the general idea of the research topic.

In this chapter, literature review is based on the past journals, articles and published reports done by the previous researchers. Partial of the content from the past journals will be extracted to be used as reference to provide evidences to the conducted research. Most of the data is obtained from the online database. A summary of Chapter 2 will be written up in the last part of this chapter.

2.2 Literature Review

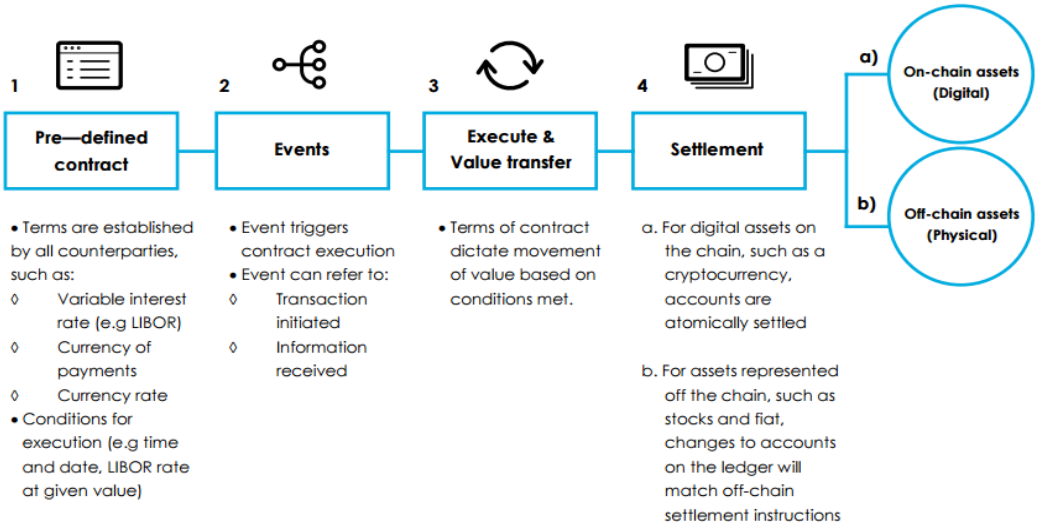
An overview of blockchain will be discussed in this chapter. It started off with emergence of Blockchain technology from one stage to another. Next, the categories and application of Blockchain in the medical field will also be detailed in this chapter.

2.2.1 Emergence of Blockchain

Blockchain started off with Bitcoin in the year 2008. Blockchain had been one of the leading digital technologies in the past decade apart from Artificial Intelligence and Big Data (Nakamoto, 2008). Husna, Sherin, Ershadu, Abu & Raphel (2018) stated that the application of Blockchain can be widely seen in the Fintech industry. Global banks such as Citibank, J.P. Morgan and Goldman Sachs have spent heavily on Blockchain technology. It is estimated that 10% of global GDP will be stored on Blockchains by 2027 ("10% of total GDP to be stored on Blockchain by 2027 WEF report", 2018)

Blockchain development is divided into five stages. They are named Blockchain 1.0, Blockchain 2.0, Blockchain 3.0, Blockchain 4.0 and Blockchain 5.0 respectively. Blockchain 1.0 emphasises on the payment method using the digital coin. Bitcoin is the first invention of Blockchain. It is defined as a peer-to-peer electronic cash system at that time. This invention initially was to solve the double spending problem (Nakamoto, 2008).

Figure 2.1: Blockchain 2.0



Source: What is Blockchain 2.0

According to Nakamoto (2008), he then discovered the technology behind Bitcoin could be separated from currency system. At this stage, it is known as Blockchain 2.0 namely the identification known as smart contract or Ethereum. Smart contract is the core of Blockchain. It helps to eliminate the need of trusted intermediaries. In addition, it helps to increase the level of security and at the same time reducing the transaction cost due to the decrease in the dependence on intermediaries ("Smart Contracts", n.d.). It also increases the protection against the data stored in the database. People are not worried that their data will be stolen by third party with wrongful intention.

According to Fitzjohn (2018), the third generation of Blockchain is known as Cardano. Cardano is an open source, decentralised public blockchain. It is fueled by its native cryptocurrency. It is used to solve the problems faced by the previous Blockchain which is scalability. Blockchain 1.0 to Blockchain 3.0 focuses on individual performance. Khatwani (2018) mentioned that the next evolution is known as Seele. Seele is used in sorting data in a large decentralized environment. It can tolerate higher mistakes that are done as compared to the previous invention. Platform that enables cross chain communication is provided to unite the different users from different Blockchain protocols (Miah, 2018). Based on Khan (2018), it had expanded its utilisation from Fintech to various industries such as tourism, real estate, Cross-Chain Function, and the digital economy ecosystem.

However for Blockchain 5.0, it is a unique Tech Blockchain. MNC such as Alibaba, Apple, Google, and Microsoft engaged actively in the Research and Development of this new technology ("The Emergence of Blockchain 5.0", 2018). From the previous Blockchain, this technology is actually improvised from various perspectives. The most obvious one is the speed itself. The speed for Blockchain 5.0 is unimaginable (Froystad, 2015).

2.2.2 Types of Blockchain

Lin & Liao (September, 2017) stated that everyone can have the access to the transactions that had being done for public Blockchain. Public Blockchain allows public access without any authorization needed. This kind of Blockchain does not have protection against hacking. This results in the high exposure of risk for the public Blockchain to be hacked. Bitcoin and Ethereum are some examples of public Blockchain.

Lin & Liao (September, 2017) stated that consortium blockchain is usually used in business-to-business (B2B). For this type of Blockchain, the data is partially decentralized. The data can be open or private in the Blockchain. The node had the authority to choose on which data to disclose. Example of consortium Blockchain is Hyperledger and R3CEV.

For private Blockchain, only certain nodes can be engaged to it. It has strict access to the data. Only certain people who are granted with permission are able to view and to gain access to the data. Bankchain is one of the examples for private Blockchain. Private Blockchain is also used in the medical and healthcare sector. A summary of the types of Blockchain is summarised in **Table 2.1**

Table 2.1: Types of Blockchain

Type	Public	Private	Consortium
Access	No permission required	Members only, who could be co-founders	Qualified users via online approvals
Innovation Target	New business model	Processes within existing relationship	Supporting existing models or launching new services
Blockchain Governance	Public consensus	Equal weight to all participants	Controlled by a single owner
Number of users	Millions	Dozens to few hundreds	Hundreds of thousands

2.2.3 Categories of Blockchain

Blockchain is divided into a few big categories. Cryptocurrency, virtual currency, DLT and hyperledger are some categories of blockchain. Each of these categories is then broken down into subcategories.

"What is Cryptocurrency. Guide for Beginners" (2017), stated that a virtual currency which is secured by cryptography. Example of cryptocurrency is Bitcoin, Ethereum, Ripple, and Litecoin. These units are usually used in a transaction of blockchain. It is equipped with limited access whereby it is accessible only with the fulfillment of specific condition.

Jake (2018) defined that virtual currency is a unit of account that is used in digital trading. It can come in the form of digital token or coin issued by virtual organisation. The currency is stored and transacted in a designed software, mobile and computer application. Physical commodities such as gold or silver do not back this type of currency. However, it is recognised by the government. Organisational or governmental administrators do not have control in the value of currency. It is the most successful digital currency among all types of blockchain.

The public often mistaken DLT as to being similar to blockchain. DLT is a decentralized, distributed ledger aspect of blockchain technology. DLT ensures a ledger is safer to be used when it is decentralized as compared to centralized authority. Individuals do not have to worry that copies of ledger are distributed elsewhere as there is no master copy (Rennock, Cohn & Butcher, 2018).

Rennock, Cohn & Butcher (2018) mentioned that an open source blockchain platform is known as hyperledger. It started its usage in the year 2015 by Linux Foundation. It provides support to blockchain-based distributed ledgers such as international business transaction that includes technology, financial and supply chain companies.

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provides support to blockchain-based distributed ledgers such as international business transaction that includes technology, financial and supply chain companies.

2.2.4 Concept of Blockchain

2.2.4.1 Characteristics of Blockchain

Blockchain consists of six key elements. These elements are described briefly in below:-

Table 2.2: Characteristics of Blockchain

Characteristics	Explanation
Decentralised	-Does not need to rely on any centralized distribution network. -Designed to issue and transfer money for Bitcoin currency user. -Support is provided to all Bitcoin transactions that have been done without any control from the third party organization. -The stored data can be updated or recorded anywhere
Transparent	-The recorded data is viewable in every node. -Enhances the trustworthiness of blockchain
Open source	-Everyone is able to view the data recorded -Able to utilize blockchain for their own application usage
Autonomy	- Record in the database cannot be freely transferred and updated in private blockchain unless with the consent of the user
Immutable	- Private ledger is unable to be modified or to be erased after gaining approval from all nodes. - Can only be changed with the condition of having more than 51% of node.
Anonymity	- Generated address is granted to the users so that they can interact with the blockchain technology. - Generate multiple addresses to prevent identity exposure -No longer kept by a central party

Source: Lin & Liao

Until now, there are still many people do not understand how does this technology works in the related field. Only about 15 % of people know what Blockchain is and how it works. (“Healthcare IT News”, 2019) Firstly, new record will be recorded in the node and broad casted to the network. Then, the message received will be checked whether it does contain the correct data by the receiving node. It will then be stored to a block.

Next, proof of work (PoW) or proof of stake (PoS) will be executed by all receiving nodes. After execution, the block will be stored into the chain. Every node will admit the block and extend the chain base continuously. Based on Lin & Liao (September, 2017), PoW is a piece of work that is easy to get verification and satisfy some conditions. However, it is costly and time-consuming to produce. It can be a random process with many trial and error methods before a valid PoW is developed. It consumes lots of electricity and computing power for this process to be done. On the other hand, PoS do not require expensive computing power like PoW. It is better shielded against malicious attack on the network. The protection comes from two sources which are the cost of executing an attack and the reduction of incentives for attack. Attacker will need to own about a majority of Bitcoin before launching an attack.

2.2.5 Structure of Blockchain

Main data, hash of previous block, hash of current block, timestamp and other information constitute a block in the blockchain (Lin & Liao, September 2017). Every component in the chain will be elaborated in detail.

Table 2.3 Structure of Blockchain

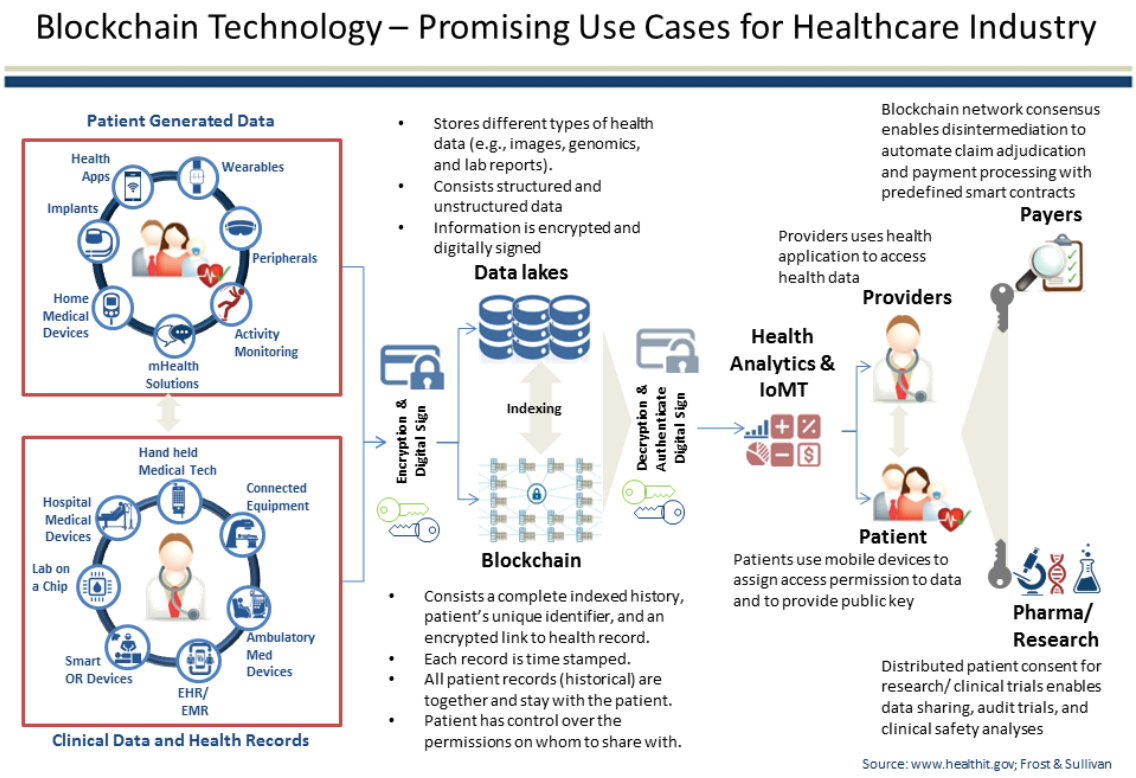
Structure of Blockchain	Explanation
Main Data	- Depends on the type of services that applies blockchain. For instance, contract records, medical records, and IoT records
Hash	- Hashed into a code and then be broadcasted to every node every time a transaction is done. -Contains thousands of transactions record in each node's block.
Timestamp	-Time of block generated
Other information	- Other information including signature of block, nonce value or other data that the user defines

Source: Lin & Liao

2.2.6 Blockchain System

2.2.6.1 System Setup

Figure 2.2: Blockchain System



Source: www.healthit.gov; Frost and Sullivan

According to Jimi (2018), the block content in the system indicates ownership of data. It can be shared by private members via peer-to-peer network. Blockchain is made up of smart contracts that are located on Ethereum that permits the tracing of changes done towards the blockchain such as the birth of a new record. Blockchain is equipped with cryptographic which can ensure the integrity of data. The nodes will encode logic to proof that the information provided is valid. Later on, it will be uploaded on blockchain.

2.2.6.2 Request File and Grant Permission

Jimi (2018) justified that when a patient's record is needed by the data user, a request is sent to the system. Only people with private key are able to create the request. It will later be sent to a pool of unprocessed request. Requests which are not processed by the consensus nodes constitute a block. The request from consensus node will then be transmitted for validation purpose.

When a request is created from an event span, the block will be broadcasted into blockchain. The authority will need to verify the blockchain in the system. Whenever irregularities are found within the system, consensus nodes that responsible of mining and monitoring the system will inform the user. The role of block header is to make sure the immutability of the data stored. An attacker who has the intention to crack into the system needs to manipulate all the block headers, starting from the genesis block. A slight mismatch of block in the system will immediately alert the data forensics about the suspicious event found (Jimi, 2018).

2.2.7 Application of Blockchain Technology

Blockchain can be seen in its usage in many fields. The implementation of blockchain in financial and agriculture had embraced the application of blockchain in other industries. For online transaction, bitcoin is one type of blockchain.

"5 Top Benefits & Challenges of Using Blockchain in Healthcare Industry" (April, 2018) iterates that blockchain provides security to the data storage. As compared to the traditional way of storing data, blockchain is a better choice for the medical field as permission is required to gain access into the database. This can prevent proliferation of data to happen. This technology provides resilience and security whereby the data cannot be simply destroyed (Mainelli & Gupta, 2016). For instance, the medical record of a patient is not allowed to be exposed to the third party or destroyed unless permission is gained from user.

Blockchain helps researchers to achieve high accuracy on the data that they gain for clinical trials. In a research, it is found that the percentage of getting accurate results is only approximately 13%. More than 700 outcomes were biased. 357 were entered without knowledge of authority while 354 were not recorded at all. This has proven that most data is inconsistent (Mainelli & Gupta, 2016). This has results in the data flaw and at the same time the quality care of data is to be doubted by the community. In order to overcome such limitation, Watsons IBM is invented to increase the accuracy of diagnosing and provide better prescription to the patients. Artificial Intelligence is used in Watsons IBM. Thus, integrity and legitimacy of data is guaranteed as it traces on every element. The manipulation of data can be prevented since it can be traced ("Cognitive Healthcare Solutions", n.d).

Moazzam (2018) mentioned that by storing sensitive data within private blockchain, it provides safety to the patients. They do not need to worry that their data will be stolen because the personal is only accessible with the consent and permission of the patients. Storing data in blockchain provides convenience to the doctors and the patients as well. The doctors do not have to spend time to search for the previous medical records of the patients even if the patients change from one hospital to another. Since private

blockchain is used in the medical field, the advantage of it is the management of medical data. The MedRec system assists the doctors by creating a central site for storing all the past medical records.

For claiming and billing management purpose is also one of the advantages of blockchain. By utilising blockchain, it reduces the administrative cost and the use of intermediaries throughout the channel. At the same time, it also minimise the number of fraud in the medical field whereby this can result in severe losses to the organisation. According to Medicare Fraud Strike Force (2017), there were merely 412 individuals responsible for the losses of USD1.3 billion suffered by the government in the year 2017.

2.2.8 Limitations and Challenges of Blockchain

The pace of technology advancement and development had made the world boardeless. At the same time, this had created opportunities for the wrongful parties to act beyond our control. These parties tend to carry out malicious actions that caused the users to be worried. Cracking and hacking issues are commonly seen in the technological world.

The Security Intelligence Report (SIR), Volume 21**,** had stated that Malaysia is ranked 11th placing in the Asia Pacific Region for cybercrimes exposure in the year 2016. This is further supported by the statistic from Royal Malaysian Police. It was stated that RM1.9 million was lost because of scamming issue in 2016 (Husna et al, 2018).

The issue of data and privacy leakage had increased in their seriousness. Therefore, records in the ledger need to be secured. For medical industry, breaches alone can result in billions of losses. According to "Healthcare IT News", 2019, Augusta University Medical Center had experienced from cyber attack in July 2018. The hackers intruded into the system to steal the patient's information, medical record, medications and treatment information

Lack of clarity on the terminology and perceived immaturity of the technology is another challenges faced by blockchain technology. The terms blockchain and DLT creates confusion to the public. The terms DLT and blockchain are often treated the same (Mainelli & Mills, 2016). This situation happens due to the lack of understanding among businesses, consumers and authorities. This had led to the consequences of using the wrong technology in operating their businesses. The perceived immaturity of technology also leads to the confusion on which technology may suits the best for their business. As concerned by the medical industry, the appropriate technology must be used by the organisation to prevent losses due to the external factors.

Phishing can be done although users are behind the firewall. From the medical perspective, it is a critical issue that should be taken into account whereby it involves

the privacy of the patients. All the medical records are transferred and kept across all the database of the related workers such as doctors, nurses.

Last but not least, security issues are one of the major concerns in blockchain technology. This issue is known as the “51% Attack”. This issue is more likely to appear in consortium and private blockchain due to the lack of rigidity of the number of peers. It occurs only when the miners of the consortium blockchain control 51% of the computing power. In contrast, public blockchain can be avoided from such problem. This is because of the model of public blockchain. In public blockchain, there are side chains which allow the blockchain to be more protected. This limitation can be resolved by having more miners in the network. As the number of peers in the network increase, the network will be more immuned from the “51% Attack”. A proof of stake (PoS) consensus algorithm is used in the new generation of blockchain to punish the malicious miners (Husna et al, 2018).

2.2.9 Laws Used in Other Countries

The law used to govern blockchain technology in -n Medical Industry is attached in **Appendix 2.1.**

2.2.9.1 United Kingdom

Computer Misuse Act (CMA) 1990

According to the statistic, the government system was attacked by hackers 84 times per week on average (McCue, 2002). This issue can be seen in its seriousness from another statistics provided by United Reporting and Alerting Scheme (UNIRAS), there are a total of 13,146 of attempted hacking cases had been reported from the year 1999 to 2002. There are certain changes made in CMA 1960 to ensure that the computer crime can be reduced.

The changes made had gained the approval from Police and Justice Act 2006. The latest CMA had slightly reduced the number of cases for computer crime. Other than the organisations mentioned above, Serious Organised Crime Agency (SOCA) had also played their responsibilities in dealing with the matter. SOCA engages in researches to find out the potential criminals that might happen (Thomas, 2006).

2.2.9.2 United States

Federal Computer Intrusion Laws

United States has discussed on ways to counter and control computer crimes for a long time (Grabasky, 2001). The Department of Justice (DOJ) pursuits hacking under Computer Fraud and Abuse Act (CFA) (Grabasky, 2001). CFA is used to exercise punishment on those who intentionally create damages to files in a protected computer.

In year 2001, CFA was improvised once again. It had increased its jurisdiction for Justice Department's to execute punishment on the wrongful parties (U.S Dept of Justice, 2002). Based on the research done by Computer Crime and Security Survey, Computer Security Institute (CSI) and Federal Bureau of Investigation (FBI), almost every multinational company in U.S have being suffered from computer crime in the past ten years (CSI / FBI, 2005). The research is further supported by the statistic of the percentage of unauthorised access into organisation's system.

2.3 Conclusion

2.3.1 What Malaysia Can Learn from Other Countries

Until today, computer crime is still a serious matter in Malaysia. The Malaysian government has to review the punishment in CCA 1997 to curb such problem. For this, Malaysia can made United States' law a reference. U.S has various sub laws to tackle computer crime issue despite U.S suffering from cyber attack since the past ten years. Besides, Malaysia can also establish an agency to specifically to solve and monitor the cyber attack in the country. Experts can be employed to manage the agency instead of depending on the policies.

CHAPTER 3: METHODOLOGY

3.0 Introduction

In order to have a better insight on this academic research, qualitative research method has been used. This method requires individual face-to-face interview with the professionals in related field. Qualitative Research is a process whereby it seeks a better understanding on the phenomena of natural setting. Instead of statistical and logical, this research method requires multiple inquiry systems for the study. This includes the usage of precedent case study, historical analysis, grounded theories by past researchers and ethnography ("What is Qualitative Research", n.d).

The data collection process is mainly conducted in Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM) and Universiti College Tunku Abdul Rahman (TARUC). We have chosen to interview two professionals from UKM, one senior lecturer in TARUC, and one experienced lecturer from UM. Face-to-face interview is also called in-person interview. Based on Paul (2008), this method is used frequently in conducting studies with the intention of getting response from various respondents. This is to explore the different perspectives of the targeted participants.

From face-to-face interview, we are able to get first-hand information from the professionals from the particular field. From there, we are able to have a clearer view of our research. This way of data collection method is able to reduce non response and at the same time maximize the quality of the information collected. It will also enhance the efficiency of the researchers in interpreting data (Paul, 2008)

3.1 Research Design

According to "What is Research Design" (n.d.) defined research design as the different strategies applied in order to carry out the research. The researcher uses a framework of methods and techniques to ensure that the research problems are solved in a logical manner. There are three types of research design which are Exploratory Research, Descriptive Research, and Causal Research (Creswell, 2013). Interviewing professionals is part of the requirement for qualitative research. Whilst various interviews techniques have been used, the research is known as an Exploratory Research.

Exploratory Research is used in exploring research questions in the research topic. Marlow (2011) said that exploratory research is used with the motive of discover new ideas and inspirations from the targeted respondents. It also helps the researchers to have a more extensive understanding on the research topic that is done. It usually generates ideas and pictures from the past cases that had happened. The interpretation of precedent cases are then used for data analysing purpose.

The rationale of choosing Exploratory Research for our research is the ability to adapt flexibility in the doing this research topic. As this kind of research method had being applied, it is able to be a piggy-back idea for the future researchers. They just need to take the study that has being done as reference. Other than that, ideas of conducting this study are taken and gathered from the online databases of Universiti Tunku Abdul Rahman (UTAR), Universiti Malaya (UM), Tunku Abdul Rahman Universiti College (TARUC) and Universiti Kebangsaan Malaysia (UKM).

3.2 Data Collection Method

Data collection is one of the most important element in conducting a research regardless of the type of research. The research topic is able to verify the validity of its outcome only by having data collected from the targeted population ("Data Collection", 2019). Primary Data and Secondary Data are the two types of techniques used to collect data. In finding information's on this research topic, both methods are used.

3.2.1 Primary Data

Primary Data is defined as the first hand information that is collected via a few ways such as surveys, interview or experiment (Hox & Boeije, 2015). In conducting this study, face-to-face interview had being used as way to collect information. This method is said to be effective as the participants of interview are experienced in the legal and technological field.

3.2.2 Secondary Data

Collection of information from past experiment, research and surveys is known as secondary data. It is collected by the current researchers for some other intentions (Dunn, Arslanian-Engoren, DeKoekkoek, Jadack & Scott, 2015). It is to further analyse the studies that have being done by the previous researchers. Precedent case studies from databases of Universiti Tunku Abdul Rahman (UTAR), Universiti Malaya (UM) and Universiti Kebangsaan Malaysia (UKM) have been used as the references for our research.

3.3 Sampling Design

3.3.1 Target Population

In order to ensure the respective research is able to achieve the expected quality, professionals and lecturers are chosen as the target population for this study. Since, they are the experts in the field which relates to this research, it is believed that the information collected is accurate and appropriate.

Two lecturers from Universiti Kebangsaan Malaysia (UKM) who are Dr. Salawati Mat Basir and Dr Nazura bt Abdul Manap respectively. They are both professionals in the law industry. Dr Salawati is an expert in International Law and Space Law. She is also a legal advisor, international trade, practicing advocate and solicitor prior joining UKM. Dr Nazura bt Abdul Manap is also an experienced law lecturer in Cyber Law, Information Technology Law as well as Computer Law. She has about 20 years of experience in the law industry.

Another lecturer is from Universiti Malaya (UM) who has blockchain background from the legal perspective. She is not willing to disclose her name in our study. Apart from her background in blockchain, she is also a member for Malaysian Blockchain Alliance in the year 2018. With all the professions and background mentioned above, a strong rationale from the legal perspective towards blockchain technology can be generated from the interview.

Respondent E is a senior lecturer from Universiti College Tunku Abdul Rahman who has a network security background from technological perspective. He is currently doing a research on Blockchain. Thus, he is able to assist us by providing information from his area of expertise.

3.3.2 Sampling Frame and Sampling Location

In this sampling process, there are five participants. They are taken into sample consideration. These respondents are from Universiti Malaya (UM), Universiti Kebangsaan Malaysia (UKM) and Universiti College Tunku Abdul Rahman (TARUC) respectively. The data collection process is mainly conducted in UKM, UM, and TARUC.

3.3.3 Sampling Element

Four professionals who have adequate and sufficient professionalism in relation to our research topic have been chosen as the respondents for carrying out the interview. Permission is given by them to disclose their name in our research. Two lecturers from UKM, and one lecturer from UM are interviewed as they have law background. Other than the respondents mentioned above, a senior lecturer from TARUC is willing to help us out by conducting an interview in order to provide clarity to our doubts from the technological perspective.

3.3.4 Sampling Method

A process of selecting sample from a group of population to transform into research information is called as sampling method (Mcleod, 2014). Sampling method can be done through random probability or non-probability random sampling method (Shantikumar, 2018). Examples of probability sampling method are Simple random, Systematic sampling, Stratified sampling, and Clustered sampling. In contrast, Convenience sampling, Quota sampling, Judgement (or Purposive) sampling and Snowball sampling are some examples of non-probability sampling method (Shantikumar, 2018).

The criterion to be chosen as a sample is to have professionalism and adequate knowledge towards the research topic that is done and has a complete comprehensive on blockchain and Malaysian Law. Data collected from the targeted respondents is reliable and professional. In this case, purposive sampling method is used to gather information to get a clearer view on this research topic.

Purposive sampling method is also known as selective sampling. Researchers will choose the most qualified participant that he think that will be able to provide the most accurate information in relation to the objectives in this research. At the same time, the targeted respondents must be willing to share their knowledge required by the researchers. This has proven that the sample for this study is not chosen at random. The criterion of the sample for this study is strictly designed.

3.3.5 Sample Size

In order to carry out this study, we have chosen four qualified participants to conduct our interview. The reason of choosing only four respondents is because time constraint issue and also lacked of related professionals that is suitable for our research. As mentioned on the above, face-to-face interview is time consuming.

3.4 Research Instrument

There are three types of research interviews which includes structured, semi-structured and unstructured. Structured interview is suitable to use to get a quick feedback from the respondents. This type of interview does not allow interaction between interviewer and interviewee. Thus, interviewee is not able to get deep understanding regarding to the research study (Gill, Stewart, Treasure & Chadwick, 2008).

Meanwhile, for semi-structured interview is very time consuming. This method is a combination of structured and unstructured interview method. Gill et al. (2008) said that the targeted sample with insufficient knowledge will result in the inability to provide information required by the researchers. This will reduce the quality of the study. This kind of interview method pursues interaction between interviewee and interviewer. It is commonly used in exploring the new ideas from the respondents.

Unstructured interview is an informal method which does not have predetermined questions. Thus, it normally creates confusion for the researchers. The respondents may not have an in depth understanding towards the subject of study. The researchers are not able to gain precise answers for the indicated questions (Mcleod, 2014).

In the field of this study, interview is the most appropriate way to gain information. Although face-to-face interview is time consuming, it can assist the researchers in clarifying the ambiguous in the medical field. Semi-structured interview provides flexibility to the interviewee. The questions set are open-ended which leaves the participants to provide their answers based on their knowledge. There is a research stated that at the first few minutes of an interview, the interviewers tend to be the most decisive. This had proven that the interviewee's point of view has no impact on interviewer during the interview process. (Moser & Korstjens, 2017). Semi-structured permits freedom of speech of the interviewer. They are able to express their feelings and emotions as well as share their opinions and knowledge throughout the interview process.

In order to carry out a high performance of interview, the interview questions are distributed to the respondents in advance. By doing so, they are able to proofread the questions and give the most accurate answer to the researchers. This can enhance the quality of answers given as well as increase the efficiency of the interview. Each interview session took about 1 hour. The entire data collection took up to about three months to complete. A sample of questionnaire is attached in **Appendix.**

3.5 Data Processing

In the data analysis process, the thematic data processing is used to induce the interview report. According to (Maguire & Delahunt, 2017), the data is well structured and organised in thematic data analysis. Based on Braun & Clarke's (2013), thematic data analysis is said to be appropriate method in qualitative research as it has a clear framework. Five steps of thematic analysis are used when carrying out data analysis for this study.

Step One: Transcription

The information collected is jotted down on a piece of paper. The data is then translated from a speech form into written text. After translating, the researchers will have a better insight towards the study field. This is the most significant step in all the thematic process as this requires a comprehensive understanding of the interviewee towards the opinions provided by the respondents. A slight misunderstanding towards the opinion will lead to a different outcome of the research ("The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance", 2018).

Step Two: Filtering initial data

The next step will be data filtering. After the transcription process, researchers will need to master the information well. They need to extract only the useful information to be their source for this research. Other unused and inadequate information will be filtered out. In addition, checking and editing of raw data is done to make sure that there is no mistake in the information provided during the interview sessions. Correction is done immediately once error is detected as it helps in filter out incomplete data ("The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance", 2018).

Step Three: Generating themes

Suitable themes are developed according to the data collected. In the end of this phase, researchers must generate various themes for the research topic, sub-theme, and all the generated themes must be tally with the extracted data. Several important themes are generated from the data collected ("The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance", 2018).

Step Four: Themes review and Themes naming

Discussion will be carried out to evaluate on which themes suit the best for the research topic. The themes selected will be reviewed into the data analysis. Information searching process will be carried out after the themes have being decided. All the chosen themes will be named based on the research topic ("The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance", 2018).

Step Five: Generating a report

Generating a written report is the final step in the thematic process. This process starts after the researchers have decided on the most suitable themes. They will generate a finalized written report which contains data analysis from the collected information. Their aim is to record, discuss, interpret and evaluate the initial data recorded during the interview sessions. This benefits the researchers in having a clearer view towards their research topic ("The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance", 2018).

3.6 Data Analysis

There are 15 themes selected in total. The themes will be written in this research includes:

1. Define blockchain Technology.
2. Importance of blockchain Technology.
3. Differences between blockchain Technology.
4. Level of recognition towards Blockchain Technology in Malaysia.
5. Limitation of Blockchain Technology.
6. Impacts of blockchain Technology.
7. Potential risk of blockchain Technology.
8. Steps to overcome potential risks.
9. Should clinics continue using the traditional data storage method?
10. Should top management support blockchain Technology in organisation?
11. Laws used to regulate the enforcement of blockchain Technology amongst Malaysian Medical Industry.
12. Is Malaysia ready to implement blockchain Technology in the medical field?
13. Provide a company that had successfully integrated blockchain Technology in their operation.
14. Challenges faced by companies in integrating blockchain Technology in their operation.
15. Should a company invest heavily in Research and Development (R&D) for blockchain Technology and treats it as an errand to protect users' information privacy?

Inducing these themes help in segmenting the collected information into a few categories. All the interview questions are set based on the themes stated above. After the interview sessions, the data will be interpreted and will be presented in a written form. It will then be transcribed into a detailed written report and will be presented in Chapter 4. Next chapter will focus on the explanations given by the interviewers in the interview sessions.

3.7 Conclusion

This chapter discusses on the methodology used in the research. Five qualified respondents are picked based on their knowledge regarding to the study field. For data collection and interpreting purpose, a face-to-face interview is used on the respective expertise. After all the relevant data is interpreted, five step thematic data processing methods are used to analyse the data. There are 15 themes in total that are generated from the discussion in this research topic. All the 15 themes are written up in the data analysis section.

CHAPTER 4: QUALITATIVE DATA ANALYSIS

4.0 Introduction

The data obtained from all four respondents will be disclosed in this chapter. Most of the respondents are equipped with legal knowledge. One of them has experience in regards to blockchain namely the medical field. Meanwhile, the other one has the background on network security from the technology perspective. In order to collect data from these respondents, a face-to-face interview has being conducted. This interview is done with the objective of exploring the impacts of blockchain technology in the medical industry from the Malaysian context. These qualified respondents are from Universiti College Tunku Abdul Rahman (TARUC), Universiti Malaya (UM) and Universiti Kebangsaan Malaysia (UKM) respectively.

Apart from relying on the online journals, having experts in the related industry to provide quality information helps the researchers to clarify their doubts on the concept of blockchain technology and its impacts towards the medical field. Hence, the data will be collected from the experts and then compiled in this chapter. The questions set for interview is generated from the themes illustrated in subtopic 3.6 in Chapter 3. Grouping data in accordance to themes allows the researchers to have a better understanding on the findings. Additionally, a more detail discussion about its application and impacts of blockchain technology will be further elaborated.

In the process of looking for suitable respondents for data collection purpose, we found out that these respondents share the same similarities which is their knowledge in the legal field. By this, the content provided by them is useful and informative. We surely believe that a clearer idea on our research will be obtained from the interview session with them addressing their opinion on blockchain technology.

The interview questions are distributed to the respective respondents a week before carrying out the interview. This is to ensure that they have sufficient time to prepare for the interview. The interview questions are structured in such a way by starting off

with (**Question 1**: What is your degree of awareness blockchain technology? How willing are you to accept its implementation in the medical industry?). This is to provide a general idea on the content and subject of the overall interview.

The name of all respondents will only be disclosed in this study with their consent obtained in advance. However, respondents who are unwilling to disclose their name is labelled as Respondent D and Respondent E. Respondents are required to sign a letter of consent to proof that they agreed to be disclosed. The consent letter will be included directly after the sample of interview questions in **Appendix** as evidence.

4.1 Biography Data

Prof. Dr. Nazura Abdul Manap is currently is an Associate Professor in the Faculty of Law in Universiti Kebangsaan Malaysia (UKM). She has about 20 years of experience in the law industry. Prof. Nazura obtained her Degree in UKM, Masters in London and finished her PhD in International Islamic University Malaysia (IIUM). Her area of expertise is Cyber Law, Computer Law and Information Technology Law. Throughout her teaching years, she has published several publications as well as doing researches relating to law.

Another respondent from UKM would be Associate Professor Dr Salawati Mat Basir. She has held a few professional positions such as legal advisor and international trade, practicing advocate and solicitor before starting her job in UKM. This had strongly justified by her familiarity in law field. Moreover, she also studied her LLB, LLM as well as PhD in UKM. The reason of getting her to be one of the respondents is because of her specialisation in International Law, Space Law, and International Development Law.

Respondent D is unwilling to disclose her identity in our study. Thus, her name will be replaced with Respondent D. She is a lecturer from Universiti Malaya that has blockchain background. She graduated her Degree in Universiti Malaya and her Master in University of London. On top of that, she is also the committee member for Malaysian Blockchain Alliance at the year 2018. She knows the operation of blockchain well so we defined her as one of the qualified respondents.

Fourth respondent is a senior lecturer who is currently working in the Faculty of Computing and Information Technology (FICT) in TARUC. Respondent E obtained his Masters in Computer Science from UTAR. His major study is Computer Science. Hence, the opinion provided will be from the technological perspective. Besides, he is also specialized in the network security field. He is currently doing research on the network security of blockchain technology. With this, we believe that we are able to gain some useful information from his research.

In short, we strongly believe owing that the respondents we have chosen are from different backgrounds, the results gained from the interview sessions will be from different perspectives. This has overcome the limitations that each respondents faced. This will also allow the future researchers to have an in-depth understanding blockchain from different perspectives.

4.2 Findings

There are 15 interview questions that we asked during this session.

Question 1: What is your degree of awareness of blockchain technology? How willing are you to accept its implementation in the medical industry.

According to Dr Nazura, she is aware and willing to accept the implementation of this technology By doing so, it reduces the perceived risk as well as the need of intermediaries in the information channels. At the same time, it also strengthens the protection against sensitive data.

Dr Salawati said that she is aware and willing to accept the implementation of Blockchain technology. It is something new in the third world country like Malaysia. United States, China and other European countries already started that by protecting the data. Moreover, we are exposed to scams nowadays. Therefore, with blockchain, scamming problems can be curbed. This technology provides priority in keeping the user's data private and safe. Apart from that, it can trace the past records as well as the future.

Respondent D stated that her degree of awareness can be considered as high because she has been actively involved in the blockchain space for the past two years. blockchain offers one of the best features in terms of security and immutability. Besides, it provides a full trace of record. In that sense, she believes that the adoption of blockchain is able to bring improvement to the medical industry.

Respondent E said that he first heard about blockchain was about one or two years ago. He had reservation against the implementation of blockchain technology into the medical industry.

Question 2: In your opinion, do you think blockchain is important in the current trend? Why?

Dr Nazura agreed by justifying that trustworthiness is needed to ensure the effectiveness of operation in the entire process. Blockchain is able to keep multiple types of information such as medical records. All the information stored will not be disclosed to any third party without the consent of the users. On top of that, the information is tempered proof. There is a low possibility for the stored information to be changed or to be manipulated.

Dr Salawati pointed out the importance of the blockchain technology. Nowadays, many people dislike their personal data to be disclosed to the third party. Thus, blockchain technology can be used to solve such problem. Blockchain is unlike normal database whereby the information might be leaked anytime or anywhere regardless of intentionally or unintentionally.

Respondent D states that people always argue on the disruptiveness of the technology. It is disruptive but in a good way and regardless of the application of this technology, the technology will still always be misused. However, she still believes that blockchain can be leveraged in many ways as the society nowadays emphasis on fast pace, efficient and effective.

From the point of view of Respondent E, blockchain is an important trend as it protects the integrity once the technology is matured enough.

Question 3: How does the traditional way of storing information differ from blockchain? Do you think that this invention benefits the society?

Dr Nazura defined that changing of entries is permitted for normal database while blockchain database does not support changes unless permission is given by the authorities. A database running on the World Wide Web uses client-server network architecture. In contrast, permissions associated with their account to change the entries that are stored on a centralized server. Normal database can be accessed by anyone but not blockchain. Blockchain brings advantage to the community to the extent of security and privacy.

According to Dr Salawati, the traditional way of storing system always breaks down and is unable to access at most of the time when the data is needed urgently. Additionally, the data capacity of the normal database is not enough to store the information. With normal database, the users are highly exposed to the hacking and leakage issues. Their information might be used by the wrongful parties with bad intentions. However, all these issues will not happen in the blockchain database.

Respondent D explained that the traditional way of information storing requires a lot of papers and files whereas blockchain only requires a database and the data stored will not be distributed like the traditional one. It is a good innovation as it is centralized. For example: insurance agents need to run to every appointed hospital to verify the reliability of the medical records. It is time consuming and at the same time the medical record obtained from hospitals may be varied from one another. All these problems can be solved by looking through in the database.

Based on Respondent E, the traditional way of storing information runs a risk of integrity being compromised. With one-way hash protection, modified information has already happened. Blockchain is a mean to minimize the risk. Hence, he thinks that this invention does benefit the society.

Question 4: Countries such as Japan and United States have recognized the usage of blockchain in relation to industry. Malaysia is one step behind of these countries. From your point of view, do you think that Malaysia should embrace its recognition in related fields? If yes, what are the steps that should be done? If no, why?

Dr Nazura stated that blockchain technology is not widely used due to the lack of trust towards the system itself and also the development of this technology. High cost is required to finance and maintain this technology and not many companies are prepared and willing to face such challenge. Some other distractions are the lack of awareness amongst the internet users, the uncertain legal impact on the implementation of the technology that leads to the difficulties in embracing its recognition.

Dr Salawati agreed that Malaysia should venture into it but financial constraint always being the main obstacle in the implementation process. First and foremost before implementing this technology, the public awareness amongst the community is needed to be increased. This is because most of the Malaysians dislike reading and make their own assumptions based on their point of view.

Respondent D mentioned that is normal for Malaysia to be left behind. Blockchain is already embracing its recognition through the seeking of permission from the users. Government agencies like *Companies Commission of Malaysia and* Election Commission have already applied the usage of blockchain in their operation. Based on the Healthcare Malaysian Blueprint that was issued last year actually did encourage the development of blockchain in the upcoming years.

Respondent E mentioned that Malaysia should be not being left behind. The government can take the initiatives to encourage development of blockchain solution. For example, encouragement can come in the form of tax reduction.

Question 5: In your account, what are the limitations and problems faced in using this technology in the medical industry?

According to Dr Nazura, she stated that the limitations include the uncertainties faced by the technology from the external and internal environment, the ownership of the data as well as the cost needed to sustain this technology.

Dr Salawati mentioned that the problem of enforcing blockchain technology would be the cost. This is because blockchain technology requires a huge database which is very costly. Without money, it cannot be implemented.

Respondent D pointed out the current problem is about the execution of the plan and solid implementation of the technology. This technology causes environmental issues due to the usage of energy consumption caused by mining. Besides in European Union Data Privacy Rule, it iterates the right of a user to erase his record permanently from the blockchain. Nevertheless, it is an arguable issue because of the characteristic of blockchain.

Respondent E provided feedback that the accuracy in medical industry is utmost important. Expertise, migration from legacy systems, privacy and computational resources required for this technology are some of the challenges for this technology.

Question 6: Do you think is there any significant impacts of enforcing blockchain in the Malaysian Medical Industry?

Dr Nazura provided a few impacts in answering this question. This includes the immutable and traceable patient's records, reduction of pharmaceutical fraud, and the data security in regards to the data. On the other hand, the negative impact includes the lack of insurance fraud. Many insurance buyers tend to provide a so call complete medical report for them.

In Dr Salawati's opinion, she said that there is no problem that is seen from the Malaysian Medical industry context. Besides, they seem to be interested on this technology. Unfortunately, the costs issue again the main concern regardless of private or government hospital. For private hospital, they need to ensure the numbers of patients are high enough to cover the expenses for blockchain technology.

Based on Respondent D, she stated that political view is one of the impacts. Everyone from the society has to be ready to accept this new technology. Public awareness should also be boosted to overcome their lack of knowledge towards this technology.

Respondent E stated some of the impacts are the accuracy of the medical records, the reduction of trusted intermediaries that might cause data leakage issue and also the improved data exchanges in clinical trials. Blockchain is a decentralized system whereby all the data stored can only be accessed by third party with permission.

Question 7: From your point of view, what do you think about the potential risks that will be faced in the process of integrating blockchain in the medical field?

Dr Nazura said that one of the potential risks faced is the storage capacity of this technology. The capacity needs to be huge enough to withstand all the data stored. Next challenge is the rules and regulations. There are no rules to address the healthcare industry. Last but not least, the lack of performance as blockchain involves verifications is also one of the challenges. People do not know how blockchain works that makes it another limitation.

According to Dr Salawati, most of the potential risks appear from the lack of understanding towards the system and financial constraints. Peak modem is needed to control this technology. Getting people in the society to really comprehend the system is hard due to the duration of existence of blockchain technology. Other than that, it also cannot be operated without a huge capacity.

From the view of Respondent D, she thinks that the risks might be lacking of technology to overcome the mining problem that is caused by blockchain technology. This will bring negative impacts to the environment. The energy consumption used by blockchain is high enough to destroy an environment.

Respondent E mentioned that the shortage of awareness amongst the employees in the hospitals. Before persuading the community to utilize blockchain, they themselves need to have a deep understanding on the blockchain technology. By doing so, lots of training need to be given to them in order to enhance their understanding.

Question 8: In order to overcome the risks, what are the precautions recommended to be taken?

Getting experts to guide through the process is the precaution recommended by Dr Nazura. However, hiring experts is not easy and it consumes a huge amount of money.

Dr Salawati said that a huge amount of money is required to ensure its success. Besides, the awareness level amongst community has also become one of the obstacles. Thus, government has to do more awareness campaigns. It is not just about developing the system but also maintaining it.

Respondent D had provided a recommendation on solving the risk stated in the previous question. She suggested the government and public institutions can cooperate to invent a technology that can lessen the level of energy consumption used by this technology.

A precaution recommended by Respondent E is to test on the robustness. It must be almost no room for error to ensure the blockchain is totally safe to be used.

Question 9: Most of the clinics are still using the traditional way to store their patients' medical record. Would you encourage these clinics to implement blockchain technology or continue with the current way of data storing method? What are the challenges clinics will face in implementing blockchain technology?

According to Dr Nazura, she said that it is not advisable to encourage them to do so as it involves a large number of players to make it work. Collaboration from the firms in the sector is required to enhance the level of development of this technology and to educate the public about this technology.

Dr Salawati encourages the clinics to integrate blockchain into their operation. The challenges faced will be the lacking of money and confidence towards this technology. Most of the people only believe in the system when they see a successful company in doing so.

Respondent D encourages the implementation of this technology with the reason of the data security. Storing in blockchain avoids the hacking of the sensitive data. Users do not need to worry that their data will be stolen by harmful parties. Unfortunately, the community is not confident towards the technology.

For this question, Respondent E agrees its implementation by saying that a small experimental deployment can be run while the main system runs to counter check its accuracy during transition. Integration or migration in legacy system and the staff training to learn and embrace the new technology are also some obstacles to be faced in the implementation process.

Question 10: Assuming you are the manager of a hospital, will you encourage the top level Management to utilize blockchain to their store medical records? Please provide justifications to support your answers.

Dr Nazura said that she does not encourage the top level management to do so. It is costly and experts are required to train the employees that are involved in the respective sectors. The uncertain legal implications had also become one of the considerations needed to be taken into account. Blockchain needs huge data storage to cope with all the medical records as it stores the history of the records as well.

Dr Salawati agreed to the statement above. She added on by stating it can be used as a reference for the future research purposes. The use of blockhain helps in tracing back the past records online.

According to Respondent D, she agrees hospitals to store data in blockchain. The cut down of intermediaries in the information channels and the protection of sensitive data from being hacked are some of the reasons provided by her to support her statement.

Respondent E will encourage the top level management to utilize blockchain with the reason of data integrity. Data integrity is one of the most important issues that users are concerned about. With blockchain, data is more integrated as compared to the traditional way of data storage.

Question 11: In your account, are there any provisions of the law regulating the application of Blockchain technology in the medical field? If there is no any legal provision, what would you recommend?

By referring to Dr Nazura, the Medical Act 1971 and Pharmacy Act are some supporting legal documentations. Apart from that, the Computer Crimes Act 1997, the Electronic Commerce Act 2016 and PDPA 2010 are used to govern the cyber activities issue.

Dr Salawati said that there is no provision of law regulating this technology due to the lack of technology. She added that it is hard to recommend for now.

In Respondent D's opinion, there is no any regulation pertaining to blockchain currently except the guideline issued by Bank Negara Malaysia and the orders issued by Securities Commission Malaysia.

Respondent E said that there is no law or provisions regulating such application of blockchain technology in the medical industry. Thus, he would like to recommend the personal data protection enforcement for patient's medical record to safeguard their information from being stolen.

Question 12: As far as the medical industry is concerned, do you think Malaysia is ready to make changes in terms of data storage?

Dr Nazura thinks that Malaysia is not ready to make changes. This is because of the cost and awareness level. It is hard to educate the society with a new technology like blockchain. They need a lot of prove to be confident on this technology.

Dr Salawati does not think that Malaysia is ready to make changes as they do not have the awareness of blockchain. Moreover, they also do not have the initiative to take blockchain technology into the consideration.

As far as Respondent D is concerned, Malaysia is ready to make changes as it on the way. Many institutions have cooperated to further develop this technology. Bank Negara Malaysia (BNM) has participated in this process. BNM has used blockchain in its operation by storing data given by other bank like HSBC and ING Bank.

Respondent E said that Malaysia is ready to make changes as long as the regulations and expertise are there. Other than that, the reliable infrastructures need to be there too to support it.

Question 13: How do you define a successful blockchain application from a company's perspective? Could you please provide us with an example?

Dr Nazura said that currently there are still no companies that are successful yet due to the awareness level amongst the society. Even in United States, there are still part of the community does not really aware what this technology is about.

Dr Salawati mentioned that as they are still trying out this technology even in the United States. Hence, it is hard in providing examples. A blockchain can be defined as successful especially from the medical and pharmacy perspectives in the tracing of past records. The entire industry will be easier to work out with blockchain.

Respondent D said that there are no companies in Malaysia had succeeded. For multinational companies like IBM has succeeded in the implementation of blockchain. However, the word "successful" is very subjective. Thus, it is hard to say that IBM actually succeeds.

According to Respondent E, successful varies from one company to another. Every company has their own value that is important to them. For instance, the banking industry will be focusing on the integrity protection

Question 14: In your opinion, why are certain companies reluctant to implement blockchain technology in their operations?

Based on Dr Nazura, the companies reluctant to use blockchain is because of the lack of expert technologies in the medical field. Next is the amount of capacity needed for data storage purpose. Cost is another issue that makes the companies maintains the existing storage method.

Dr Salawati answered this question by justifying that the companies do not really comprehend what blockchain is. They treated blockchain the same like the normal database. Additionally, they have the third world mentality by listening to other's point of view without any verification from other reliable sources.

Respondent D justified this statement by pinpointing the issues of cost and standard of procedures. There are a lot of bureaucratic processes needed to be done before the decision can be done.

Maturities of the technology, costs used to implement this technology, as well as expertise to support the technology are some of the reasons provided by Respondent E in answering such question.

Question 15: Research and Development have always been the key of success for an organisation. Do you think that a company should spend heavily on developing blockchain technology for social benefit purposes?

Dr Nazura does not think that it is the right time to spend on blockchain due to the current Malaysian economy status.

Dr Salawati encourages the companies to spend heavily on developing blockchain technology due to the positive side of this technology.

Respondent D agreed to this statement by giving her elaboration stating that many companies have spent heavily to develop this technology. A lot of grants have been issued to public institutions and universities to help out this industry. The Gate Foundation has used blockchain technology to provide soft funds to AmBank Group.

Respondent E mentioned that from a win-win setting, if the company having blockchain to give assurance to their clients or business partners to protect information and the cost of development is still within the company's means, it is worth it.

4.3 Conclusion

From this interview, the participants have highlighted the impacts of blockchain technology. The potential challenges and risks as well as the importance of blockchain technology are also being provided. Laws used to govern the blockchain technology in the Malaysian Medical are also given by some of the respondents. Last but not least, some respondents are willing to disclose their name in the research while some are not. Thus, Respondent D and Respondent E will used to replace their names.

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.0 Introduction

Chapter 1 is the overview of the entire research. In this chapter, the background related to the study had been discussed. The characteristics that blockchain technology have directly impacted several industries such as medical industry, technology industry and some other industries that have integrated blockchain in their operations. blockchain technology is regulated by various provisions such as Personal Data Protection Act 2010, Good Medical Practice, Cyber Law 1997, Digital Signature Act 1997 and the institutional frameworks such as Ministry of Health and Cyber Security Malaysia. Among the problem statement, potential problems such as the data breach problem faced by MNCs, leakage of sensitive personal data and also the cyber-attack faced by most of the companies are clearly defined.

Meanwhile, for the objectives of conducting the research our research has defined the concept of blockchain and determined the impacts namely the good impacts and bad impacts from the medical industry. This study is also done to have a better understanding on blockchain and also to analyse the relevancy of blockchain in the medical field. In addition, the benefits and limitations of blockchain technology will be defined in this research. A list of suggestions will be provided to the relevant institutions in order to improve on blockchain technology in the Malaysian medical field in Chapter 5. This chapter is mainly about conducting an analysis on the operation of blockchain and also getting a clearer idea from the research process.

Chapter 2 is an in-depth discussion on the blockchain technology. The Literature Review outlined the emergence of blockchain, the acceptance of blockchain in different countries, types and the different categories of blockchain. The structure, concept, system its application and limitations are also discussed in detail in Chapter 2.

Chapter 3 discussed on the methodologies used to carry out this academic study. Since this research is a qualitative research, research design, data collection method, sampling design, research instrument, data processing, and data analysis. Five qualified respondents had assisted us out in the data collection process by providing their opinions from their related fields. A semi-structured face-to-face interview is used for data collection purpose. A five steps data processing method is used to interpret the data collected from respondents in the interview sessions. 15 themes were developed after the discussion and the information is gathered from the respondents and that information are compiled for data analysis.

Chapter 4 is mainly about the qualitative data analysis. Biodata of all respondents were described in subsection 4.1. Next, the information collected was processed in the findings of the research. Identifying and explaining the major findings according to the 15 themes in subtopic 3.6 are the main objective of doing this research. Other than that, the interview data were also compounded in this chapter in order to provide a better understanding on the themes selected.

Chapter 5 is the overall summary of the studies. All major findings were summarized to cross check on the research objectives stated in Chapter 1. This step is done to ensure all the objectives mentioned were achieved. Besides, the implications and limitations of the study had also been identified and explained clearly. Last but not least, a few recommendations were also given to future researchers at the end of the study.

5.1 Discussions on Major Findings

Many useful information are gathered from the interview session with the respondents. Data collected are separated into 15 themes for better presentation and understanding purpose.

Theme One: *Define blockchain Technology*. The willingness to accept the implementation of blockchain technology in the medical industry is discussed by five respondents. They are willing to accept the implementation of this technology because this technology is beneficial to the society from different perspectives.

Theme Two: *Importance of blockchain Technology.* This theme discussed on the importance of blockchain technology. Blockchain is significant from various perspectives based on the answers provided by the respondents. This technology solves the information leakage problem. It protects the sensitive data against leakage and hacking.

Theme Three: *Differences between blockchain Technology*. Differences between blockchain and the traditional way of data storing is illustrated in this theme. The main difference can be seen is the storing method. The traditional way requires papers and files. This way is riskier as compared to blockchain technology. Data cannot be restored once it is destroyed by natural disaster or accident. Meanwhile, for blockchain, the data will not be lost even if natural disaster happens.

Theme Four: *Level of recognition towards blockchain Technology in Malaysia.* In this theme, the level of recognition of blockchain is discussed. All of the respondents think that Malaysia should embrace this technology but it can only be worked out by having a huge amount of money.

Theme Five: *Limitation of blockchain Technology.* The limitations are subjective according to the respondents. To summarize, the cost issue had become one of the most common issue in developing new technology. Secondly, is the uncertainties faced by the technology from the external and internal environment. Next limitation

will be lacking of solid implementation of the technology. Insufficient expertise, migration from legacy systems, privacy and computational resources are also part of the challenges for this technology.

Theme Six: *Impacts of blockchain Technology.* There are several impacts discussed in this theme. This includes the immutable and traceable patient's records. Cost, public awareness and accuracy of the medical records are also some of the impacts given by the respondents.

Theme Seven: *Potential risk of blockchain Technology.* The potential risk is discussed in this theme. The potential risk includes storage capacity, lack of understanding towards the system, lacking of technology, and the shortage of awareness amongst the employees in the hospital.

Theme Eight: *Steps to overcome potential risks.* In this theme, steps are provided to solve the risk mentioned above. The recommendations provided includes the hiring experts, developing the level of awareness, collaboration between government and public institutions to overcome the environmental problem caused from mining of blockchain. The next step is to test on the robustness of the technology.

Theme Nine: *Should clinics continue using the traditional data storage method?* To summarize, majority of the respondents encourage clinics to use blockchain as it benefits the society from many perspectives especially in term of data security.

Theme Ten: *Should top management supports blockchain Technology in organisation?* Most of the respondents will encourage the top level management to implement blockchain. They justified that the data stored in blockchain can be used references for the future research. By using this technology, it reduces the intermediaries in the information channel and also for data integrity purpose.

Theme Eleven: *Laws used to regulate the enforcement of blockchain Technology amongst Malaysian Medical Industry.* Currently, there is no law or provision regulating this technology except for the guideline issued by Bank Negara Malaysia and the orders issued by Securities Commission Malaysia. Meanwhile, there is another recommendation provided by another respondent is to have personal data protection.

Theme Twelve: *Is Malaysia ready to implement blockchain Technology in the medical field?* This answer is very subjective. Some may think that Malaysia is ready to make changes while some may think that Malaysia is not ready yet based on the findings mentioned previously.

Theme Thirteen: *Provide a company that had successfully integrated blockchain Technology in their operation.* Majority of the respondents said that there are no companies that succeed currently because blockchain technology is still considered as infant industry.

Theme Fourteen: *Challenges faced by companies in integrating blockchain Technology in their operations.* The challenges include the lacking of technologies to cope with the data capacity, the standard of procedure (SOP) involved, and the cost. Lacking of knowledge in regards to blockchain had also become one of the challenges.

Theme Fifthteen: *Should a company invest heavily in Research and Development (R&D) for blockchain Technology and treats it as an errand to protect users' information privacy?* To summarize, the company should spend heavily in R&D since many initiatives had been offered to this industry. As long as everyone in the society cooperates, this technology will be a success in Malaysia.

5.2 Implication of Study

The main objective of carrying out this research is about understanding the concept of blockchain technology. Conducting a research using major findings is to investigate the impacts of blockchain technology in the medical field from the Malaysian context. The contribution of this study is to provide further information in regards of blockchain technology for the Malaysian Medical industry.

The current awareness level of blockchain technology is still considered as low in Malaysia. Thus, future researchers are highly encouraged to conduct more researches relating to blockchain to boost the awareness level of the society. Future researchers must engage closely with the community to monitor their awareness level towards blockchain technology and at the same time to ensure that the correct perception is given to them. This research is also important to the Malaysian Medical Industry from the perspective of hospital employees, related institutions as well as consumers.

5.3 Limitations of Study

A few limitations were found in the process of conducting the research. A semi-structured face-to-face interview is used as the research instrument in this study. This way of data collection is time consuming. In the data gathering process, four respondents have been chosen to be interviewed. On top of that, it is also because of time constraint. We are only given 21 weeks to finish up the research. Moreover, there were no support from organizations or sponsorship given for the researchers and this is also one of the limitations to the quality of the report generated.

5.4 Recommendation for Future Research

The government should make some amendment on the laws of Computer Crime Act 1997 and PDPA 2010. This is done to ensure that the laws used are better in regulating blockchain technology. People are not confident towards this technology due to the lack of laws to protect their information from being hacked. The current laws are only used to govern the current technology, not the blockchain technology. Since this technology is new in Malaysia, the laws used need to be more precise and stricter. By referring to the statistics provided in the previous chapters, it can be seen that there are still many problems happening around. Even for the current technology, the personal information of patients is still being hacked. They assume blockchain technology will be the same as the current technology. Thus, the government has to amend the current legislations and at the same time creating new laws to govern the blockchain technology in order to enhance the confidence of the community.

Moreover, Malaysian Medical Council and the Malaysian Environmental Non-Government Organization need to work closely with each other to curb the problem caused by the mining of blockchain. It is crucial to develop new technology along maintaining the environment. Providing assurance to the patients is one of the recommendations. Practitioners have to sign guarantee letter promising that he is obliged to the responsibility to not disclose the personal information to third party without any consent from the patients according to the provisions listed in PDPA 2010. This step is done to avoid the distribution of sensitive data to the wrongful party.

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Appendix 1.1

Table 1: List of Laws

Statutes	Section	Subsection & Explanation
PDPA 2010	5- Data user that processes personal data must ensure he complies with the following Personal Data Protection Principles	**(1)**The processing of personal data by a data user shall be in compliance with the following Personal Data Protection Principles (a) the General Principle; (b) the Notice and Choice Principle; (c) the Disclosure Principle; (d) the Security Principle; (e) the Retention Principle; (f) the Data Integrity Principle; and (g) the Access Principle, as set out in sections 6, 7, 8, 9, 10, 11 and 12
		(2) Subject to **Section 45** and **46**, a data user who contravenes subsection (1) commits an offence and shall, on conviction, be liable to a fine not exceeding three hundred thousand ringgit or to imprisonment for a term not exceeding two years or both
	6- General Priniciple	**(1)** A data user shall not— **(a)reveal sensitive information to third party unless consent is obtained prior disclosing; or**

		in the case of personal data other than sensitive personal data, process personal data about a data subject unless the data subject has given his consent to the processing of the personal data; or (b) **Handling sensitive data according to the provisions stated in Section 40.** in the case of sensitive personal data, process sensitive personal data about a data subject except in accordance with the provisions of section 40.

		(2) Notwithstanding paragraph (1)(a), **a data user is granted permission to disclose information under certain circumstances of —** A data user may process personal data about a data subject if the processing is necessary— (a) for the performance of a contract to which the data subject is a party; (b) for the taking of steps at the request of the data subject with a view to entering into a contract; (c) for compliance with any legal obligation to which the data user is the subject, other than an obligation imposed by a contract; (d) in order to protect the vital interests of the data subject; (e) for the administration of justice; or (f) for the exercise of any functions conferred on any person by or under any law. **(3)** Personal data shall not be processed unless— (a) the personal data is processed for a lawful purpose directly related to an activity of the data user; 20 Laws of Malaysia ACT 709

		(b) the processing of the personal data is necessary for or directly related to that purpose; and (c) the personal data is adequate but not excessive in relation to that purpose.

	7- Notice and Choice Principle	**(1)** A data user shall by written notice inform a data subject— (a) that personal data of the data subject is being processed by or on behalf of the data user, and shall provide a description of the personal data to that data subject; (b) the purposes for which the personal data is being or is to be collected and further processed; (c) of any information available to the data user as to the source of that personal data; (d) of the data subject's right to request access to and to request correction of the personal data and how to contact the data user with any inquiries or complaints in respect of the personal data; (e) of the class of third parties to whom the data user discloses or may disclose the personal data; (f) of the choices and means the data user offers the data subject for limiting the processing of personal data, including personal data relating to other persons who may be identified from that personal data; (g) whether it is obligatory or voluntary for the data subject to supply the personal data; and Personal Data Protection 21 (h) where it is obligatory for the data subject to supply the personal data, the consequences for the data subject if he fails to supply the personal data.

		(2) The notice under subsection (1) shall be given as soon as practicable by the data user— (a) when the data subject is first asked by the data user to provide his personal data; (b) when the data user first collects the personal data of the data subject; or (c) in any other case, before the data user— (i) uses the personal data of the data subject for a purpose other than the purpose for which the personal data was collected; or (ii) discloses the personal data to a third party. **(3)** A notice under subsection (1) shall be in the national and English languages, and the individual shall be provided with a clear and readily accessible means to exercise his choice, where necessary, in the national and English languages
	8- Disclosure Principle	Subject to section 39, no personal data shall, without the consent of the data subject, be disclosed— (a) for any purpose other than— (i) the purpose for which the personal data was to be disclosed at the time of collection of the personal data; or

		(ii) a purpose directly related to the purpose referred to in subparagraph (i); or (c)to any party other than a third party of the class of third parties as specified in paragraph 7(1)(e).
	9- Security Principle	**(1)** A data user shall, when processing personal data, take practical steps to protect the personal data from any loss, misuse, modification, unauthorized or accidental access or disclosure, alteration or destruction by having regard— (a) to the nature of the personal data and the harm that would result from such loss, misuse, modification, unauthorized or accidental access or disclosure, alteration or destruction; (b) to the place or location where the personal data is stored; (c) to any security measures incorporated into any equipment in which the personal data is stored; (d) to the measures taken for ensuring the reliability, integrity and competence of personnel having access to the personal data; and (e) to the measures taken for ensuring the secure transfer of the personal data.

		(2) Where processing of personal data is carried out by a data processor on behalf of the data user, the data user shall, for the purpose of protecting the personal data from any loss, misuse, modification, unauthorized or accidental access or disclosure, alteration or destruction, ensure that the data processor— (a) provides sufficient guarantees in respect of the technical and organizational security measures governing the processing to be carried out; and (b) takes reasonable steps to ensure compliance with those measures.

	10- Retention Principle	**(1)** The personal data processed for any purpose shall not be kept longer than is necessary for the fulfilment of that purpose. **(2)** It shall be the duty of a data user to take all reasonable steps to ensure that all personal data is destroyed or permanently deleted if it is no longer required for the purpose for which it was to be processed. Based on Data Integrity Principle 11, A data user shall take reasonable steps to ensure that the personal data is accurate, complete, not misleading and kept up-to-date by having regard to the purpose, including any directly related purpose, for which the personal data was collected and further processed.
	11 - Data Integrity Principle	A data user shall take reasonable steps to ensure that the personal data is accurate, complete, not misleading and kept up-to-date by having regard to the purpose, including any directly related purpose, for which the personal data was collected and further processed.

	12 - Access Principle	A data subject shall be given access to his personal data held by a data user and be able to correct that personal data where the personal data is inaccurate, incomplete, misleading or not up-to-date, except where compliance with a request to such access or correction is refused under this Act.
	30 - Right of access to personal data	**(1)** An individual is entitled to be informed by a data user whether personal data of which that individual is the data subject is being processed by or on behalf of the data user. **(2)** A requestor may, upon payment of a prescribed fee, make a data access request in writing to the data user— (a) for information of the data subject's personal data that is being processed by or on behalf of the data user; and (b) to have communicated to him a copy of the personal data in an intelligible form. **(3)** A data access request for any information under subsection (2) shall be treated as a single request, and a data access request for information under paragraph (2)(a) shall, in the absence of any indication to the contrary, be treated as extending also to such request under paragraph (2)(b).

		(4) In the case of a data user having separate entries in respect of personal data held for different purposes, a separate data access request shall be made for each separate entry. **(5)** Where a data user does not hold the personal data, but controls the processing of the personal data in such a way as to prohibit the data user who holds the personal data from complying, whether in whole or part, with the data access request under subsection (2) which relates to the personal data, the first-mentioned data user shall be deemed to hold the personal data and the provisions of this Act shall be construed accordingly.
	34 - Right to correct personal data	**(1)** Where— (a) a copy of the personal data has been supplied by the data user in compliance with the data access request under section 30 and the requestor considers that the personal data is inaccurate, incomplete, misleading or not up-to-date; or (b) the data subject knows that his personal data being held by the data user is inaccurate, incomplete, misleading or not up-to-date, the requestor or data subject, as the case may be, may make a data correction request in writing to the data user that the data user makes the necessary correction to the personal data.

		(2) Where a data user does not hold the personal data, but controls the processing of the personal data in such a way as to prohibit the data user who holds the personal data from complying, whether in whole or in part, with the data correction request under subsection (1) Which relates to the personal data, the first-mentioned data user shall be deemed to be the data user to whom such a request may be made and the provisions of this Act shall be construed accordingly.
	38 - Withdrawal of consent to process personal data	**(1)** A data subject may by notice in writing withdraw his consent to the processing of personal data in respect of which he is the data subject. **(2)** The data user shall, upon receiving the notice under subsection (1), cease the processing of the personal data. **(3)** The failure of the data subject to exercise the right conferred by subsection (1) does not affect any other rights conferred on him by this Part. **(4)** A data user who contravenes subsection (2) commits an offence and shall, on conviction, be liable to a fine not exceeding one hundred thousand ringgit or to imprisonment for a term not exceeding one year or to both.

	39 - Extent of disclosure of personal data	Notwithstanding section 8, personal data of a data subject may be disclosed by a data user for any purpose other than the purpose for which the personal data was to be disclosed at the time of its collection or any other purpose directly related to that purpose, only under the following circumstances: (a) the data subject has given his consent to the disclosure; (b) the disclosure — (i) is necessary for the purpose of preventing or detecting a crime, or for the purpose of investigations; or (ii) was required or authorized by or under any law or by the order of a court; (c) the data user acted in the reasonable belief that he had in law the right to disclose the personal data to the other person; (d) the data user acted in the reasonable belief that he would have had the consent of the data subject if the data subject had known of the disclosing of the personal data and the circumstances of such disclosure; or (e) the disclosure was justified as being in the public interest in circumstances as determined by the Minister.

	42 - Rights to prevent processing likely to cause damage and distress	**(1)** Subject to subsection (2), a data subject may, at any time by notice in writing to a data user, referred to as the "data subject notice", require the data user at the end of such period as is reasonable in the circumstances, to— (a) cease the processing of or processing for a specified purpose or in a specified manner; or (b) not begin the processing of or processing for a specified purpose or in a specified manner, any personal data in respect of which he is the data subject if, based on reasons to be stated by him— (A) the processing of that personal data or the processing of personal data for that purpose or in that manner is causing or is likely to cause substantial damage or substantial distress to him or to another person; and (B) the damage or distress is or would be unwarranted.
Digital Signature Act 1997	28 - Disclosures on inquiry	**(1)** A licensed certification authority shall, on an inquiry being made to it under this Act, disclose any material certification practice statement and any fact material to either the reliability of a certificate which it has issued or its ability to perform its services.

		(2) A licensed certification authority may require a signed, written and reasonably specific inquiry from an identified person, and payment of the prescribed fee, as conditions precedent to effecting a disclosure required under subsection (1).
	43 - Duty of subscriber to keep private key secure	By accepting a certificate issued by a licensed certification authority, the subscriber named in the certificate assumes a duty to exercise reasonable care to retain control of the private key and prevent its disclosure to any person not authorized to create the subscriber's digital signature.
	44 - Property in private key	A private key is the personal property of the subscriber who rightfully holds it.

	45 - Licensed certification authority to be fiduciary if holding subscriber's private key	Where a licensed certification authority holds the private key corresponding to a public key listed in a certificate which it has issued, the licensed certification authority shall hold the private key as a fiduciary of the subscriber named in the certificate, and may use that private key only with the subscriber's prior written approval, unless the subscriber expressly and in writing grants the private key to the licensed certification authority and expressly and in writing permits the licensed certification authority to hold the private key according to other terms.
Computer Crime Act 1997	2 (2) - For the purposes of this Act, a person secures access to any program or data held in a computer if, by causing a computer to perform any function, he—	(a) alters or erases the program or data; (b) copies or moves it to any storage medium other than that in which it is held or to a different location in the storage medium in which it is held; (c) uses it; or (d) causes it to be output from the computer in which it is held whether by having it displayed or in any other manner, and references to access to a program or data and to an intent to secure such access shall be construed accordingly.

	2 (5) For the purposes of this Act, access of any kind by any person to any program or data held in a computer is unauthorized if—	(a) he is not himself entitled to control access of the kind in question to the program or data; and (b) he does not have the consent or exceeds any right or consent to access by him of the kind in question to the program or data from any person who is so entitled.
	3 - Unauthorized access to computer material	**(1)** A person shall be guilty of an offence if— (a) he causes a computer to perform any function with intent to secure access to any program or data held in any computer; (b) the access he intends to secure is unauthorized; and (c) he knows at the time when he causes the computer to perform the function that is the case.
	5 - Unauthorized modification of the contents of any computer	**(1)** A person shall be guilty of an offence if he does any act which he knows will cause unauthorized modification of the contents of any computer.

Appendix 2.1: List of Korean Law

Law	Article	Content	Principle for Protecting Information
Framework Act on Health and Medical Services	Article 13 (Confidentiality Agreement)	Regarding health and medical treatment, individual physical and health secret of privacy are not interfered.	The Right to Privacy
Medical Law	Article 21 (Access to Records) Section 1, Section 2	Principally prohibited from disclosing patient medical information to other people save for patients (Allow exceptions legally)	Use Limitation Principle
	Article 21 (Access to Records) Section 3	Stipulate a condition that medical staff shall send medical treatment records to other medical staff on condition of patients' consents.	Use Limitation Principle, Individual Participation Principle
	Article 23 (Electric Medical Records) Section 3	Forbidden to disclose, modify, or ruin personal information stored in electronic medical records.	Security Safeguards Principle

	Article 18 (Prescription Writing and Delivery)	Forbidden to detect, disclose, modify or ruin personal information stored in electronic prescriptions.	Security Safeguards Principle
Act on the Protection of Personal Information	Article 23 (Control on Processing Sensitive Information) Presidential Decree Article 18	"Sensitive Information" including health, sex life and genes; principally, process is prohibited	Use Limitation Principle

Appendix 3.1: Interview Questions

Q1 What is your degree of awareness of blockchain technology? How willing are you to accept its implementation in the medical industry?

Q2 In your opinion, do you think blockchain is important in the current trend? Why?

Q3 How does the traditional way of storing information differ from blockchain? How do you think that this invention benefits the society?

Q4 Countries such as Japan and United States have recognised the usage of blockchain in relation to industry. Malaysia is one step behind of these countries. From your point of view, do you think that Malaysia should embrace its recognition in related field? If yes, what are the steps that should be done? If no, why?

Q5 In your account, what are the limitations and problems faced in using this technology in the medical industry?

Q6 Do you think is there any significant impacts of enforcing blockchain in the Malaysian Medical Industry?

Q7 From your point of view, what do you think about the potential risks that will be faced in the process of integrating blockchain in the medical field?

Q8 In order to overcome the risks, what are the precautions recommended to be taken?

Q9 Most of the clinics are still using the traditional way to store their patients' medical record. Would you encourage these clinics to implement blockchain technology or continue with the current way of data storing method? What are the challenges clinics will face in implementing blockchain technology?

Q10 Assuming you are the manager of a hospital, will you encourage the top level Management to utilise blockchain to their store medical records? Please provide justifications to support your answers.

Q11 In your account, are there any provisions of the law regulating the application of blockchain technology in the medical field? If there is no any legal provision, what would you recommend?

Q12 As far as the medical industry is concerned, do you think Malaysia is ready to make changes in terms of data storage?

Q13 How do you define a successful blockchain application from a company's perspective? Could you please provide us with an example?

Q14 In your opinion, why are certain companies reluctant to implement blockchain technology in their operations?

Q15 Research and Development has always been the key of success for an organisation. Do you think that a company should spend heavily on developing blockchain technology for social benefit purposes?

Interview Response: Dr Nazura (Appendix 4.2)

Q1 What is your degree of awareness of blockchain technology? How willing are you to accept its implementation in the medical industry?

Ans: Blockchain is a shared, distributed ledger that facilitates the process of recording transactions and tracking assets in a business network. Virtually anything of value can be tracked and traded on a blockchain network. Thus, reducing the risk and cutting costs involved. The blockchain network is efficient and economical because it eliminates duplication of effort and reduces the need of intermediaries. It is also less vulnerable, because it uses consensus models to validate information. Transaction is secure, authenticated and verifiable.

Q2 In your opinion, do you think blockchain is important in the current trend? Why?

Ans: Important. Applicable to any types of secured record keeping. Eg: medical records. The information is also tempered proof. It has low possibility for the stored information to be changed or to be manipulated.

Q3 How does the traditional way of storing information differ from blockchain? How do you think that this invention benefits the society?

Ans: Changing of entries is permitted for normal database while blockchain database does not support changes unless permission is given by the authorities. A database running on the World Wide Web uses client-server network architecture. In contrast, permissions associated with their account to change the entries that are stored on a centralized server. Normal database can be accessed by anyone but not Blockchain.

Q4 Countries such as Japan and United States have recognised the usage of blockchain in relation to industry. Malaysia is one step behind of these countries. From your point of view, do you think that Malaysia should embrace its recognition in related field? If yes, what are the steps that should be done? If no, why?

Ans: Lack of trust towards the system and the development of this technology. High cost is required to finance and maintain this technology and not many companies are prepared and willing to face such challenge. Lack of awareness amongst the internet

users, the uncertain legal impact on the implementation of the technology are some of the distractions.

Q5 In your account, what are the limitations and problems faced in using this technology in the medical industry?

Ans: Uncertainties faced by the technology from the external and internal environment, the ownership of the data as well as the cost needed to sustain this technology.

Q6 Do you think is there any significant impacts of enforcing blockchain in the Malaysian Medical Industry?

Ans: Positive impacts: Immutable and traceable patient's records, reduction of pharmaceutical fraud and the data security in regards to the data. The negative impact: Lack of insurance fraud. Many insurance buyers tend to provide a so called complete medical report to them.

Q7 From your point of view, what do you think about the potential risks that will be faced in the process of integrating blockchain in the medical field?

Ans: Challenges: Capacity needs to be huge enough to withstand all the data stored, rules and regulations. There are no rules to address the healthcare industry. The lack of performance as blockchain involves verifications. People do not know how blockchain works.

Q8 In order to overcome the risks, what are the precautions recommended to be taken?

Ans: Hiring experts to get through the process.

Q9 Most of the clinics are still using the traditional way to store their patients' medical record. Would you encourage these clinics to implement blockchain technology or continue with the current way of data storing method? What are the challenges clinics will face in implementing blockchain technology?

Ans: not advisable. Involves a large number of players and collaboration from the firms in the sector is required to enhance the level of development of this technology and to educate the public about this technology.

Q10 Assuming you are the manager of a hospital, will you encourage the top level Management to utilise blockchain to their store medical records? Please provide justifications to support your answers.

Ans: Does not encourage. It is costly and experts are required to train the employees. The uncertain legal implications had also become one of the considerations needed to be taken into account.

Q11 In your account, are there any provisions of the law regulating the application of blockchain technology in the medical field? If there is no any legal provision, what would you recommend?

Ans: Medical Act 1971 and Pharmacy Act, Computer Crimes Act 1997, the Electronic Commerce Act 2016 and PDPA 2010.

Q12 As far as the medical industry is concerned, do you think Malaysia is ready to make changes in terms of data storage?

Ans: Malaysia is not ready to make changes- cost and awareness level- hard to educate the society with a new technology. They need a lot of prove.

Q13 How do you define a successful blockchain application from a company's perspective? Could you please provide us with an example?

Ans: Currently there are still no companies that are successful yet even in United States.

Q14 In your opinion, why are certain companies reluctant to implement blockchain technology in their operations?

Ans: Lack of cost and expert technologies in the medical field, Amount of capacity needed for data storage purpose.

Q15 Research and Development has always been the key of success for an organisation. Do you think that a company should spend heavily on developing blockchain technology for social benefit purposes?

Ans: Is the right time to spend on blockchain due to the current Malaysian economy status.

Interview Response: Dr Salawati (Appendix 4.3)

Q1 What is your degree of awareness of blockchain technology? How willing are you to accept its implementation in the medical industry?

Ans: Aware and willing to accept the implementation. It is something new in the third world country. Exposed to scams- scamming problems can be curbed- provides priority in keeping the user's data private and safe- Trace the past records as well as the future.

Q2 In your opinion, do you think blockchain is important in the current trend? Why?

Ans: Many people dislike their personal data to be disclosed to the third party. Blockchain protects information from leaking regardless of intentionally or unintentionally.

Q3 How does the traditional way of storing information differ from blockchain? How do you think that this invention benefits the society?

Ans: Traditional way: Always breaks down and is unable to access. The data capacity of the normal database is not enough. Normal database, the users are highly exposed to the hacking and leakage issues.

Q4 Countries such as Japan and United States have recognised the usage of blockchain in relation to industry. Malaysia is one step behind of these countries. From your point of view, do you think that Malaysia should embrace its recognition in related field. If yes, what are the steps that should be done? If no, why?

Ans: Agree. Financial constraint- public awareness amongst the community is needed to be increased. Malaysians dislike reading and make their own assumptions based on their point of view.

Q5 In your account, what are the limitations and problems faced in using this technology in the medical industry?

Ans: Cost. It requires a huge database. Without money, it cannot be implemented.

Q6 Do you think is there any significant impacts of enforcing blockchain in the Malaysian Medical Industry?

Ans: No problem seen. They seem to be interested on this technology. Costs issue- Private hospital needs to ensure the numbers of patients are high enough to cover the expenses for blockchain technology.

Q7 From your point of view, what do you think about the potential risks that will be faced in the process of integrating blockchain in the medical field?

Ans: Lack of understanding towards the system as well as the financial constraints. To ensure precision, a peak modem is needed. Getting people to really comprehend the system is hard. It also cannot be operated without a huge capacity.

Q8 In order to overcome the risks, what are the precautions recommended to be taken?

Ans: Huge amount of money is required to ensure its success. The public awareness is another determinant which determines the level of success of the company. Government has to do more awareness campaigns.

Q9 Most of the clinics are still using the traditional way to store their patients' medical record. Would you encourage these clinics to implement blockchain technology or continue with the current way of data storing method? What are the challenges clinics will face in implementing blockchain technology?

Ans: Encourage. Lacking of money and confidence towards this technology. Most of the people only believe in the system when they see a successful company in doing so.

Q10 Assuming you are the manager of a hospital, will you encourage the top level Management to utilise blockchain to their store medical records? Please provide justifications to support your answers.

Ans: Agree. Use as a reference for the future research purposes. The use of blockhain helps in tracing back the past records online.

Q11 In your account, are there any provisions of the law regulating the application of blockchain technology in the medical field? If there is no any legal provision, what would you recommend?

Ans: No provision of law regulating this technology due to the lack of technology. It is hard to recommend for now.

Q12 As far as the medical industry is concerned, do you think Malaysia is ready to make changes in terms of data storage?

Ans: Malaysia is not ready to make changes as they do not have the awareness and initiative.

Q13 How do you define a successful blockchain application from a company's perspective? Could you please provide us with an example?

Ans: They are still trying out this technology even in the United States. It is hard in providing examples. A blockchain can be defined as successful especially from the medical and pharmacy perspectives in the tracing of past records.

Q14 In your opinion, why are certain companies reluctant to implement blockchain technology in their operations?

Ans: Companies do not really comprehend what blockchain is. They have the misperception and wrong concept about. They treated blockchain the same like the normal database. They have the third world mentality by listening to other's point of view without any verification from other reliable sources.

Q15 Research and Development has always been the key of success for an organisation. Do you think that a company should spend heavily on developing blockchain technology for social benefit purposes?

Ans: Encourage. Due to the positive side of this technology.

Interview Response: Respondent D (Appendix 4.4)

Q1 What is your degree of awareness of blockchain technology? How willing are you to accept its implementation in the medical industry?

Ans: Degree of awareness can be considered as high- has been actively involved in the Blockchain space for the past two years. Blockchain offers one of the best features in terms of security and immutability. Besides, it provides a full trace of record. In that sense, the adoption of Blockchain is able to bring improvement to the medical industry.

Q2 In your opinion, do you think blockchain is important in the current trend? Why?

Ans: Argue on the disruptiveness of the technology. Disruptive but in a good way and regardless of the application of this technology, the technology will still always be misused. The same goes to Blockchain. Blockchain can be leveraged in many ways as the society nowadays emphasis on fast pace, efficient and effective.

Q3 How does the traditional way of storing information differ from blockchain? How do you think that this invention benefits the society?

Ans: traditional storage requires a lot of papers and files whereas blockchain only requires a database and the data stored will not be distributed. It depends since there are many perspectives to be considered. If it is from the perspective of storage, it is a good innovation as it is centralized.

Q4 Countries such as Japan and United States have recognised the usage of blockchain in relation to industry. Malaysia is one step behind of these countries. From your point of view, do you think that Malaysia should embrace its recognition in related field? If yes, what are the steps that should be done? If no, why?

Ans: Malaysia is still a developing country in various sectors. Government agencies like Companies Commission of Malaysia and Election Commission have already applied the usage of blockchain in their operation. Based on the Healthcare Malaysian Blueprint that was issued last year actually did encourage the development of Blockchain.

Q5 In your account, what are the limitations and problems faced in using this technology in the medical industry?

Ans: Execution of the plan and solid implementation of the technology. Is not good to rush as it is a new technology- Environmental issues due to the usage of energy consumption caused by mining. European Union Data Privacy Rule, it iterates the right of a user to erase his record permanently from the blockchain.

Q6 Do you think is there any significant impacts of enforcing blockchain in the Malaysian Medical Industry?

Ans: Political view. Everyone from the society has to be ready to accept this new technology. Public awareness should also be boosted

Q7 From your point of view, what do you think about the potential risks that will be faced in the process of integrating blockchain in the medical field?

Ans: Lacking of technology to overcome the mining. Energy consumption used by blockchain is high.

Q8 In order to overcome the risks, what are the precautions recommended to be taken?

Ans: Government and public institutions can cooperate to invent a technology that can lessen the level of energy consumption.

Q9 Most of the clinics are still using the traditional way to store their patients' medical record. Would you encourage these clinics to implement blockchain technology or continue with the current way of data storing method? What are the challenges clinics will face in implementing blockchain technology?

Ans: Data security. Storing in blockchain avoids the hacking of the sensitive data. Users do not need to worry that their data will be stolen by harmful parties. Unfortunately, the community is not confident.

Q10 Assuming you are the manager of a hospital, will you encourage the top level Management to utilise blockchain to their store medical records? Please provide justifications to support your answers.

Ans: Agree. Due to the cut down of intermediaries in the information channels and the protection of sensitive data from being hacked.

Q11 In your account, are there any provisions of the law regulating the application of blockchain technology in the medical field? If there is no any legal provision, what would you recommend?

Ans: No any regulation pertaining to blockchain currently except the guideline issued by Bank Negara Malaysia and the orders issued by Securities Commission Malaysia.

Q12 As far as the medical industry is concerned, do you think Malaysia is ready to make changes in terms of data storage?

Ans: Malaysia is ready to make changes as it on the way. Bank Negara Malaysia (BNM) has participated in this process. BNM has used blockchain in its operation by storing data given by other bank like HSBC and ING Bank.

Q13 How do you define a successful blockchain application from a company's perspective? Could you please provide us with an example?

Ans: No companies in Malaysia had succeeded. For multinational companies like IBM has succeeded in the implementation of blockchain. The word "successful" is very subjective.

Q14 In your opinion, why are certain companies reluctant to implement blockchain technology in their operations?

Ans: Cost and standard of procedures. There are a lot of bureaucratic processes needed to be done before the decision can be done.

Q15 Research and Development has always been the key of success for an organisation. Do you think that a company should spend heavily on developing blockchain technology for social benefit purposes?

Ans: Many companies have spent heavily. A lot of grants have been issued to public institutions and universities. The Gate Foundation provides soft funds to AmBank Group.

Interview Response: Respondent E (Appendix 4.5)

Q1 What is your degree of awareness of blockchain technology? How willing are you to accept its implementation in the medical industry?

Ans: I have first heard of blockchain back in about one or two years ago. I have reservation on implementing blockchain in the medical industry.

Q2 In your opinion, do you think blockchain is important in the current trend? Why?

Ans: It is important an important trend. Once the technology is matured enough, it a means of protecting integrity.

Q3 How does the traditional way of storing information differ from blockchain? How do you think that this invention benefits the society?

Ans: Traditional way of storing information runs a risk of integrity being compromised. With one-way hash protection, modified information has already happened. Blockchain is a means to minimise the risk.

Q4 Countries such as Japan and United States have recognised the usage of blockchain in relation to industry. Malaysia is one step behind of these countries. From your point of view, do you think that Malaysia should embrace its recognition in related field? If yes, what are the steps that should be done? If no, why?

Ans: Malaysia should be not being left behind. Government can take the initiative to encourage development of blockchain solution. For example, encouragement can come in the form of tax reduction.

Q5 In your account, what are the limitations and problems faced in using this technology in the medical industry?

Ans: Accuracy in medical industry is up-most important. Expertise, migration from legacy systems, privacy and computational resources required for this technology are the challenges for this technology.

Q6 Do you think is there any significant impacts of enforcing blockchain in the Malaysian Medical Industry?

Ans: Accuracy of the medical records, the reduction of trusted intermediaries that might cause data leakage issue and also the improved data exchanges in clinical trials. Blockchain is a decentralized system whereby all the data stored can only be accessed by third party with permission.

Q7 From your point of view, what do you think about the potential risks that will be faced in the process of integrating blockchain in the medical field?

Ans: Shortage of awareness amongst the employees in the hospitals. Before persuading the community to utilize blockchain, they themselves need to have a deep understanding on the blockchain technology. By doing so, lots of training need to be given to them.

Q8 In order to overcome the risks, what are the precautions recommended to be taken?

Ans: The robustness need to be tested. It is to ensure almost no room for error.

Q9 Most of the clinics are still using the traditional way to store their patients' medical record. Would you encourage these clinics to implement blockchain technology or continue with the current way of data storing method? What are the challenges clinics will face in implementing blockchain technology?

Ans: Small experimental deployment can be run while the main system still runs to counter check its accuracy during transition. Backup plan (working and fast) in case anything was to go wrong. Integration or migration in legacy system. Staff training to learn and embrace the new technology.

Q10 Assuming you are the manager of a hospital, will you encourage the top level Management to utilise blockchain to their store medical records? Please provide justifications to support your answers.

Ans: Will encourage due to data integrity. Data integrity is one of the most important issues that users are concerned about. With blockchain, data is more integrated as compared to the traditional way of data storage.

Q11 In your account, are there any provisions of the law regulating the application of blockchain technology in the medical field? If there is no any legal provision, what would you recommend?

Ans: No. Recommend: Personal data protection enforcement for patient's medical record.

Q12 As far as the medical industry is concerned, do you think Malaysia is ready to make changes in terms of data storage?

Ans: Yes, as long as there is regulations and expertise are there. The reliable infrastructure needs to be there to support it.

Q13 How do you define a successful blockchain application from a company's perspective? Could you please provide us with an example?

Ans: It would vary from company to company. Depend on what is important for them. For example, banking industry will be focus on integrity protection.

Q14 In your opinion, why are certain companies reluctant to implement blockchain technology in their operations?

Ans: Maturity, cost, expertise to support the technology.

Q15 Research and Development has always been the key of success for an organisation. Do you think that a company should spend heavily on developing blockchain technology for social benefit purposes?

Ans: From a win-win setting, if the company having blockchain to give assurance to their clients or business partners to protect information and the cost of development is still within the company's means, it is worth it.