Overview of Blockchain and
Possible Use Cases in the Thai Payment System

By

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B.A. Mathematics & Economics, Wesleyan University, 2011
MBA Tsinghua University, 2016

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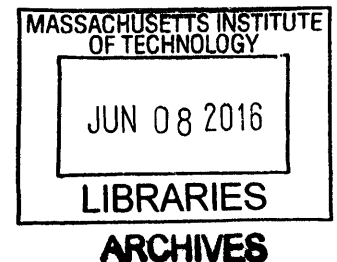
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ABSTRACT

In recent years, there has been a lot of hype and interest around Bitcoin and cryptocurrencies. Following the invention of Bitcoin in 2008, blockchain, the public ledger that supports Bitcoin transaction, has also emerged as a hot topic. Blockchain has attracted attention from many parties around the world including academic scholars, practitioners in many industries, and policymakers in many There are many discussions about whether or not blockchain technology can be beyond its application as a public ledger that records Bitcoin transactions.

This paper will start by providing an overview of blockchain technology, including definition, background information, key milestones, costs and benefits, and current applications. The last part of the paper will be an analysis of possible blockchain applications that may potentially help address some concerns in the Thai payment

Acknowledgements

Throughout the past few months of writing this thesis, I have received tremendous help from many people including professors, friends, and family. The experience has been very rewarding and it would be impossible for me to complete this thesis without the help from the following people:

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Secondly, I would like to thank my friends and supervisors from Kasikorn Bank and Bank of Thailand, who have sacrificed their time to let me interview them to deepen my understanding of the payment system in Thailand. Without their help, it would take me tremendous efforts to gather all the relevant information.

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1. Introduction

Blockchain technology was first established in 2009 as the peer-to-peer public ledger for the cryptocurrency, Bitcoin.[1] Blockchain technology was originally developed to support Bitcoin and thus did not receive a lot of attention in its early years. Six years on, even though the market is still adapting to Bitcoin, there has been increased interest in developing blockchain technology beyond its application as a Bitcoin public ledger. With the technology beginning to gain market recognition, many developers and companies have stepped into this area and started to develop new use cases and applications.

As the infrastructure needed to establish the blockchain ecosystem continues to grow, the pace and volume of capital injection from venture capital firms and large enterprises into blockchain-related startups and companies has accelerated very fast. The maturity of these companies can bring new economic efficiencies, disrupt how things work in many traditional industries, and create further innovations in emerging fields.

Like many new technological innovations at an early stage, there is confusion regarding blockchain's potential use cases, its advantages and disadvantages, and the technology itself. Furthermore, the knowledge and development of blockchain technology and its ecosystem is mainly happening and spreading in the West, but not so much in the East. Hence, I hope to use this thesis to provide clear and useful knowledge about blockchain, lay out the current and potential applications of the technology, and develop several use cases to match needs in Thailand.

In this thesis, I will provide key milestones of the development of blockchain, describe the current overall landscape, compare the costs and the benefits of the

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[1] Cryptocurrency is a digital currency in which encryption techniques are used to control the creation of new units and verify the transaction

technology, point out its limitations, explore and lay out current applications in the U.S., and finally, map the needs to create potential use cases of blockchain in the payment system in Thailand.

The information in this thesis will mainly come from three types of sources: existing literature, interviews with industry experts and practitioners, and my own analysis. The main research questions include:

- How is blockchain developed? What are the key breakthroughs?
- What are the costs and benefits of this technology?
- What are the applications of blockchain technology in the market today?
- How do these applications help address the challenges in the Thai payment system?

The main objective of this thesis is to deepen readers' knowledge about this new revolutionary technology while providing one of the first studies of blockchain technology as it relates to Thai payment systems.

Currently, there are many challenges in the Thai payment system that can be categorized in aspects that include regulation, technology, and cross-border transactions. Even though there are several advantages in using blockchain technology to address these challenges, there are still some drawbacks. I hope the insights gained from this thesis will be the first stepping stone for further study of blockchain technology in the area of payments and other industries in Thailand.

2. Background and Overview of Blockchain Technology

When people refer to the term "block chain" or "blockchain", meanings can vary as blockchain comes in different structural forms. In this paper, "blockchain" refers to a peer-to-peer public ledger, such as the Bitcoin blockchain, which is maintained by a distributed network of computers that do not require any central authority or third party verification. It consists of a chronological chain of blocks where each block stores transactional records that take place in the chain. Thus, the name "blockchain." In addition, these blocks are generated from open-source software, so anyone can review and (by transacting on the network) add records to the network. Once the transaction is recorded, no one can change or erase the record from the network. As a result, blockchain is a complete and immutable record of time-stamped transactions or activities that take place within a network.[2]

Traditionally, an individual completes transactions through a third party guarantor, centralized authority, or an intermediary such as a bank, the government, etc. These institutions not only record the transactions of currency or ownership, they also sometime act as a guarantor in case of unforeseeable circumstances. Using a similar idea, Satoshi Nakamoto invented Bitcoin, a digital asset and payment system, and released the invention as open-source software in 2008.[3] As mentioned above, each transaction is verified by a distributed network of computers or "nodes" and recorded in a blockchain, the backbone of all "cryptocurrencies". Bitcoin or other types of digital coins serves as a unit of account, a medium of exchange, and a way to store monetary value. The value of a coin is determined by open market demand and supply, similar to

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[2] Taylor, Simon, "Blockchain: understanding the potential", 2015

[3] Davis, Joshua, "The Crypto-Currency: Bitcoin and its mysterious inventor", The New Yorker, 31 October 2014

traditional currencies. This makes the cryptocurrency system a purely market-driven exchange where no one can control or manipulate the value of the cryptocurrency.
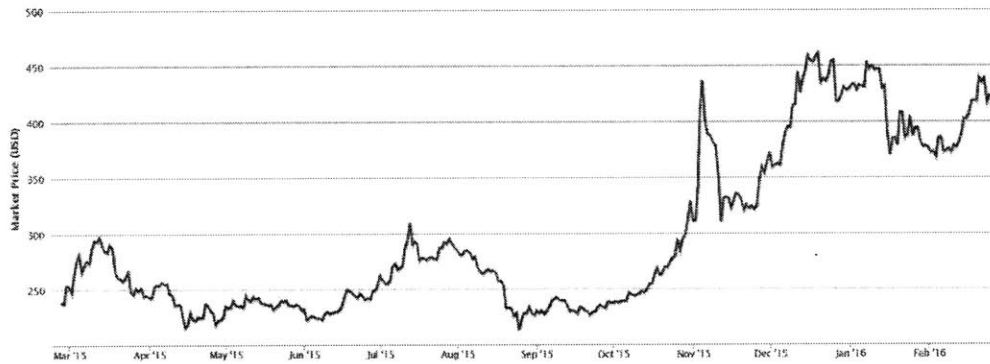

Figure 1.1 Market Price of Bitcoin/USD from 2015-2016

Source: blockchain.info

Ownership of cryptocurrencies is passed using private keys, which is a method of decrypting codes that is known only to the intended recipient.[4] When an individual buys or sells Bitcoin, a private key or token is broadcast to the system. Without knowledge of the private key, a transaction cannot be verified, and the Bitcoin will not be spent. If an owner loses his or her private key, there is no evidence of ownership; consequently, the owner's Bitcoins will be unusable and permanently lost.[5]

The process of identifying and verifying a transaction is conducted by "miners," who use nodes or a network of computers, while the successful results are recorded on the blockchain. In order for a transaction to be accepted by the network, these miners have to perform "proof of work" utilizing special algorithms and high computing power from their computers. Miners are compensated from a decentralized incentive system for their

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[4] Hirsch, Frederick J. "SSL/TLS Strong Encryption: An Introduction". 17 April 2013.

[5] https://www.techopedia.com/definition/16135/private-key

service and computing power contribution in the form of cryptocurrencies.[6] Note that there are new protocols in which a transaction can be identified and validated without the use of miners or proof of work, but instead through a consensus process which records the consensus result to the blockchain within seconds. One alternative method to proof of work is a method called "proof of stake." Proof of work requires users to run hashing algorithms or other encryptions to validate electronic transactions, whereas proof of stake only requires users to validate their ownership or the "stake" in the currency. This method consumes less energy and computing power, but may not be suitable in some situations.[7]

The completeness and immutability of blockchain make it possible to eliminate the third-party verification authority or a centralized authority, and reduces mistakes from human error and information manipulation. Eliminating the intermediaries also reduces transaction costs, time delays, and other risks associated with employing middlemen. In a way, blockchain not only reduces the number of parties involved in a transaction, but also reduces its total cost. Furthermore, because the blockchain system is decentralized, no single entity has the power to control, abuse the system, or make changes to the records. The whole distributed network needs to come to a consensus or else the transaction will not be validated.[8]

Moreover, in contrast to a centralized system, no one owns or controls the blockchain system, but everyone is allowed to participate. In a centralized system, access is based on the credibility of an individual party to the central authority; in some systems, only a certain group of people is granted access with other groups needing to

[6] https://www.Bitcoinmining.com/

[7] King, Sunny. "PPCoin: Peer-to-Peer Crypto-Currency with Proof-of-Stake", https://www.peercoin.net/assets/paper/peercoin-paper.pdf

[8] King, Sunny. "PPCoin: Peer-to-Peer Crypto-Currency with Proof-of-Stake", https://www.peercoin.net/assets/paper/peercoin-paper.pdf

fulfill additional requirements, creating unfairness. Apart from the unfair access, there is also a high chance that integrity within the system will be compromised by the individuals that control it. The goal of the Bitcoin blockchain system, on the other hand, is to build a system in which the only way to gain is to play by the rules. Although some argue that there is a risk of defrauding the system by creating false transactions, doing so would require a large amount of computing power and significant costs; more than half of the nodes need to be controlled in order to alter the information recorded in the blockchain, and the cost of executing the fraud can easily exceed the monetary benefits.[9] In addition, the system also helps ensure that there is no double spending.

Lastly, the level of security, robustness, and adoptability of a system depends on network effects. As more people use a system, there are more incentives to mine; as the number of users and miners increases, the system becomes more robust, secure, valuable, and attractive to a larger audience. Since the Bitcoin blockchain technology is open-source, there is no licensing or legal obstruction to innovation. Essentially, anyone can connect to the network and build products and applications for the system. The increasing number of participants in the system is a crucial factor in determining and evaluating the viability and further prospects of blockchain technology.[10]

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[9] https://www.Bitcoinmining.com/

[10] Narayanan, Arvind, "Bitcoin and Cryptocurrency Technologies" (Draft), 2016

Figure 1.2 Number of Bitcoin Blockchain Transactions Per Day from 2009-2016

Source: blockchain.info

Benefits of Blockchain
Durability – Decentralized network allows distributed ledgers to be more durable. Blockchain ledgers are less vulnerable to unfortunate events such as a network attack or power outrage.
Integrity – Transactions are executed as coded; no need to depend on third-party input.
Transparency – In public blockchains, distributed ledgers are publicly viewable and changes to the transaction are also traceable.
Immutability – Validated records are immutable; an unaltered history of activities.
Longevity – Recorded distributed ledgers can be accessed from anywhere, independent of devices, service providers, or application developers.
Reliability – Failure of certain nodes does not affect or compromise the functionality or effectiveness of blockchain.
Availability – The data and information within a blockchain is available to everyone.

Figure 1.3 Benefits of Blockchain

Source: Needham Insights, 21 October 2015

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Current Limitations of Blockchain
Technical Knowledge – Users need a relatively high degree of technical understanding to utilize this technology.
Storage and Retrieval – Asset values are stored digitally, but asset's value does not necessarily reflect its real-world value. For example, a crashed car's value would still need to be evaluated by a third party to determine its fair market value.
Cannot be Managed by a Third Party – There are businesses that manage cryptocurrencies on behalf of others, but they do so at the risk of compromising the money's security. The Bitcoin blockchain system is designed so that only the owner can control the money using his or her private key.
Uncertain Future – Although the technology sounds very promising and the number of users has been growing rapidly, there is possibility that this technology will not take off in the near future as it is too advanced for the current market.

Figure 1.4 Current Limitations of Blockchain

Source: http://www.truthcoin.info/blog/limits-of-blockchain, 28 November 2014

Implications for Users
Disintermediation – Blockchain technology helps instill trust between the two parties involved in a transaction without needing any intermediary to ensure that each party honors the agreement.
Empowered Users – Instead of letting an intermediary control information, users and users alone drive a transaction and control their own transaction information.
Better Data – The data generated and recorded in blockchain are complete, verified, consistent, accurate, and available for any users in the system. In addition, businesses can store their data in the cloud and conduct data analytics with complete data sets.
Faster Growth for Businesses – Many businesses spend a lot of time and resources to foster relationships and build trust with customers. Blockchain technology

addresses this problem by providing customers with trust that the businesses promise to deliver.

Figure 1.5 Implications for Blockchain Users

Source: Needham Insights, 21 October 2015

Different Types of Blockchain

Currently, there are many types of blockchains. The Bitcoin blockchain is the first version of blockchain technology, and still is the most prevalent one in the market. However, because of certain perceived limitations, many developers have created alternative blockchains that aim to either substitute or complement the Bitcoin blockchain. These blockchains claim to address certain weaknesses of the Bitcoin blockchain such as settlement time, transaction size, consensus method, permission granting method, and other functions.[11] Presently, the biggest topic that blockchain developers are solving is not whether blockchain can be used for applications outside of digital currency (it has already been proven that it can) but rather what are the optimal areas where the benefits of blockchain technology can be maximized.[12]

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[11] Narayanan, Arvind, "Bitcoin and Cryptocurrency Technologies" (Draft), 2016

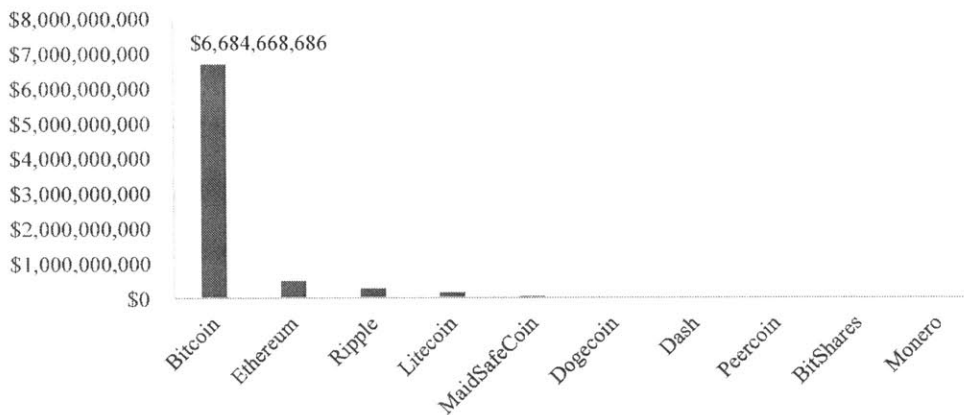[12] Furlonger, D., "Guest colum: The Future of Money," Gartner, 2012

Figure 1.6 Blockchain Market Capitalization as of 29th February 2016

Source: coinmarketcap.com

In this section, I will first describe examples of the main types of blockchain technology available today. Later in Chapter 3's discussion of current applications of blockchain I will focus mainly on the Bitcoin blockchain . Apart from the Bitcoin blockchain, the three main types of blockchain that gain developers' interests: alternative blockchain, colored coins, and sidechains.[13]

Alternative blockchains are new blockchains that are independent of Bitcoin blockchain technology. They still rely on blockchain algorithms to achieve distributed consensus for a transaction.[14] The goal of alternative blockchains is to address some limitations of the Bitcoin blockchain, such as speed and transaction size. However, because of the widespread use of the Bitcoin blockchain, as shown in Figure 1.3, it is very unlikely that the marginal benefits from alternative blockchains will surpass the network effect benefits of the Bitcoin blockchain. Furthermore, since the Bitcoin blockchain protocol is open-source and not static, developers can easily enhance and replicate the benefits of alternative blockchains and adapt them to Bitcoin blockchain

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[13] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[14] Alternative chain, Bitcoin Wiki

technology.[15] However, it is important to note that some alternative blockchains are developed ultimately for different purposes, and thus it is not completely appropriate to compare them directly to the Bitcoin blockchain. For instance, Ethereum addresses the area of smart contracts whereas Ripple addresses the area of private blockchains.[16] A private blockchain is a blockchain in which write permissions are kept centralized within one institution or to a certain group of individuals, whereas read permissions may or may not be limited to public. Hence, these alternative blockchains are not competing directly with Bitcoin. Litecoin, on the other hand, may be considered a direct competitor.[17] In a way, alternative blockchain is a broad term that describes various blockchain strategies; there are many blockchain subsets that are included in this category, and these subsets may or may not be created to address the same goals as Bitcoin blockchain.[18]

Colored coin, on the other hand, is a method to extend Bitcoin blockchain technology beyond its original digital currency transaction application. Essentially, colored coin is a smaller fraction of a Bitcoin that is created to represent an asset other than a cryptocurrency, such as the share of a company, a bond, etc.[19] When based on Bitcoin blockchain technology, colored coin can leverage Bitcoin's large network effect and continue to develop alongside advancements in Bitcoin protocol advancements. The disadvantages of colored coin are similar to Bitcoin in that colored coin has limitations in certain areas such as speed and transaction size. One large organization that has started to use colored coin as a company-wide blockchain experiment is the Nasdaq Stock Exchange. In this initiative, colored coin technology is used for pre-IPO private

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[15] Ibid

[16] Ibid

[17] Ibid

[18] Ibid

[19] Ibid

company share trading.[20]

Lastly, sidechain technology leverages both alternative blockchain and Bitcoin blockchain to create a better experience for users. It is currently under development, and if successful, would help unlock the limitations of the Bitcoin blockchain, while also allowing users to take advantage of the large network effect from the Bitcoin blockchain market.

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[20] Ibid

3. Current Applications of Blockchain

The potential applications of blockchain technology are numerous. Since 2009, many developers and investors have invested a tremendous amount of human and technological resources into this technology. The following are eleven applications of blockchain that I have identified and believe address major pain points and add significant value to society. Please note that these are merely initial applications of this technology, and that the most useful applications of blockchain may yet be developed. Furthermore, the eleven applications below can be categorized into two groups: the first group focuses on improving existing processes and services, and the second consists of more breakthrough innovations. Please keep in mind that these are potential applications and a thorough proof of concept for each application is needed in order to make each application available to a larger audience.

3.1 Payments

In 2013, payments businesses generated \$425 billion in transaction revenues alone.[21] The benefits of using blockchain technology to improve efficiencies in the payment system include:

- Security improvement, as users have full control of their payment transaction information
- Shortening of settlement duration
- Easier access to payments as bank accounts are not needed
- Reduced overall costs in the payment system
    - Decreased transactional cost
    - More efficient payment infrastructure

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[21] The Boston Consulting Group, "Global Payments 2014", September 2014.

The first benefit of blockchain technology in a payments application is enhanced security and the privacy of customers' transactional information. Blockchain technology allows customers to execute a "push" transaction, a transaction in which customers send money to merchants without providing any personal financial information. An opposite example of a "push" transaction is a "pull" transaction.[22] In a "pull" transaction, merchants use customers' financial data to withdraw money from customers' bank accounts. Currently, traditional online credit card transactions are one example of a "pull" transaction. To address the concern of security and privacy, blockchain-based payments allow customers to isolate their financial information from the purchasing order to merchants, lowering the probability of financial information theft. Many large companies such as PayPal, Apple Pay, and Google Play have realized this problem, and are trying to address it using the "token" technology.[23] Instead of providing merchants with customers' financial information, tokens are used to store this sensitive data using cryptography. Once a token is used, it cannot be reused again. Even though this reduces the exposure of customers' financial information to merchants and reduces the amount of financial information theft, there is still one problem – customers' financial information is still exposed to PayPal, Apple, and Google. On the contrary, blockchain technology allows customers to have full control of their financial information without providing the information to any intermediary.[24]

Furthermore, there are many incentives for merchants to use a blockchain-based payment system. First, merchants can save merchant fees that they would otherwise have pay to servicing financial institutions. Second, businesses can be operated globally as blockchain technology facilitates seamless payments for customers and merchants around the world. Third, the technology helps reduce the risk of chargeback fraud.

[22] Marc Andreessen, "Why Bitcoin Matters," New York Times, January, 2014

[23] Ibid

[24] Ibid

Lastly, the technology helps reduce the risk of exposing customers' financial information. Merchants are normally charged 2-3 percent for all credit card transactions via EDC machines i.e. payment terminals provided by financial institutions on which merchants can swipe or dip cards to receive payments. With blockchain technology, the estimated savings from EDC payments to financial service providers can be as high as 90 percent.[25] For instance, Stripe only charges 0.5 percent for payments using Bitcoin while traditional financial institutions charge an approximate 3 percent fee for payments using credit cards.[26] Merchants can enjoy the benefit of greatly reduced transaction costs and create further incentives for customers to shift to utilizing Bitcoin-based payment methods.[27]

Second, another advantage of the blockchain payments application is a shorter settlement period. Usually, the settlement period for credit or debit card transactions can take up to a few days, whereas the settlement period for a Bitcoin-based transaction is just a few hours. Businesses are able to obtain better short-term liquidity and reduce costs using Bitcoins; this is a game changer especially for companies that depend on fast cash turnover. Moreover, a faster settlement period also reduces foreign exchange risk as there is less volatility in foreign exchange rates within a shorter period of time.[28]

Third, blockchain-based payments would make small or micro payments feasible, encouraging more payments in the system. Financial institutions usually charge a minimum fixed cost for small or micro transactions. This makes it unfeasible or very costly for small businesses to use the current payment system. In contrast, there is no fixed cost of transaction in a blockchain-based payment system. This would not only encourage more small businesses to use the payment system, it also helps enhance the

[25] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[26] Stripe Company Website

[27] Marc Andreessen, "Why Bitcoin Matters," New York Times, January, 2014

[28] Ibid

number of data observations that can be collected from historical records of payments. One example would be the purchasing of online newspapers.[29] Many newspapers usually require readers to subscribe monthly, but rarely that we would see a price per article or per page.

Lastly, there is no bank account required to use blockchain-based paymen systems. This opens doors to many more customers, especially those in developing countries who do not have access to bank accounts.[30]

It is undeniable that the blockchain-based payments will take some time to achieve critical mass as more institutions and users still need to be educated and adopt this sophisticated technology. However, since it is an open-source system, more and more developers and entrepreneurs will keep enhancing the system and help speed up its adoption. In 2014, the MIT Bitcoin Club raised $500,000 from alumni and Bitcoin enthusiasts to implement an initiative in which $100 worth of Bitcoin was given to 4,500 undergraduate students to spend in local restaurants and retailers. The goal of this initiative was to study early uses of digital currencies.[31] There is also strong evidence for increased adoption of Bitcoin blockchain technology in the global market as well; Figure 1.2 shows that the number of blockchain-based transactions has been increasing exponentially.[32]

3.2   Digital assets

Apart from payments, blockchain technology can be very useful in the management of digital assets. Many major stock exchanges such as the Nasdaq Stock Exchange have

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[29] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[30] Ibid

[31] Ibid

[32] Ibid

already started initiatives to use blockchain to enhance their clearing and settlement processes.[33] This application to digital asset management can be divided into two sub-categories: first, exchanges can use blockchain technology to facilitate the exchange of cryptocurrencies such as Bitcoin. Second, companies can develop their own platforms to facilitate the exchange of other underlying financial assets such as stocks, bonds, mobile credits, etc.[34]

The original intention of developing the blockchain technology was for it to serve as a backbone for Bitcoin, the most prevalent cryptocurrency. So it is no surprise that one of the most useful applications of the technology is to facilitate the buying and selling of cryptocurrencies around the world. At present, there are two methods to acquire Bitcoins: one is by mining, and the other is by purchasing Bitcoin with traditional currencies. Mining Bitcoins is a process in which miners solve complex cryptographic puzzles, provide proof of work, and in return are rewarded with Bitcoins.[35]

A more recent and exciting development of blockchain in exchanges is beyond the scope of cryptocurrencies. One area that seems to receive a lot of attention at the moment is the use of blockchain to reduce costs and settlement time in the clearing and settlement of digital assets. Digital assets can be both private and public, and include stocks, bonds, gift cards, and other forms of credit.[36] Technological advancements in communication technology has allowed traders and investors to execute deals or transactions rapidly, however, the process of completing a settlement is still very inefficient both in terms of cost and time. The average time for one transaction

[33] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[34] Ibid

[35] Ibid

[36] Ibid

settlement in the U.S. is three days, while in emerging countries settlement periods can be even longer.[37] Apart from the settlement period, both counterparties also need to transfer ownership in a way such that that both parties are not exposed to counterparty risks. This can further prolong the process and generate unnecessary costs.

Furthermore, trading these assets usually requires one or sometime a series of intermediaries, unnecessarily increasing costs and further delaying the transaction. In 2014, revenue gained by intermediaries totaled $70-85 billion.[38] Blockchain technology was invented to address the problem of inefficient intermediaries while reducing the settlement period to a matter of minutes or even very close to real time. Moreover, an indirect benefit of the technology is the reduction of human errors in a transaction. The more parties involved in a transaction, the higher the probability of human errors. Because blockchain minimizes the number of parties involved, it automatically helps reduce error rates. Lastly, apart from the exchange of digital assets, well-known financial organizations such as the Nasdaq Stock Exchange and many blockchain developers have started to use blockchain technology for registering asset ownership and for issuing assets during the pre-exchange process.[39]

3.3 Smart contracts

Smart contracts are software protocols used to facilitate, validate, and enforce agreements between two or more counterparties in a contract. They are created to provide a digital and enforceable agreement that supersedes the traditional legal contract. As smart contracts are both self-executed and self-enforced, they reduce the number of

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[37] http://www.investopedia.com/terms/s/settlement_period.asp

[38] The Capital Markets Industry, Oliver Wyman, 2014

[39] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

transactions as well as other costs and risks associated with creating a legal contract for both individuals and businesses.[40]

The concept of a smart contract was first developed in 1996 by an engineer named Nick Szabo.[41] He explained that vending machines can be operated using smart contracts: vending machines release goods when certain conditions are met. In this case, when a correct amount of money is collected, a specific item is released. Building on this concept, we can apply smart contracts to various kinds of agreements to transfer rights, ownership, and liabilities in an appropriate manner.[42] For example, a smart contract between a bank and a car buyer can state that the buyer has the rights and ownership to the car, so long as installments continue to be paid. However, if the contract is breached, the smart contract would return the rights and ownership of the car back to the bank by returning the digital keys.[43]

In a digital world, the idea of a blockchain-based smart contract is quite simple. When conditions are met, computer protocols can trigger a single or series of actions, such as the sending of information or the releasing of goods and services. The benefits of this application include reduction in costs from eliminating legal and other intermediaries' fees, reduction in human errors, and reduction in contract execution period. Below are a few examples of smart contract use cases in different industries.

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[40] https://en.wikipedia.org/wiki/Smart_contract

[41] Szabo, N. "Smart Contracts: Building Blocks for Digital Markets", 1996

[42] Ibid

[43] Ibid

Smart Contract Use Case Industries	Description
E-commerce	Smart contracts can facilitate better online trade in B2B, B2C and C2C businesses by reducing transactional costs, human errors, and counterparty risk.
Machine-to-machine (M2M)	Smart contracts can facilitate machine-to-machine automation, for example, a car with a smart contract can automatically pay for parking.
Service or access permission	Hotels can use smart contracts to generate digital keys that are only usable during a customer's period of stay. This eliminates the need for physical key cards.
Funding control	Smart contracts can control funds based on the actions of its beneficiaries. For example, scholarship funding can be released in a controlled manner based on a student's attendance record.
Gambling	Smart contracts can be utilized to automatically pay winners accordingly.

Figure 4.1 Examples of Use Cases of Smart Contracts

Source: BBVA Research Digital Economy Outlook, October 2015

However, the application of blockchain becomes more complex in a physical world because physical actions, which cannot be performed digitally, need to be recorded and verified. A few solutions have been suggested to address this problem: multi-signature transactions, prediction markets, and oracle services.[44]

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[44] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

Multi-signature transactions refer to transactions that require more than two counterparties to agree to the terms in a contract. An example of this is an escrow agent. Even though smart contracts are created to eliminate unnecessary of third party or intermediary involvement, there may still be some instances of disputes. Hence if and when a dispute happens, an escrow agent can decided whether the terms that have been agreed upon by both counterparties have been honored.[45]

On the other hand, prediction markets value the consensus of the crowd over a third party vote or other intermediaries. Prediction markets give the crowd monetary incentives to participate. Each participant can vote yes or no for whether or not the contract terms have been honored. The incentive received would depend on the probability of the event occurring compared to the final outcome.[46]

Lastly, similar to prediction markets, oracle services are provided by intermediaries who validate the outcome of the events and input the information to smart contract data services.[47]

These are the three main solutions that have been created to address the feasibility of using smart contracts in the physical world. Other less well-known solutions are also being developed to further enhance the feasibility of blockchain-based smart contracts.

3.4 Identity

In 2013, $21 billion was lost to 13.1 million victims of digital fraud.[48] One out of three victims was a victim of identity fraud. However, the amount of damage dropped significantly in 2014 to $18 billion in damage impacting 12.6 million victims, showing

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[45] Ibid

[46] Ibid

[47] Ibid

[48] Javelin Strategy & Research report 2014

that financial institutions have put a lot of effort and resources into controlling identity theft. However, many online and offline purchasing points still require users to provide their credit card and other personal information. At the end of the day, users still do not have full privacy over their personal information. Thus, it seems that incremental efforts and solutions provided by financial institutions only solve the symptoms and not the root causes of the problem. Blockchain may be able to provide the solution to address the root cause of identity fraud. Not only can the blockchain-based digital identities improve cybersecurity, they can also substantially reduce the cost of digital identity maintenance.

Blockchain-based digital identities allow customers to have full control and protection over their personal and financial information, while still enabling seamless payment experiences. Customers can choose what information they want to share with websites or other third parties by using an independent blockchain-based identity service instead of using social media information.[49] In addition, the cost of blockchain-based digital identity services is significantly lower than current costs of digital identity maintenance.[50] This cost savings to merchants and financial institutions can be used for a more frequent identity fraud investigations to further lower identity fraud risks.

Apart from protecting customer information, blockchain-based technology also enhances the overall customer experience. First, customers do not have to repeatedly enter their personal information every time they wish to access their emails or purchase goods and services online. How many times a day do customers currently have to input passwords, addresses, social security numbers, and other personal information when they want to purchase things from different websites? Once customers store their

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[49] Javelin Strategy & Research report 2014

[50] Ibid

personal information in a blockchain-based digital identity, the information can be used with different online merchants, different email accounts, etc. This not only enhances the customer experience, it also reduces the probability of identity theft and exposure to hacking as there are fewer places where customers need to input their information. Second, blockchain technology increases the consistency and credibility of ratings and reputations of merchants, making it easier for customers to evaluate sellers. Although many e-commerce companies such as Amazon, eBay, and Best Buy provide a relatively reliable ratings system, the ratings and credibility of the specific merchant are only limited to purchases on that particular website. Blockchain allows a merchant's reputation to be transferable throughout the Internet. This would incentivize merchants to provide good services, as one bad rating can really hurt their overall reputation. This ultimately enhances the overall customer experience.

For merchants, the main benefits of blockchain-based digital identities are lower costs of identity theft, and the convenience of seamless payments. Even though financial institutions provide a certain level of protection for both customers and merchants in online transactions, every year, many merchants still have to reimburse financial institutions for fraud claims by customers. Some cases are caused by internal mistakes, some cases are caused by hackers, and some cases are caused by fraud.[51] Using blockchain-based digital identities reduces chargeback fraud and consequently reduces the reimbursement amount covered by merchants. Furthermore, the technology makes it easier for customers to execute a transaction, as they do not have to input their identity verification several times. It also decreases the rate of cart abandonment. Moreover, blockchain technology also provides access to buyers all over the world, increasing a merchant's customer base. Lastly, the technology greatly reduces costs and increases the speed of identity verification compared to the current process of fraud prevention,

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[51] Javelin Strategy & Research report 2014

which is expensive and time-consuming.[52]

3.5   Verifiable data and documentation

Another benefit of blockchain is immutability in documentation. Data that has been recorded using the Bitcoin blockchain is immutable, meaning that it cannot be changed once it is input in the system. Please note that currently only the Bitcoin blockchain is immutable as this is the only system that has enough network effect to perform "proof of work", complex calculations using thousands of nodes globally.[53] Furthermore, records on blockchain are in chronological order and time-stamped. Since the time of each record is documented, the time of particular record, which may consist of an image, a video, a payment transaction, etc., can be proved irrefutably. When data is recorded into the Bitcoin blockchain, the system generates a hash (similar to a notary or stamp) that can be seen and verified by anyone. After the data has been recorded, anyone in the system can prove the existence of the transaction by matching the hash given to him or her to the hash stored in the blockchain system.[54] If these records have been changed, the matching would fail. This feature is what makes Bitcoin blockchain immutable.

This is a significant breakthrough in record keeping. Blockchain technology can help societies leapfrog the way information is documented and verified. One use case is in the convenient and rapid recording of data regarding legal documents, intellectual property, or any intangible property. In addition, the time stamp feature allows users to verify when each particular record was input in the system, eliminating the need for notaries.[55] In addition, blockchain can also substantially reduce corruption in societies.

[52] Ibid

[53] Taylor, Simon, "Blockchain: understanding the potential", 2015

[54] Ibid

[55] Ibid

Because records are better retained, transparency in documentation is increased while the process of auditing is greatly simplified. Several developing countries such as Honduras have already started initiatives to explore the use of blockchain to help decrease corruption within the government.[56]

3.6 Interconnectivity of Smart Devices

As the world becomes more interconnected by billions of smart devices, software, and hardware, behind-the-scenes cyber infrastructure become increasingly important. Over time, cyber infrastructure has moved from a single or a few nodes of computers to a more decentralized but integrated network of smart devices including computers, phones, tablets, etc. Some people refer to this interconnectedness of billions of smart devices and the ability to collect and exchange data on these devices as the internet of things (IoT).[57] Security, privacy, interconnectivity, and scalability in this IoT world have become more important than ever, and have attracted a lot of attention from many companies and developers.

Concerns of security and privacy have appeared several times in previous use cases and are also the main issues in cyber infrastructure. Users input an enormous amount of information into the internet, including personal, social, financial, or behavioral information. In some cases, companies such as Facebook, Google, or Amazon know about more you more than you know about yourself; in one New York Times article, the author told a story about how Facebook can generate advertisements targeting pregnant women before these women even know they are pregnant.[58] Of course, this is not an issue if the wealth of information is put into good use, allowing these companies to

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[56] Ibid

[57] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[58] Case in MIT Digital Marketing class

better understand customers and create more suitable products. However, the amount of information circulated in the cyber world is substantial, and this information is prone to theft. The best solution for preventing this problem is decentralizing all the data. The centralization of data permits certain parties such as governments or hackers to use and exploit devices and data without users' consent, whereas the decentralizing of data makes it much more difficult for outsiders to get hold of a large user database, and thus greatly reduces the risk of security and privacy breaches.[59]

The second concern that comes with centralization is the high probability of a large spillover effect in case failure occurs. If a centralized system is compromised, casualties could be everyone in the community. With blockchain, damage is limited to a single or limited data point or transaction. So, in terms of costs and benefit, blockchain technology also lessens incentives for hackers to breach a system.[60]

Third, if each manufacturer creates and manages its own centralized platform, society takes on a dead weight loss as the interconnectedness between devices is limited. This problem also limits creativity and innovation for developers, as they have to choose which platforms to develop their ideas to serve a small customer segment. On the other hand, blockchain, like the internet, is owned by the public. Blockchain technology enhances the interconnectivity between smart devices, and allows developers to become more innovative. Moreover, customers do not need to worry whether their smart devices will continue to function if the original manufacture experiences bankruptcy or ceases to exist.

Fourth, verifying whether these smart devices work properly and are connected properly can be an obscured process, especially if only a single entity owns the access

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[59] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[60] Ibid

rights. One recent example is the FBI's request for access to all Apple devices.[61] User information is prone to manipulation or other kinds of abuse if the process is opaque. Blockchain technology makes the data transfer and auditing process more transparent, as authority and trust are not put in the hands of a single entity. The use of decentralized trust in blockchain technology helps address this problem by making all actions from inputting to auditing the data more transparent.[62]

Lastly, if electronic devices are managed on their own centralized systems, operating and maintenance costs could become very high. As more and more smart devices are connected, customers expect these devices to be connected in a seamless manner; data transfer and storage should be easy, and the device's capability should also last for a certain period of time. With a decentralized blockchain system, manufactures can push down the cost of maintenance, while consumers can also feel confident that their data and the functionalities of their smart devices will last regardless of the manufacturing company's long term existence.[63]

In conclusion, the interconnectivity of smart devices makes the world more integrated, but if not manage properly, the benefits could easily turn into disadvantages. Blockchain-based decentralization can be the solution that provides preventative measures to potential problems and enhance seamless experiences across all smart devices.

3.7   Data storage and analysis

Currently, many people use cloud storage to store their data online. Companies such

[61] Zetter, K., "The FBI drops its case against Apple after finding a way into that iphone", 2016

[62] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[63] Ibid

as Amazon, Dropbox, and Google are the main providers of cloud storage.[64] Customers usually receive a certain amount of storage for free; if they would like to increase the storage amount, they can pay a monthly subscription fee. Subscription fees range from $5 per month to much higher, depending on the amount of extra storage space.[65] Imagine instead of paying these providers subscription fee, we can leverage blockchain technology to create a free "Uber of cloud storage" in which an individual's data can be stored securely on another individual's hardware.[66] By leveraging the blockchain network, costs of cloud storage can be significantly lowered while increasing availability and security.

Like Uber, blockchain technology leverages existing hardware infrastructure including personal hard drives and other storage devices to create an inexpensive and efficient distributed network of cloud storage. Since this method does not require any new construction of data storage, naturally, it is substantially cheaper than services offered by cloud storage providers. Furthermore, blockchain-based data storage also allows people with free data storage to gain additional income by renting out their free storage space, making society as a whole more efficient.[67]

Apart from cost reductions and increased efficiencies, blockchain-based data storage is likely to be more secure than those offered by existing cloud storage providers. While current cloud storage providers keep data in a centralized manner, blockchain technology shreds data into millions of pieces and spreads these pieces across a distributed network of available nodes.[68] Centralized cloud storage can easily be accessed if hackers can bypass a service provider's security. On the other hand, hackers

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[64] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[65] Benchmark of storage fees from 5 largest providers

[66] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[67] Ibid

[68] Ibid

need to access thousands of computers in the decentralized blockchain system, locate the right files within each computer, and then put together the information.[69] Furthermore, if an individual renting out storage space in the blockchain system tries to access a shredded piece of information, the network will identify the individual as a "bad" node, ban the individual from the network, and transfer that particular shredded piece of information elsewhere.[70] Moreover, each shredded piece of information is stored with adjustable levels of redundancy to protect data integrity. So, for more valuable data, customers can pay a little more for a higher level of redundancy. In terms of speed, since data is simultaneously downloaded from various nodes across the system, download speeds from a blockchain system is much higher than those from a single location.[71] These characteristics make decentralized blockchain-based data storage significantly more secure than current centralized cloud storage systems.

Lastly, data can be stored for an endless period of time in a decentralized blockchain-based system. When individuals providing storage space delist their nodes from the system, the pieces of information stored on their computers will be automatically be moved to other available locations. In contrast, data stored with cloud service providers would be lost if these providers cease to exist or if the centralized data storage is breached.[72]

In summary, blockchain-based decentralized data storage offers a customized, cheap, and secure way to store data for different customers. Customers who want more security for valuable data can purchase more nodes for more shredding and redundancy of data storage. Customers who value speed can purchase more nodes with closer

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[69] Ibid

[70] Ibid

[71] Ibid

[72] "Blockchain: The Next Big Thing or is it?", The Economist, May 2015

location proximity. Customers who just need somewhere to store relatively less valuable data can leverage a distributed network and store data at no cost.[73]

Despite all potential applications of blockchain technology described above, it is not without its flaws. Within the realm of payments, the rigid supply chain of Bitcoins can cause price fluctuations, the anonymity of trades may encourage illegal transactions, and hackers and criminals may still compromise its security. Outside the realm of payments, the use of blockchain technology is still relatively primitive and would require a substantial amount of work on proof of concepts before they can be officially implemented. In addition, only a handful of people in the world have knowledge about this technology, and it may take a lot of effort and time to educate new users. In the next section, I will provide an overview of the Thai payment system and describe in further detail the challenges of applying blockchain technology to the area of payments.

4. Payment system in Thailand

4.1 Overview

In Thailand, payments volume accounts for five percent of the national gross domestic product (GDP), with the average total volume as high as 300 billion Baht or approximately $8.33 billion in 2015.[74] A country's payment system and infrastructure form the backbone of its economic activity; after all, they dictate the efficiencies of economic activities such as how funds flow, how funds are cleared and settled, how transaction fees are structured, etc. The better the backbone, the greater the volume of economic activity. On the other hand, it is also equally important to pay attention to potential risks, especially systemic risks that may arise due to issues such as lack of

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[73] Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[74] Tanai K., The Oversight of Payment Systems, 2014

credit and security. These risks not only decrease the efficiency and seamlessness of transactions, but can also compromise the stability of the whole financial system.

Apart from the long-term goal of successfully managing price stability, in the short term, the majority of central banks around the world aim to minimize financial instability in their domestic financial systems, with the payment system as one of the main enablers of stability.[75] Due to the sheer size of payments volume and global technological advancements in the area of payments, many banks in Thailand, including the central bank, Bank of Thailand (BOT), have started to invest in and initiate series of projects to transform the traditional payment system into one that is more seamless and efficient. The BOT plays an important role in the Thai payment system in three areas: regulations, product offerings, and facilitation for all players in the payments ecosystem. The objective of this section is to provide an overview of the payment system in Thailand and point out some potential challenges in the system that can be addressed by blockchain technology. In this first section, I will provide an overview of the payment system in Thailand, covering:

1. Conceptual overview and infrastructure of the Thai payment system

2. Organizational structure and hierarchy of the Thai payment system

3. Challenges and inefficiencies faced by the Thai financial industry in terms of regulation, technology, and other relevant aspects

Generally speaking, payments can be divided into two types: cash and non-cash. The more popular type of payment in Thailand as well as the rest of the Asia Pacific region is still cash, which includes bank notes and coins. Cash payments account for approximately 90 percent all transactions in the system in 2010.[76] However, growth in cashless transactions has been phenomenal, and growth momentum is expected to

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[75] Capie, 1994

[76] McKinsey Global Payments Map

continue. Non-cash payments consist of cheques, promissory notes, bills of exchanges, electronic fund transfers, and other methods of electronic transfer.[77]

Share of cash in number of transactions, 2010
Percent

India	99.7
Indonesia	99.5
China	98.0
Thailand	97.1
Malaysia	92.5
Taiwan	82.9
Japan	76.8
Korea	65.6
Singapore	65.2
Australia	63.1
Hong Kong	55.1

Growth in cashless transactions, 2010-2015
Percent

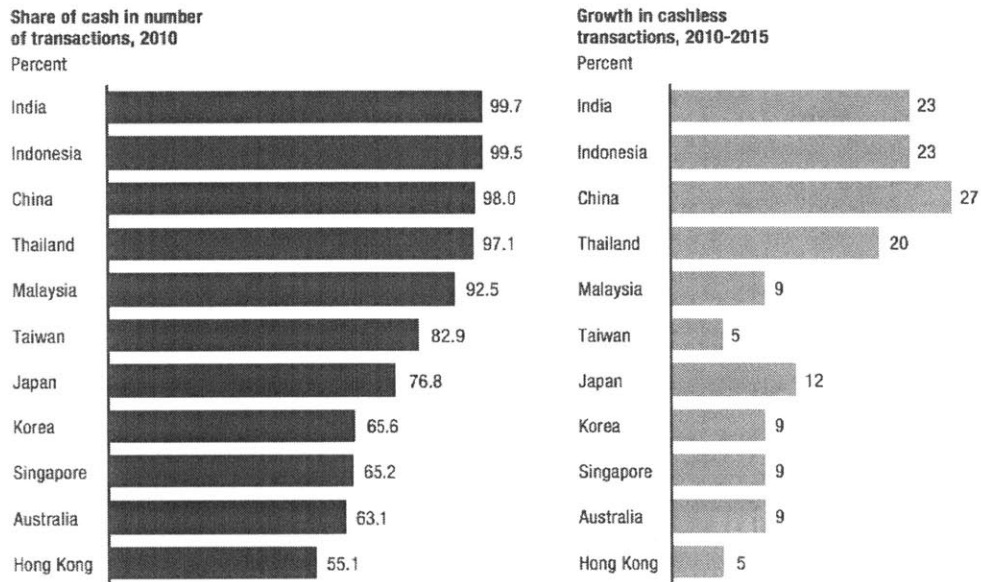|	
India	23
Indonesia	23
China	27
Thailand	20
Malaysia	9
Taiwan	5
Japan	12
Korea	9
Singapore	9
Australia	9
Hong Kong	5

Figure 4.2 Cash Transaction Trend in Asia Pacific

Source: McKinsey Global Payments Map

Payments can also be categorized by payment schemes. Schemes are essentially how payments are set up and how they are settled, and include the infrastructure payments are processed through and service providers. In Thailand, payments service providers can be divided into three major parties, namely the central bank, commercial banks, and others.[78]

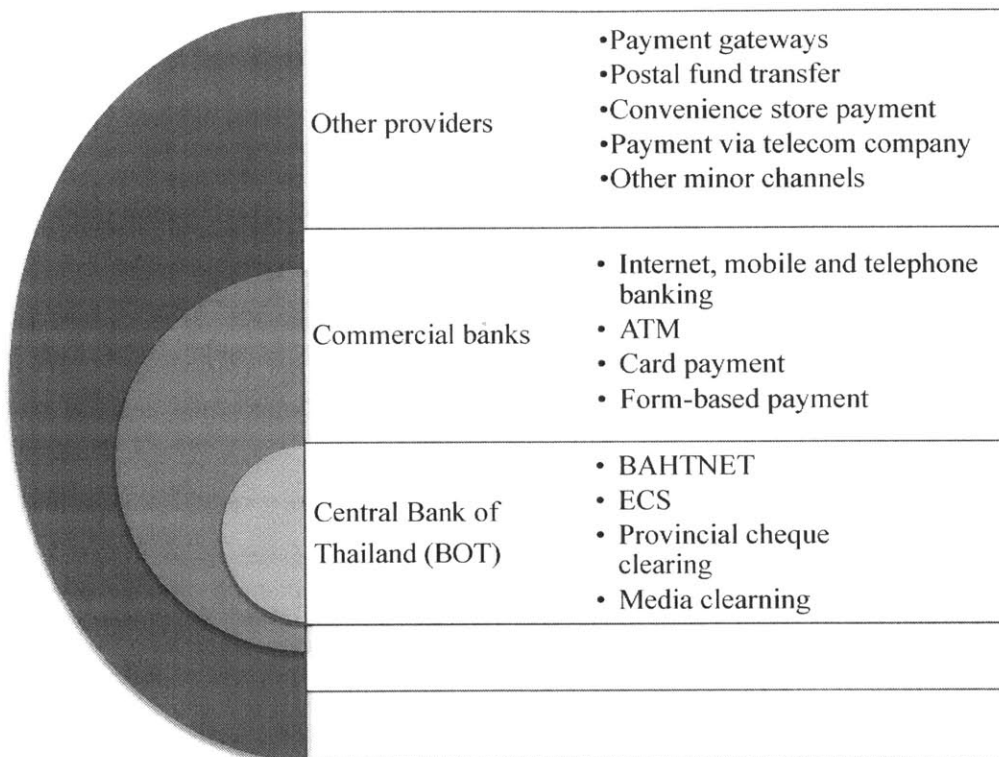[77] Ibid

[78] Lavita S., Thai Payment Strategies, 2014

Figure 4.3 Different Types of Payment Schemes and

Payment Service Providers in Thailand

Source: Tanai K., The Oversight of Payment Systems, 2011

The first layer is the payments scheme provided by BOT. This payments scheme mainly serves as the payment infrastructure between banks, large financial institutions, and other organizations with deposit accounts in BOT.[79] Bank of Thailand Automated High-value Transfer Network (BAHTNET), launched in May 1995, is a payment system that supports the Real-Time Gross Settlement (RTGS) of large value fund transfers.[80] The Electronic Cheque Clearing System (ECS) handles the clearing of cheque payments between financial institutions, while provincial cheque clearing

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[79] Bank of Thailand,

https://www.bot.or.th/English/PaymentSystems/PSServices/bahtnet/Pages/default.aspx

[80] Ibid

handles the clearing of cheque payments across different provinces in Thailand.[81] Last but not least is media clearing, which is a payment system that handles all small value fund transfers.[82]

The second layer is the payment schemes provided by commercial banks. This consists of all card-based, formed-based, ATM, and different types of electronic transactions within each commercial bank. Even though this payment scheme is operated by commercial banks, the payment scheme and overall operation are indirectly controlled by BOT. These commercial banks also need to comply to the Commercial Bank Act of 1962.[83]

The last layer is the payment schemes provided by non-financial institutions. Operations of these non-financial institutions are not subject to BOT supervision.[84] This last type of payment scheme consists of payment services offered by post offices, convenience stores, telecommunication companies, and other private companies. This type of payment scheme has just emerged in Thailand in the past few years, but has experienced a tremendous growth. An example of a well-known non-financial payment scheme is the one provided by telecommunication companies in Thailand such as Pay Sabuy and True Money. Another well-known scheme is provided by convenience stores such as Seven Eleven.[85] This type of payment is becoming very popular mainly due to the low transaction fees compared with commercial banks even for very small transaction amounts.

[81] Ibid

[82] Ibid

[83] Lavita S., Thai Payment Strategies, 2014

[84] Ibid

[85] Ibid

4.2 Challenges in the Thai payment system and potential solutions offered by blockchain

In the early 1990s, BOT launched an initiative to transform the Thai payment system with the following goals: to modernize the payments clearing system, and to develop a new electronic payment system that will bring the country towards a more efficient non-cash era.[86] The central bank has reviewed and amended many financial regulations to meet and match consumers' needs while trying to maintain domestic financial stability. However, changes have not been executed fast enough to adapt to rapid advances in international financial technology and the market. There are still many challenges that need to be addressed in the Thai payment systems. In the sections below I outline the key areas for improvements.

4.2.1 Regulation

Regulation plays a very important role in the Thai financial system, especially in payments. Even though many developed countries have created explicit regulatory frameworks and passed legislation regarding their payment systems, many other developing countries such as Thailand still rely on existing regulations, which may be unclear. In Thailand, law and regulation on payments have not been reviewed to support the fast changing payments landscape, and many areas of regulation have been left for individuals to implicitly interpret. Examples of existing legislation related to payments include the Bank of Thailand Act of 1942, the Commercial Banking Act of 1962, and the Currency Act of 1958.[87] These acts and legislations barely or do not cover the area of information technology, cyber fraud, electronic transfer, etc.[88] The Thai government

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[86] Bank of Thailand, 2015. Payment Systems in Thailand., Bangkok

[87] Ibid

[88] Ibid

has been trying to reform financial regulations, but the speed of implementation has been extremely slow.

Even though blockchain cannot be used to speed up regulatory reform, it can be used as a workaround solution to address some issues that are not addressed by current regulations. One area that that blockchain technology can provide a workaround solution for is cyber security. Since all transactions are recorded in a public system and cannot be altered once recorded, the revised regulations can be backdated, therefore discouraging people from committing fraud. In addition, blockchain technology in and of itself reduces the amount of security fraud as users have full control of their payments, as described in an earlier section. Thus instead of waiting for regulatory protection, blockchain technology strengthens fraud prevention and indirectly reduces the urgent need for regulatory reform.

4.2.2 Technology

Apart from regulatory challenges, there are also obstacles related to technology. There are three key technology-related concerns in the Thai payment system that the government is trying to address. The first is local commercial banks' lack of IT competency. At present, most local commercial banks outsource almost all of their software services to so-called Application Service Providers, which are usually overseas IT firms.[89] It is true that this strategy can save a significant amount in costs for commercial banks in the short run, but in the long run, these local commercial banks will suffer from not having built an IT competency. To make things worse, more players such as foreign banks and non-financial IT service providers may enter the market and increase competition.

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[89] Tanai K., The Oversight of Payment Systems, 2014

Second, some commercial banks are still using virtual private networks (VPNs), instead of secured proprietary networks for fund transfers.[90] Currently, there is a huge debate about whether or not to regulate these smaller commercial banks that use a VPN system, which helps save transactional costs.[91] The concerns are mostly related to security issues, as fund transfers made using a VPN have to pass through a public network.

Lastly, there is concern in duplicated investment costs, and not to mention high maintenance costs.[92] The combined amount of investment by all commercial banks in Thailand into the payment system is very high. Furthermore, there is no interoperability between banks, hence customer experience worsens due to this walled garden. BOT is trying to create a new system that is based on more open and shared payment infrastructure, but so far nothing concrete has materialized from the discussion.[93] Customers still need to pay very high transaction fees when transferring funds between different financial institutions. Customers sometimes also have to pay a fee for transferring funds across different provinces within the same financial institution.[94] This leads to inefficiencies in the overall financial system, and a disconnected user experience.

Blockchain technology can help address this technological challenge of the Thai payment system in many ways. First, with blockchain, there would be no need to train staff on proprietary systems in skills that may quickly become obsolete. In addition, there would be no need to invest in building a new system, as blockchain is already a system that is available to the public. Even though it is a public network, transactions on the network are verified by the consensus of a large network of nodes around the globe,

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[90] Ibid

[91] Ibid

[92] Bank of Thailand, 2015. Payment Systems in Thailand., Bangkok

[93] Tanai K., The Oversight of Payment Systems, 2014

[94] Ibid

in contrast with VPN, which is controlled by a handful of individuals. With blockchain, the overall efficiency of the payment system in terms of investment costs and infrastructure can increase since all financial institutions would share the same infrastructure. Furthermore, from the customer point of view, their experience is enhanced with significantly reduced transaction costs.

4.2.3   International remittance

The last type of concern in the Thai financial payment system is related to cross-border transactions and its underlying payment infrastructure. Fund transfers between different countries in Asia, especially in Southeast Asia, are very inefficient.[95] There are high transaction fees, high foreign exchange settlement exposure, and a long settlement duration. Examples of current payment systems that are in place include Continuous Link Settlement (CLS), the Hong Kong dollar clearing systems offered by the Hong Kong Monetary Authority (HKMA), and the Worldwide Automated Transaction Clearing House (WATCH).[96] The first two systems are used for large fund transfers, while the latter is usually used for smaller payment transactions. Similar to the walled gardens in the payment systems of commercial banks, these systems are not linked in a seamless manner, creating higher foreign exchange exposure and a longer settlement duration.

Blockchain technology is a public system that can be used by all parties regardless of nationality and location, greatly reducing the needs for multiple payment platforms owned by each country, and allows transactions to be conducted in local currencies. Consequently, since a cross-border payment transaction conducted using blockchain technology would be executed just once through a single platform, the foreign exchange

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[95] Tanai K., The Oversight of Payment Systems, 2014

[96] Bank of Thailand, 2015. Payment Systems in Thailand., Bangkok

exposure that may otherwise be incurred from having to process the payment through several payment platforms is reduced.

4.3 Challenges of Blockchain technology in payments

Bitcoin blockchain technology faces many challenges that may undermine its future adoption and viability. These challenges must be addressed in order for Bitcoin blockchain technology to achieve its full potential.

4.3.1 Rigid supply of Bitcoin

We know from macroeconomic theory that the main mechanism central banks use to implement monetary policy is the control of money supply. Each central bank decides when and how much money to issue depending on economic conditions. With Bitcoin, there is no central authority to monitor and control the money supply. In the Bitcoin system, issuance of the digital currency is automated and depends on certain programmed parameters.[97] Thus, the supply of Bitcoin is rigid, causing high volatility in the exchange rate.

Many Bitcoin supporters argue that if Bitcoin is used as a store of value or a unit of account, the problem of vitality is understandable as Bitcoin is only at its early stage of development with a limited number of users. However, if it is used as a medium of exchange, then volatility is less of a problem.[98] Bitcoin's fluctuation in price can rapidly be mitigated by first quoting items in their fiat currency, exchanging them for their Bitcoin-equivalent, and then immediately selling them in their fiat currency again.[99]

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[97] Bank of England, "The economics of digital currencies", 2014

[98] Ibid

[99] Ibid

In the world of economics, many questions still remain unanswered. If Bitcoin experiences a recession, who serve as the lender of last resort? Should there be a central authority to control and monitor the issuance of the digital currency? Before Bitcoin becomes mainstream, many of these important economic questions need to be answered.

4.3.2 Association with illegal activities

The pseudonymous nature of Bitcoin transactions makes it a natural channel for criminals to try to exploit and conduct illegal activities.[100] However, this does not mean that Bitcoin itself is illegal. Just like cash, it can be used for legal and illegal transactions.

One famous example of an illegal use of Bitcoin is the case of the online black market Silk Road. Silk Road was a marketplace for the illegal trading of drugs, weapons, child pornography, murder commissions, etc. In 2013, the Silk Road market was shut down by the FBI, and more than 144,00 Bitcoins were seized.[101] After the news came out, the price of Bitcoin dropped drastically by more than 30 percent.[102]

The use of Bitcoin in these events raises concerns among potential legitimate users and has attracted more regulatory scrutiny by governments around the world. Many governments issued warnings about cryptocurrency and some even ban it. In 2014, three Chinese state-owned banks announced that they would forbid all account holders from engaging in Bitcoin transactions.[103] As a result, the price of Bitcoin dropped over 10 percent as traders feared further crackdown by the Chinese government, as the Chinese

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[100] Hagiu, A., "Bitcoin: The Future of Digital Payments?", 2014

[101] Ibid

[102] Ibid

[103] Paul Vigna, "Bitcoin Prices Down 10 percent After Chinese Banks Cut Off Local Exchanges," Wall Street Journal, April, 2014,
http://blogs.wsj.com/moneybeat/2014/04/10/Bitcoin-prices-down-10-after-chinese-banks-cut-off-local-exchanges/

Bitcoin market accounted for more than 50 percent of Bitcoin trade in 2013.[104]

These are the main challenges in the payment system using Bitcoin blockchain technology. Nonetheless, many entrepreneurs still believe in the future of Bitcoin and have put in an incredible amount of time and effort on speeding up its adoption. In my opinion, the future of Bitcoin will be determined by both internal and external factors. Internally, continuing development will enhance its reliability, accessibility, and eventually adoption by a larger audience. However, meeting these internal factors will not suffice, as external factors such as cooperation from different stakeholders (including governments, merchants, and businesses) will also play important roles in determining the future success of this technology.

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[104] Alex Wilhelm, "Bitcoin Slips Following News of Fresh Restriction in China," TechCrunch, April, 2014, http://techcrunch.com/2014/04/27/Bitcoin-slips-following-news-of-fresh-restrictions-in-china/

5. Conclusion

Some people are excited about blockchain because of its technical role in supporting Bitcoin, while others are more interested in its potential applications beyond the realm of cryptocurrency. Many well-known investors such as Peter Thiel, Eric Schmidt, and John Reed and large financial institutions such as Nasdaq, Goldman Sachs, Citigroup, and Barclays have started to pay serious attention and make investments in blockchain technology. Furthermore, top universities such as MIT and Stanford also have initiated many projects to explore the potential of this technology.

The examples of blockchain applications laid out in this thesis – payments, digital assets, smart contracts, identity, verifiable data and document, interconnectivity of smart devices, and data storage – represents just the beginning. Specifically in payments, Bitcoin blockchain technology has come a long way since 2008. It has the potential to alleviate inefficiencies in Thai payment system, and shows clear advantages such as cost savings and shorter settlement duration. Credibility and confidence will increase as regulations and the ecosystem mature. The maturity of the ecosystem will not happen overnight. It will likely be a slow process, overtaking market segments one by one. Moreover, in order for the ecosystem to mature, challenges such as regulation, volatility, and trust have to be addressed.

Lastly, recent illegal activities have attracted some negative attention to Bitcoin blockchain technology. As governments around the world put blockchain technology under more scrutiny, it may become more difficult to explore the possibilities and opportunities that the technology has to offer. Nonetheless, many blockchain enthusiasts still believe in the long-term future of the technology. Will blockchain achieve mass adoption? Only time will tell.

Bibliography

[1]   Allsopp, Peter., and Whitmore, Paul, 1999. Thailand DVP Report, Bank of Thailand

[2]   Bank of Thailand, 1995. The Bank of Thailand Regulation on BAHTNET

[3]   Bank of Thailand, 1996a. The Bank of Thailand Regulation on ECS

[4]   Bank of Thailand, 2013. Payment Systems in Thailand., Bangkok.

[5]   Bank of Thailand, 2015. Payment Systems in Thailand., Bangkok.

[6]   Karp Nathaniel, "Blockchain Technology: The Ultimate Disruption in Financial System", BBVA Research, 2015

[7]   Bogart, Spencer, "The Blockchain Report: Welcome to the Internet of Value", Needham Insights, 2015

[8]   Narayanan, Arvind, "Bitcoin and Cryptocurrency Technologies" (Draft), 2016

[9]   Zyskind, Guy, "Decentralizing Privacy: Using Blockchain to Protect Personal Data", 2015

[10]   "Blockchain: The Next Big Thing or is it?", The Economist, May 2015

[11]   Marc Andreessen, "Why Bitcoin Matters," New York Times, January, 2014, http://dealbook.nytimes.com/2014/02/21/why-Bitcoin-matters

[12]   Nakamoto, S, "Bitcoin: A Peer-to-Peer Electronic Cash System," http://Bitcoin.org/Bitcoin.pdf

[13]   "Number of Transaction Per Day," BlockChain, http://blockchain.info/charts/n-transactions?showDataPoints=true&show_he ader=true&daysAverageString=7&scale=0

[14]   "Pizza for Bitcoins?" Bitcoin Talk, https://Bitcointalk.org/index.php?topic=137.msg1195#msg1195

[15] Taylor, Simon, "Blockchain: understanding the potential", 2015

[16] Davis, Joshua, "The Crypto-Currency: Bitcoin and its mysterious inventor", The New Yorker, 31 October 2014

[17] Tim Harnyak, "Mt.Gox Bitcoin price falls below $100 as withdrawal suspension continues," PCWorld, February, 2014, http://www.pcworld.com/article/2100100/mt-gox-Bitcoin-price-falls-below-100.html

[18] Furlonger, D., "Guest column: The Future of Money," Gartner, 2012

[19] The Boston Consulting Group, "Global Payments 2014", September 2014

[20] Tanai K., The Oversight of Payment Systems, 2014