Saxion University of Applied Sciences

Bachelor's thesis

BLOCKCHAIN TECHNOLOGY IN BANKING INDUSTRY

Presented by

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Academic year 2019-2020

June 2020

Abstract

This paper is a review of the literature on blockchain in relationship with banking sector, which is facing numerous problems. Compared to the current trend in technological development, the traditional uncompetitive banking system is non-transparent, complicated with multiple records kept separately and various intermediate parties which in consequence, give rise to multiple costs, transaction time and dispute in banks, especially in case of international payment. A strategy to deal with financial inclusion is also an issue, along with the lacking credit information system. These problems, however, can be addressed by applying blockchain, or distributed ledger, which is a newly emerging technology with tremendous potential mainly from its nature of generating a single transparent record and the ability to eliminate unnecessary intermediaries.

The paper provides basic concepts of blockchain technology, identifies some prominent problems in banks along with specific potential benefits, and afterwards collects and reviews actual cases. The review is organized around three research questions. The researched knowledge on these questions is summarized and questions for future researches are also included.

Acknowledgment

This research paper is submitted for the graduation Bachelor thesis of program International Financial and Accounting at Saxion University of Applied Sciences. This research topic plays a crucial part in my study progress and is the key determinant for fulfilling the graduate requirements of my program.

Throughout the process, I would like to express my thankfulness to people who supported me in finishing this research. I am truly thankful to my first supervisor, Mr. Kramer for always being supportive, willing to discuss the difficulties I was going through and giving me constant feedback in order to improve my paper. I would also like to extend my gratitude to Mr. Veuger, thanks to whom this research topic was initiated, and who gave me valuable feedback during my thesis execution.

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Chapter 1: Introduction

1.1. Problem Description

This topic was initiated by my company coach, Jan Veuger, a lecturer and professional in blockchain technology at Saxion University, who has taken notice of the current trend in applying blockchain technology and the existence of problems in the banking industry. The research is performed based on his given topic, to investigate the current knowledge surrounding these subjects and answer some pending related questions, in anticipation of a contribution to different aspects regarding this newly-developed technology, complementing the current developing literature body.

Blockchain – a relatively new technology – is defined as a public ledger system which maintains the integrity of transaction data (Yli-Huumo et al., 2016), or a distributed database of records of every transaction, digital events that have been executed and shared among the parties that participate in it (Crosby et al., 2016). As described by Guo & Liang, blockchain has been recognized as "a disruptive innovation of the Internet era" and "a major breakthrough in data storage and information transmission" (2016). Its characteristic is documented by Crosby et al. as a system in which information can never be erased once they are entered, thereby, contains a certain and verifiable record of all transaction ever made, opening the door for a democratic open and scalable digital economy from a centralized one (2016).

Blockchain was initially developed as the technology behind Bitcoin, a renowned cryptocurrency, functioning as a worldwide distributed ledger which is capable of recording anything of value (Tapscott & Tapscott, 2017) and was identified as Blockchain 1.0, nonetheless, its unlimited potential results in the introduction of Blockchain 2.0 for economic, market and financial applications and Blockchain 3.0 for applications beyond finance, markets and currency (Perera et al., 2020). Yli-Huumo et al., while studying current researches on this new technology, acknowledge the fact that even though Bitcoin is still the most common application used, the applications of Blockchain are not limited to cryptocurrencies but it could furthermore be applied in different environment (2016). This is also in unison with Crosby et al.'s statement, stressing on the fact that Bitcoin is the most popular use case from this technology, however, there is a wide range of other applications in both financial and non-financial world, with endless opportunities (2016).

Due to its far-ranging possibilities, this disruptive technology has raised considerable interest from and is being adopted by numerous firms in the banking and financial-service industry, including banks, insurers, audit and professional service firms (Tapscott & Tapscott, 2017; Treleaven et al., 2017). The increasing use in financial institutions & banks is mentioned by Crosby et al., 2016, exampling different real life applications such as the recent joined forces of nine of the world's biggest banks including Barclays and Goldman Sachs5 with the New York based financial technology firm R3 in September 2015 to create a blockchain-based framework for using this technology in the financial market. This trend is also evident in the effort from Goldman Sachs,

J.P. Morgan, UBS, and other banking giants to establish blockchain laboratories, collaborate closely with blockchain platforms and publish studies on this topic (Guo & Liang, 2016).

Nevertheless, whether this technology can become a leverage for the industry still depends on the different advantages it can bring to each case. The excitement for this new technology, according to Felin & Lakhani (2018), might be warranted, given that the organizations focus on how they can use the technology to support their strategy, in order not to waste substantial investments. The authors at the same time advice companies to resist following the trend before they actually understand what problems they can solve with blockchain and for whom, how it will help them with reaching new customers, with improving efficiency or transparency in their supply chains, for example. Consequently, this leads management to a substantial question: Is blockchain the right answer for solving the existing problems?

The majority of current blockchain research field still surround the basic information regarding definition, overall benefits and advantages since blockchain is still a newly employed technology (Crosby et al., 2016). There are already paper addressing the impact of blockchain on banks (Tapscott & Tapscott, 2017; Guo & Liang, 2016; Lewis et al., 2017), however, they mainly incorporate general problems & benefits and not much evidence is present. The current literature field is still under-developed which makes room for a variety of questions to be generated and researched.

This paper aims to achieve an insight into the application of blockchain technology with the scope limited to banking industry, discussing the potential benefits it can bring, and eventually, answering the question of whether blockchain can actually solve the existing problems specifically in this sector.

1.2. Research Question

1.2.1. Main Question

In this study, the following main question is to be answered:

Can Blockchain Technology solve the existing problems in the banking industry?

1.2.2. Sub Questions

In order to answer the Main question, the research is planned based on reviewing literature and synthesizing information regarding blockchain in banking to answer the sub questions. First, in answering the question of whether blockchain technology can solve the problems or not, the problems existing for the banking industry need to be identified. From understanding the specific problems, this paper will address the benefits blockchain technology could bring specifically to the case of banks, comparing with the pre-mentioned problems (applying general benefits in theoretical framework to the case) to figure out if those benefits/features can be of help to solving these issues or not. Finally, the research looks into cases/initiatives of blockchain-based application in banking sector, thereupon gives evidence on whether those problems can actually be solved by blockchain or not.

The sub questions for this paper are:

- What are the existing problems of banking industry?
- What are the potential benefits of blockchain in banking which can help with solving the problems?
- What are some initiatives/use cases which can prove the usefulness of blockchain in solving the problems?

1.2.3. Limitation and disclaimer

On request of company coach, the scope of this paper is limited to the use of blockchain on banking industry, focusing purely on the advantages instead of disadvantages in order to answer the main question. In answering this main question, the paper wants to focus more on the ability to use blockchain's advantageous aspects in a way to solve banks' problems, instead of comparing benefits and drawbacks when using it to deal with problems, thus, the disadvantages are considered irrelevant and are overlooked when researching.

Since it is a new technology, the literatures are limited, therefore, besides sources from scientific articles, the knowledge is also generated from reading online newsletters, professional conferences and websites from some related famous organizations, such as bank, blockchain community.

1.3. Research Methodology

Literature review

This paper is going to answer the questions based on conducting a substantial literature review on blockchain in banking and analyzing its applications. A theoretical framework is developed from studying existing literature and the general knowledge about blockchain which is related to answering the main question.

In this study, a literature review will be performed. Through reviewing literatures, the paper investigates the existing knowledges and finds evidence related to answering the research questions. The process of screening and analyzing literatures is to understand current information regarding blockchain technology and banking system, from which the problems in banking sector and advantages of blockchain can be realized, and an analysis of these information to give answer to the questions can be performed. Besides reviewing articles from journal, since blockchain technology is still relatively new, other types of literature are also taken into consideration to broaden the evidence and get more current knowledge on the topic, including white paper, technical report and newsletter from trusted websites.

However, the methods used vary for each sub question, depending on the information needed to get the answer.

For sub question 1, the general method of literature review of scientific articles is used, along with non-scientific papers to find the problems and evidences. Besides searching for articles related to banks, banking technology and problems, before reviewing, I read different newspapers and

searched for reports from current banks who are engaging in developing blockchain technology in order to generate initial ideas about the banking system and problems considered relevant in the banking industry. Afterwards, evidences are collected and analyzed through articles.

In sub question 2, to find out specific benefits of blockchain technology on banking industry, I reviewed existing scientific articles related to blockchain application in banks. Other white papers with the topic regarding blockchain, distributed ledger technology in banking, financial sector are also analyzed. The literatures are collected from the main databases chosen for this research; however, white papers are also searched for through Hyperledger website, which is a trusted open source community for blockchain deployment.

For sub question 3, the aim is to find out whether there are relevant actual cases which can prove the realistic of blockchain's potential ability in solving banks' problems. Because of this purpose, together with the fact that blockchain technology is still new so the already applied cases are also limited, I performed a search on the website of CoinGeek to find relevant and recent application cases. And finally, the information of some related cases is summed up in the form of a table.

Choice of literature

Since not all papers in current researches are related to the research questions, they are assessed for actual relevance. Overall, this paper decides to use specific inclusion and exclusion criteria to screen the resources, including keywords and content screening, exclusion of papers to get more relevant information.

This exclusion criteria consists of:

(1) Paper without full text sources availability

(2) Papers which are not in English languages

Identification of Keywords

In searching for relevant information to answer the sub questions, there are main keywords identified according to the main topic: Blockchain, Banking, Bank, Distributed ledger technology, Finance, Financial, Problems in banking, banking technology, opportunities, benefits. In order to ensure that relevant papers are not missed, and since blockchain is still a new topic, the keywords remain broad with different abbreviations and are searched in different combinations. Besides those general keywords used throughout the paper, other keywords are also generated depending on each specific case to find particular evidence, such as dispute, financial inclusion.

After searching, the papers are chosen for screening if they contain all the keywords used and consecutively the abstracts and keywords assigned for them are investigated. In the case they include too much irrelevant keywords regarding other subjects or topics, the articles are then excluded to prevent too broad information. Nevertheless, since the literature field is still limited, with very few papers targeted directly to the topic, in some cases, even though the title only includes one or parts of the searched term, the paper is also taken into consideration and goes through the process of abstract and contents review to determine it relevance.

Selection of Engines

To ensure the relativity and appropriation of the searched information, reliable and academic sources are determined and used in this paper. The main databases chosen for scientific articles include:

- Google scholar
- Saxion online library and the related databases: ScienceDirect, Research gate

1.4. Research Objective

The paper is generated in order to answer the original given question, enriching the present knowledge regarding blockchain technology and its application, acting as a foundation for future researches about this topic or the related issues. Further, this paper can become a source of reference material for management in getting knowledge about blockchain, understanding its benefits before the actual application process.

1.5. Thesis Structure

In the following chapter, chapter 2, a theoretical framework indicating frameworks used as a background for answering the question in this thesis, is included.

Sub question 1 for the problems existing in banking industry is going to be addressed in Chapter 3 of this paper.

Consecutively, chapter 4 is going to deal with the potential benefits in sub question 2.

Finally, sub question 3 regarding the cases and initiatives are going to be answered in chapter 5 of this research.

Chapter 2: Theoretical Framework

2.1. Technologies behind blockchain which fuel its unique features

How blockchain works

Blockchain is a sequence of blocks, according to Zheng et al. (2018), which keeps a complete list of transaction records like conventional public ledger. These blocks create a sequence, with each block links to the immediately previous block by a hash value from that previous block, which is called the parent block (Zheng et al., 2018), and this chain continues to grow as new blocks are continuously appended (Perera et al., 2020). Blockchain makes use of a decentralized network of nodes to protect the records from being tampered or modified, allowing the participants to view the digital ledger shared over a distributed network in a secure way (Perera et al., 2020). Behind this emerging technology is a combination of multiple concepts, Perera et al. in attempt to analyze potential applications of blockchain in the construction industry, reviewed the key technologies behind blockchain, ranging from peer-to-peer protocols, hashing algorithm, cryptographic primitives such as public-key cryptography to distributed consensus algorithms (2020).

The core blockchain components, addressed by Treleaven et al. (2017), comprise of distributed-ledger technology (DLT) and smart contracts.

Smart contract technology

"Smart contracts are legal contracts written in computer code that execute automatically once certain conditions, specified in the contract, are fulfilled" (Lewis et al., 2017, p. 13). A smart contract constitutes the agreed upon rules by participants to "govern the evolution of 'facts' in the distributed ledger" (p. 15), it can be a computer program attempting to make sure that all transactions comply with the legal agreements and ensure the authoritative records by DLT regarding the existence, status, evolution of the legal agreement they represent (Treleaven et al., 2017). It digitally facilitates and enforces the digital assets transfer following software-defined contract conditions (Casey et al., 2018).

Casey et al. mentions a key property of smart contracts is that there is no trusted third party such as a trustee, an escrow agent required as intermediary between the contracting entities, enforcing the contract execution on its own (2018). The ability of smart contracts lies in reducing friction when transferring value between entities and the development of automated transaction (Casey et al., 2018), serving as a wrapper that moves value and executes the contract's terms automatically, similarly, it has the potential to automate laws and statutes, improving the efficiency and transparency of government services (Treleaven et al., 2017).

Distributed ledger technology (DLT)

A distributed ledger, by definition, is "a decentralized, shared, replicated, and synchronized record of transactions between contracting parties secured by cryptographic sealing" (Treleaven, 2017). According to Lewis et al. (2017), a DLT network is setup based on 3 basic elements: a digital

ledger, a consensus mechanism for confirming transactions and a network of node operators (see Appendix for the virtualization of the setup).

Our current digital economy, which is based on relying on a third party for the security and privacy of our assets, namely an email service provider, a certification authority, a social network such as Facebook, or a bank in terms of money delivery notification, is vulnerable to the hacking, manipulation or compromise of these intermediaries (Crosby, 2016). In this case, blockchain technology can prove to be useful with its ability to enable a distributed consensus, where every online transaction can be verified at any time, without compromising the involved assets and parties' privacy. Together with anonymity, this distributed consensus is one of the two important characteristics of blockchain technology (Crosby, 2016).

Consensus in a blockchain is referred to as a series of procedures related to approving and confirming a transaction or set of transactions through the use of consensus algorithms, which is adopted by most of the public blockchains, alongside Proof of Work, to guarantee that transactions could not be tampered with. Lewis et al. (2017) indicate that all blockchains have a consensus mechanism, which is used to add new blocks to the database, and this mechanism would also differ depending on the blockchain's design, whether it is permissioned or permissionless. While in a permissioned blockchain, the consensus mechanism is affected by the degree in which participants in the network are willing to trust each other and the transaction is confirmed by a permissioning member or cryptographic consensus mechanism accessible only by permissioning members; permissionless blockchains use various algorithms to ensure the transactions' validity and rely on their network of participants in confirming transactions (Lewis et al., 2017).

2.2. Features and Benefits

Decentralization

Blockchain comprises of a decentralized peer-to-peer network, since the main property of the blockchain distributed ledger system is the absence ò centralized data storage mechanism, it provides robustness and eliminate many-to-one traffic flows, avoiding delays and single point of failure (Perera et al., 2020). Casey et al. (2018, p.14) highlight the potential of blockchain: "[..] blockchains and other distributed ledgers are distinguishable from existing databases primarily by their distributed architecture and their use of consensus mechanisms that avoid reliance on centralized, trusted intermediaries".

Immutability

The benefits of blockchain may be derived from the removal of the requirement for participants to trust a particular entity or person in preserving the record on their behalf, leading to more direct, peer-to-peer transactions and diminishing overall friction in the system, reducing processing time, lowering barriers to entry, and decreasing back-office costs involved in data reconciliation across organizations (Casey et al., 2018). Due to the relatively automated consensus mechanism, blockchain enables a near-instantaneous update of every copy of the ledger, and since every node

shares the same copy of the ledger, all ledgers reflect this change once a transaction is added to the blockchain (Lewis et al., 2017; Perera et al., 2020). This instant update eliminates the need for further post-trade reconciliation; moreover, the blocks are added in a way that transactions are chained together, hence it becomes more difficult to fraudulently change the transaction as it gets older, creating an essentially immutable database (Lewis et al., 2017). By ensuring that regenerating blocks is difficult, the consensus mechanisms increase the network members' confidence in a transaction that will never be changed as the number of transactions following it escalates (Lewis et al., 2017).

Safety and Security

Holding much more promising future than digital payments, Blockchain allows for a safe and secure trading of almost anything, from money, ideas, copyrights, while at the same time eliminates the middle man. Almost anything of value can be managed by using blockchain, including investments, real estate, and essentially, it can be done virtually, limiting security risk (Binh, 2018).

Efficiency

With its outstanding characteristic, smart contracts are predicted to accompany implementations of blockchain technology, in order to achieve their full potential; they can also be added to distributed ledgers to self-execute on the basis of information in the ledger, opening the door to automation of processes that currently require manual interventions (Lewis et al., 2017).

Arising from the use of blockchain technology, benefits in settlement period reduction and faster payment are also prominent. Lewis et al. addresses these two potentials in their study on blockchain as a financial market innovation (2017). In summary, the settlement periods, defined as "the time between the execution of a trade and the performance of all duties necessary to satisfy all parties' obligations" (p. 13), can be reduced tremendously through the swift record of submissions and their confirmation; a DLT service with digital identities would also come in handy for especially foreign exchange industry to shorten settlement times since global payments systems apparently require multiple regulatory checks and lengthy settlement cycles (Lewis et al., 2017).

Chapter 3: Problems of Banking industry

In order to answer the main question, the existing, current problems need to be understood first before going into analyzing if blockchain has the potential to solve these problems or not.

3.1. Problems existing

ING bank who has been leading in applying blockchain in solving banking problems shared facts of the industry included in the financial agreements process and the issues in how those transactions are currently being registered and agreed upon (Mark, 2016):

- Recorded by both parties
- In different system
- Based on (one-way) messages
- Incurring a lot of costs to fix any differences.

Multiple versions of the truth

One of the current limitations in the financial market system is the multiple versions of the truth (DTCC, 2016). In the paper from DTCC, the layers of financial market systems are described to be "siloed and contain multiple level of truth", with "minimal transparency into each system" (2016, p.5), and these different versions of the truth require each bank to maintain large, costly application code in order to reconcile (DTCC, 2016). This process of reconciliation, which concerns ensuring the matching of internal records related to a transaction across the relevant parties, is time-consuming and labor-intensive as it involves the reconciliation of information among different ledgers, recorded and stored in different formats (Committee on Payments and Market Infrastructures [CPMI], 2017). Moreover, the system is also considered to be "unnecessarily complex", due to their evolution over the course of decades, with minimal standards, not well integrated and contains many manual processing steps (DTCC, 2016, p.5). This complicated system of financial market with multiple versions of truth, as a matter of fact, is costly, time-wasting and is exposed to problems in matching information among related parties.

Cross-border payment

Banking sector deals with a lot of payment settlements, in which cross-border payments play an important part and at the same time, can face specific issues.

According to Voronchenko (2017), the approach of interbank transactions at present requires for an intermediate bank which acts as a trusted third party, and in case of a transfer from bank A to bank B, it is necessary for both banks to open an account in bank C, an intermediate, and transfer the funds there so that bank C can debit and credit corresponding accounts of those two banks to finalize the transaction (Voronchenko, 2017).

With respect to international transfer, as mentioned by Voronchenko (2017), there are two types of trusted third parties, correspondent banks and intermediate banks, with the first one responsible

for processing the transaction with a local currency while the later one playing the same role as above.

Correspondent banking

The correspondent relationships are maintained with foreign banks to facilitate cross-border payments and to access their local payment systems (ANZ & Wells Fargo, 2016). The process, in each relationship, involves the opening of local currency account (Nostro account) of a bank with a foreign bank, and every time a customer requests for a cross-border payment, that bank pays the recipient by sending an instruction to the foreign bank to pay from the Nostro account (ANZ & Wells Fargo, 2016). The record for this Nostro account payment is maintained separately by the sending bank, and then must be reconciled with the foreign bank's statement at the end of the day (ANZ & Wells Fargo, 2016).

Through 35 years of evolving, despite of its improvements, correspondent banking still depends on maintaining and reconciling two separate versions of the account statement, for instance, the Nostro account holder keeps their own mirror ledger (ANZ & Wells Fargo, 2016). This complicated model with multiple versions of truth, as mentioned above, might lead to undesirable challenges which, according to ANZ & Wells Fargo (2016), include:

- Poor payment transparency, for both banks and customers;
- Onerous reconciliation activities and investigations;
- Delays in advising of fund disbursement; and
- Inefficiencies in management and usage of liquidity and funding.

In such a setting of interbank and international transfer, the transaction costs are usually high and the amount of trust that is required for the system to work is uncomfortable for the industry (Voronchenko, 2017). The expensive settlement of cross-border payments is mentioned by Mills et al., who state that currently, electronic cross-border payments are under the effect of transferring funds through a series of correspondent banking relationship, and are often assessed with multiple fees (2016). From the clients' perspective, the transactions take a considerable amount of time which is another drawback (Voronchenko, 2017), the settlement times for cross-border payments can take up to five days for the most common currency pairings (Mills et al., 2016). Depending on the jurisdiction and the banks involved, costs are generally passed on to the end-users and may be deducted from the face amount of the funds transferred (Mills et al., 2016).

The fact that multiple versions of truth are held separately, especially in case of international transactions which already involve complex processes and middle parties, leads to the poor transparency and the possibility of errors and dissatisfaction with the transaction. Hence, there is a high chance of transaction and a dispute may be initiated. According to Godejohn et al., a dispute for payment transaction occurs in cases where either the consumer or merchant is dissatisfied with some aspect of the transaction, caused by the non-performance of the agreed upon obligation or the assertion that a payment transaction is fraudulent (2011). A dispute may arise in this case, between consumer and merchant, or between another party involved in the transaction process such as an acquirer, issuer, and a consumer can request for a refund to their account (Godejohn et

al., 2011). Not only can this process of refunding become complicated with different parties entangled, but also it is time-consuming and might be tiring for customers to go through; costly, time-consuming for banks and may discourage customers' engagement with banks if not handled suitably.

Financial inclusion

Another aspect in banking which is linked to its contribution to the development of society is the financial inclusion strategy. By definition, financial inclusion is the delivery of affordable banking services to the vast sections of disadvantaged and low-income groups (Damodaran, 2013). Financial inclusion is believed to enhance the economy (Damodaran, 2013), and is not merely a socio-political but also an economic imperative, which was realized by different organization, for instance, Reserve Bank of India in reviewing Monetary Policy urged banks to include in their prime objectives financial inclusion (Damodaran, 2013). However, Damodaran points out that in spite of considerable improvements in financial viability, profitability and competitiveness, concerns still exist regarding the needed banking services have not reached a vast segment of the population, especially the underprivileged parts (2013). Also, the difficulties these groups face are addressed by Mills et al., saying that especially for low-income households, it is difficult to access to financial services because of high account fees, prohibitive costs associated with traveling to a bank (Mills et al., 2016). Being inseparable from the whole economy, banking sector also needs to take financial inclusion into account for its own and the society's sustainable development.

Information system

On another hand, due to its nature, banking sector faces one of their most prominent problem, which is the lack of information in the bank credit information system (Guo & Liang, 2016). This has caused both difficulties for commercial banks to be limited in the business expansion and SMEs, together with individuals, to obtain loans easily from banks. Furthermore, this results in frequent non-performing loans and the difficulties in screening and controlling the loan quality of commercial banks (Guo & Liang, 2016). The banking industry, because of their limitation in customer information, which is the most manifest flaw in this field, has experienced a bottleneck in credit creation, since credit plays an essential part in financial activity, however, banks can only obtain general overview of consumption scenarios through credit card bills, compared to the innovative platforms from Alipay for example, which can acquire detail information in customers' consumption, consumption ratios, and even customers' living expenses (Guo & Liang, 2016).

The situation of global financial system, overall, is mentioned in the white paper from Tapscott & Tapscott (2017) as "rife with problems" (p. 2), though it moves trillions of dollars every day and serves billions of people. Moreover, this system is adding cost through fees and delays, generating friction through redundant and onerous paperwork, and facing the risks of fraud and crime (Tapscott & Tapscott), evidenced by the actual figure of 45% of financial intermediaries, payment network, stock exchanges, money transfer services for example, suffer from economic crime annually (2017). The costs, such as increasing regulatory costs, are added and ultimately leaving consumers bearing the burden (Tapscott & Tapscott, 2017).

Trend in technological changing

In a paper tracing the development of financial transaction system in Vietnam involving blockchain, Binh (2018) states that technical trends are impacting the current industry. The evolve of digital transformation in Financial Services is evident in the percentage of 40% of Americans who have not visited a bank or credit union within the previous six months, the number of physical banks has also dropped by almost half between the period from 1995 to 2015, which is contributed largely by the increase in online and mobile banking. Furthermore, the customers are going elsewhere, to find mobile "financial wellness platforms" (p.188) with all the functions of budget, bank, pay and crowd-fund. Banks therefore are no longer the only option, but instead there are numerous other companies that are cheaper, faster and easier in saving, lending and investing compared to the former financial giants.

Despite being seemingly a threat to current traditional operation in banks, blockchain technology, however, acts as an opportunity for the change and evolution in the banking sector. Consequently, banks will have to face with the risk of elimination in the current evolving industry if they continue to step back and disregard the new technological development, for instance, in case of commercial banks, they need to depend on new growth of technology to accelerate product and service innovations, eventually adapting to new demands from customers and the competitive environments (Guo & Liang, 2016).

However, according to ING (n.d.), one of the leading banks in this trend: "At first sight it appears to be a technology in which banks can be pushed increasingly to one side but it can actually take us forward in terms of the safer, cheaper and more effective storage of transactions". Crosby et al. also considers blockchain as a promising technology, claiming that Financial institutions & banks no longer see this technology as a threat to traditional business models, in fact, the world's biggest banks are looking for opportunities by doing research on innovative blockchain applications (2016). The authors also mentioned in a recent interview with Rain Lohmus of Estonia's LHV bank, who told that they find Blockchain to be the most tested and secure for some banking and finance related applications.

The authors Tapscott & Tapscott (2017) raise a question "Why is our financial system so inefficient?" and name three outstanding problems: it is antiquated, "a kludge of industrial technologies and paper-based processes dressed up in a digital wrapper" (p. 3); it is centralized, resistant to change and at risk of systems failures and attacks; it is exclusionary, rejecting billions of people accessed to basic financial tools. And blockchain, eventually, is said to be an emerged solution (Tapscott & Tapscott, 2017).

3.2. Conclusion

The prominent issues shared among banks stay within the financial agreement process as observed from ING's case, including different systems, recorded by different parties, one-way message, and costs arising to fix any differences.

First, the main problem is addressed: Multiple versions of truth, or the record of different parties, which is complex and with minimal transparency; costly to maintain and resulting in costs and time wasted in matching or reconciliation of information on different ledgers with different formats; no widely used standards and involve many manual steps.

In cross-border payment, the process is also complicated and calls for a trusted third party, correspondent bank or intermediate bank, with the correspondent banking under the influence of complex model of multiple versions of truth. This also results in interbank and international transfer with high transaction costs, high trust requirement, multiple fees due to transferring through a series of correspondent banking relationship, long settlement times and increased costs for end-users.

Ultimately, keeping separate records, especially in case of international payment, leads to dispute in banks, which can be complicated, costly for banks and time-consuming, tiring for customers, discouraging them to engage with banks.

Second, the problem of improving financial inclusion is mentioned, with banks' responsibility to provide financial services to current underprivileged population. This is followed by the issues in banking information system, where there are difficulties for customers to get loans, for banks to screen, control loan quality and credit creation due to the limited customers' information.

Other problems are mentioned, from costs added through fees and delays, regulatory costs burdening consumers, to friction through unnecessary paperwork and risks of fraud and crime. Moreover, there is a trend in technology engagement which opens a door to new technological adaptations, demands for changes in the traditional banking sector instead of getting replaced by competitors.

Chapter 4: The potential benefits of blockchain in banking

In this chapter, following the problems perceived in banking sector, the paper goes into investigating potential benefits specific for banking industry, developed further from theoretical framework's fundamental knowledge, hence, by comparing with the existing issues, give the answer to whether this new technology is the promising solution for those problems.

4.1. Potential benefits

According to ING (n.d.), one of the leading banks in this trend: "At first sight it appears to be a technology in which banks can be pushed increasingly to one side but it can actually take us forward in terms of the safer, cheaper and more effective storage of transactions". Crosby et al. also consider blockchain as a promising technology, claiming that Financial institutions & banks no longer see this technology as a threat to traditional business models, in fact, the world's biggest banks are looking for opportunities by doing research on innovative blockchain applications (2016). The authors also mentioned in a recent interview Rain Lohmus of Estonia's LHV bank, who told that they find Blockchain to be the most tested and secure for some banking and finance related applications.

In this sense, Mark (2016) states on behalf of ING that they realize the potential from a DLT, arising from its special characteristics:

- Consensus
- Validity
- Uniqueness
- Immutability
- Authentication

As a matter of fact, blockchain technology is able to inaugurate a credit mechanism in a situation of lacking mutual trust among involved parties, therefore, deals with the high costs from non-technical aspects of centralization. The majority of problems arose from the process of financial services are believed to be resolved by applying blockchain (Guo & Liang, 2016). The authors Guo & Liang (2016) list some specific application scenarios for blockchain technology in this case:

- Payment clearing system – distributed clearing mechanism: Complicated processes are involved in interbank payments, which often rely on intermediary clearing firms, ranging from bookkeeping, transaction reconciliation to balance reconciliation, payment initiation, with cross-border payments as example. Point-to-point payment can be offered by blockchain technology to eliminate the intermediary link, considerably improving service efficiency and reduce the transaction costs of banks.
- Bank credit information systems: in dealing with different ineffectiveness of bank credit information systems' privacy and security due to the scarcity, poor quality of data in

judging personal credit situation, difficulties in institutional data sharing, the unclear ownership of data user; blockchain technology provides with assistance in issues such as: establishing data ownership by performing data encryption; promoting data sharing through the automatic recording of big data by credit agencies, the storing and sharing encrypted forms of customer's credit status among institutions.

- Distributed innovations in financial transactions: reduce drastically manual interventions and employ smart contracts to digitize procedures that heavily rely on paper, improving the supply-chain finance which involves a substantial amount of paper-based transactions and high risks, costs and low efficiency due to numerous intermediaries. Among different parties, blockchain empowers the sharing of contractual information on a decentralized distributed ledger and the automation of payments through smart contracts.

According to Treleaven et al. (2017), blockchain systems provide a number of attractive attributes for the banking and financial-services markets:

- Resilient: the system has no single point of failure since it is a decentralized network without a central server.
- Integrity: since they operate by using distributed open source protocols, there is no need to trust in a third party for transaction execution.
- Transparent: all changes are visible for all parties
- Unchangeable: ensure a high degree of confidence for applications and users since transactions cannot be reversed re-sequenced.

Blockchain as a solution for challenges in cross-border transactions

"These challenges could be largely addressed if the industry were to trust a single record of account that could be shared and maintained by multiple correspondent banks" (ANZ & WF, 2016, p.3). Blockchains, or distributed ledger technologies ("DLTs") offer a novel solution to the requirement to maintain a single source of truth that is jointly owned by all participants in the system. When combined with process standardisation and improvement, this technology has the potential to increase the speed of cross-border payment finality, while also providing increased auditability and preserving the confidentiality of transaction flows (ANZ & WF, 2016).

It is believed that that a secure distributed ledger, with complete, traceable, transaction history for a set of assets shared and accessible only between trusted parties, could provide a significant improvement in certain areas of current infrastructure (DTCC, 2016). It could support solutions to address current business challenges (DTCC, 2016), by ensuring:

- A common, shared, version of the truth – every trusted member has a copy of the same history of all transactions in an asset.

- The shared ledger, used by every trusted party involved in trading a particular asset, establishes a network and data standard that can be integrated with tools, workflows and asset management systems in a simplified, consistent manner.

In consequence, the above improvement can support banks with their complex international transaction process. Information collected through interviews with industry stakeholders by Mills et al. indicates that firms have several common motivations behind efforts to develop and employ DLT arrangements (Mills et al., 2016):

- Reduced complexity (especially in multiparty, cross-border transactions)
- Improved end-to-end processing speed and availability of assets and funds. Similarly, stated in the paper from CPMI (2017), DLT is usually promoted as allowing faster settlement of transactions in an arrangement, and could simplify existing process flows by reducing friction to the sharing of information among participants.
- Decreased need for reconciliation across multiple recordkeeping infrastructures, which is also noted by CPMI that: the use of DLT, apart from eliminating or decreasing burdensome back office activities, might also reduce data discrepancy and facilitate quicker reconciliation through enabling information in a common format to be shared across entities involved in a transaction (2017).

In the application scenarios mentioned above, blockchain is said to have the ability to reduce the transaction costs of banks by eliminating the intermediary link. This is particularly relevant in the case of cross-border transactions, wherein a complex relationship with intermediaries is present. Thereby, blockchain technology possesses the potential benefit of cutting the costs for international transactions. According to Hernandez (2017, p.2), "blockchain transactions are borderless", regardless of where two sides of a transaction are located, the same minimal fee is charged. In the current situation where the remittance cost in average is 7.6 per cent globally and can go up to 20 per cent depending on the sending and receiving country, blockchain can bring enormous advantage since cutting the cost only by 5 percentage points can already save US$16bn per year (Hernandez, 2017).

Solution for financial inclusion

Financial inclusion is another challenge both domestically and abroad that some are attempting to address with DLT. Some of the potential benefits of DLT for cross-border payments described above might also be able to help address issues involving cross-border remittances as well as challenges in providing end-users with universal access to a wide range of financial services (Mills et al., 2016).

In rural areas where banking services are limited and it is difficult for customers to go to banks, remittances can become extremely expensive since the process is complicated with various intermediaries and multiple added fees. In this case, the advantages of DLT such as eliminating the middle entities, simplifying the transaction process can help banks promoting financial inclusion by providing more simple ways to make transactions, with faster processing time and

lower final costs bared by customers. Similarly, Mills et al., (2016) state that developers contend DLT might assist financial inclusion by potentially allowing technology firms such as mobile phone providers to provide DLT-based financial services directly to end users at a lower cost than traditional financial intermediaries can (or would); expanding access to customer groups not served by ordinary banks, and ultimately reducing costs for retail consumers.

Efficiency and reducing costs

Blockchain's value is visible in its applications promoting the formation of "multi-center, weakly intermediated" scenarios, enhancing the efficiency of the banking industry (Guo & Liang, 2016). Blockchain technology has the potential to provide large efficiency gains in businesses that currently require costly intermediation, including financial services (Tapscott & Tapscott, 2017). Most firms cite opportunities to reduce friction and costs. After all, most financial intermediaries themselves rely on a dizzying, complex, and costly array of intermediaries to run their own operations. Santander, a European bank, put the potential savings at $20 billion a year. Capgemini, a consultancy, estimates that consumers could save up to $16 billion in banking and insurance fees each year through blockchain-based applications (Tapscott & Tapscott, 2017)

The benefits from reducing costs of intermediation are also realized by Casey et al., (2018) that secure, verifiable transactions can remarkably decrease operational and counterparty risk, with no more multiple waiting days to make sure that the counterparty actually delivers or pays for what was purchased.

Another common expense is the need to reconcile transactions between different centrally maintained ledgers. Among investment banks, blockchain technology could reduce reconciliation and other infrastructure costs by $8–12 billion a year, according to one report discussed in Casey et al.'s research (2018).

"Fundamentally, [it is] an improvement over the way that, traditionally, databases have been designed and used in the past" (Lewis et al., 2017, p.2). As noted by Lewis et al., (2017) the vast majority traditional databases are relational, storing data in tables that can be updated and searched by users. These databases are centralized, require trust from users in the central authority to keep accurate records and the maintenance of technological infrastructure to prevent losing data from equipment failure or cyberattacks, and thereby, represent a single point of failure.

A potential benefit, in comparison to traditional ledgers is the ability to offer near-real time transaction, proved by Hernandez (2017) while comparing these two types of ledgers, showing that whilst the time lag for ledgers of intermediaries such as bank account can take days or even weeks to complete, the transactions on blockchain can be completed in ten minutes on average. The author also compares different aspects regarding these two ledgers, highlighting the immutability (transactions cannot be reversed), distributed, public, transparent (anyone can view the near-real time updated ledger) characteristics and encryptions with pseudo-anonymity (makes it difficult to hack blockchain).

4.2. Conclusion

The majority of problems arose from the financial services are believed to be resolved by applying blockchain, based on specific application scenarios. First, the distributed mechanism resolves the issue of complicated processes in interbank payments, with cross-border payment as example, by eliminating intermediary link with point-to-point payment. Second, in terms of bank credit information system, blockchain establishes data ownership by encryption, promotes institutional data sharing through the automatic recording of big data from credit agencies, deals with privacy and security by storing and sharing encrypted data among institutions. Third, the distributed ledger technology and smart contracts can both be used to reduce substantial manual interventions and paper-based procedures, helping with risks, costs and low efficiency due to intermediaries in the supply-chain finance, enhancing contractual information sharing and automation of payments through smart contracts.

The particular attributes blockchain systems provide banks with are listed as resilient with no single point of failure, integrity from mitigating the need for a third trusted party for transaction execution, transparent with changes visible for all parties, unchangeable since transactions cannot be reversed, ensuring high degree of confidence.

Regarding correspondent banking challenges, or challenges in cross-border transactions, instead of multiple versions of records, the distributed ledger technology (DLT) offers a single record, a single source of truth owned by all participants. This is expected to increase the speed of cross-border payment finality, provide increased auditability, preserve confidentiality of transaction flows. Additionally, with the unnecessarily complicated system mentioned in chapter 3, DLT arrangements prove their potential benefit in reducing complexity, especially in multiparty, cross-border transactions. This improvement consequently decreases the need for reconciliation across multiple recordkeeping infrastructures, furthermore, reduces data discrepancy or enables quicker reconciliation with information shared in a common format, and save international transactions costs. With a more streamlined data shared by every related parties, the errors and disagreement in transaction information are mitigated, thus, lower the need to initiate a dispute between banks especially for complex payment transactions such as international transfer.

Subsequently, another benefit in solving financial inclusion problem is discussed. Similar to some benefits proposed for cross-border payment, financial inclusion can take advantage of properties such as a single source of truth, no trusted third party, hence, providing a simplified solution with high speed of transaction and lower cost.

Other benefits for banks are discussed, together with the substantial cost saving from relying on intermediaries are: no single point of failure as compared to the traditional centralized databases, near-real time transaction, immutability, distributed, public, transparent and encryptions with pseudo-anonymity (harder to hack)..

Chapter 5: Use cases and initiatives

In order to prove and support the opinion on whether blockchain technology is actually beneficial for banking sector, this chapter strives to collects and analyzing some potential use cases together with their impacts and targeted usage, discussing if they are in line with what is mentioned above related to specific benefits aiming to solve existing issues or not.

The below table is the sum up of some initiatives and use cases as evidence for beneficial/potential applications of Blockchain.

Name of case/initiative	Application field	Impacts/Benefits
UnionBank pilots I2i platform	Remittance services (bank-to-bank across borders) Connect rural banks together & to UnionBank	- Save costs, near real-time transaction - Promote financial inclusion in underserved areas
Shinhan Bank	Security of information P2P stock lending platform	- Security of customers' personal information & records - Efficiency (Security, expediency & efficiency of lending process-new platform)
TradeWindow's 'single trading window'-platform	Digitizing trade process	- Reduce risk of fraud & cybersecurity threats - Save costs (from courier) Save costs (from documents sharing-certificates, invoices)
Ripple's xCurrent solution (software) for banks	Cross-border payments	- Save costs (lower operational costs-settlement, payment processing & reconciliation costs) - Shorten time (increase speed-message, clear & settle payment) - Transparency - Efficiency

Chapter 6: Conclusion

Conclusion

The main purpose of this paper is to research on the topic blockchain and banking, in order to provide answer for the main question: Can Blockchain Technology solve the existing problems in the banking industry?

Overall, this paper argues that blockchain technology can become a solution for solving the existing problems of in the current banking system since its ability of a shared distributed ledger can simplify the complicated banking system, eliminating intermediaries to save time, reduce different costs, especially for cross-border transactions, and with eliminated risk of dispute; furthermore, solving the financial inclusion difficulty and improve the limited credit information system.

The world of global financial system "rife with problems" (Tapscott & Tapscott, 2017). The most prominent problem existing in banking sector is the current system of multiple versions of the truth. This system is also the root for the shared issues in banks proposed by ING, who points out the problems of recording by both parties, in different system, based on (one-way) messages and incurring lots of costs to fix differences. This complex system contains many manual steps, is costly, time-consuming and hard to match information. Especially, in the case of cross-border payments, which play an important role in banking sector, the multiple versions of records can be even more challenging, given the setting of complex processes and the requirement for a third party such as correspondent bank. The costs in this case are relatively high, together with the long settlement time needed. Furthermore, there is a high possibility of a dispute in banks resulted from different versions of truth.

The lack information in a bank credit information system also contributes to the problems. Another issue is the need for improving financial inclusion in rural and underprivileged groups, which is considered banks' responsibility to the society. Other problems also exist, regarding different costs from fees, delays, regulatory; friction through paperwork, risks of fraud. Besides, a trend in technological development, to some extent, is pushing banks out of their zone of traditional banking to adopt new technologies such as blockchain.

In this paper, blockchain has been proved to possess potential benefits for solving the above problems. First, regarding the problem of multiple versions of the truth in banks, the DLT can offer a single record, a source of truth owned by all the participants. The distributed mechanism can be a solution for complex and costly processes in interbank payments, using point-to-point payment to eliminate intermediary link, thus, improving the speed of cross-border payment significantly. Moreover, less complexity enables less need for reconciliation across different infrastructures. With a more simplified, transparent distributed network of information, applying this new technology can prevent errors in reconciling transaction information and disagreements among the involved parties, thereby, solving the problem of possible disputes, especially for complex payment transactions like cross-border transfer.

Additionally, blockchain technology can be useful for solving the problem of bank credit information system through the ability to promote the sharing and storing of customer's credit status among institutions in encrypted forms, ensuring also the privacy and security of customers' data. Furthermore, blockchain helps to stimulate data sharing through the automatic recording of big data by credit agencies, and establish data ownership.

The issue of financial inclusion can also be addressed by the use of blockchain technology, for instance, blockchain is capable of eliminating intermediaries, simplify transactions for faster processing time and lower costs for customers. And regarding other problems, as stated in this paper, both the DLT and smart contracts can be used to reduce manual interventions and paper-based procedures, help with risks, efficiency and costs saving from depending on intermediaries. Further, blockchain also benefits banks with its ability to facilitate near-real time transaction, immutability, transparency, and a database with no single point of failure compared to traditional centralized ones.

The paper also found some cases in which blockchain technology is applied, which are the proof for benefits mentioned above. Real life cases show that blockchain's potential advantages are realistic and can be used to solve actual problems in banks. The initiatives and cases suggest the usefulness of blockchain technology from supporting cross-border payments, promoting financial inclusion in underserved areas, to securing and assisting customers' information and records, improving efficiency, saving costs from digitizing paperwork documents, costs settlement, reconciliation costs, and saving time to settle payment.

This research serves the purpose of answering the given topic by my company coach: investigating the emerging technology of blockchain and its use in banking industry. By answering the given question, this paper hopes to contribute to the current knowledge about this new technology, providing another aspect that can assist future researches in the field of blockchain technology. Furthermore, this paper can also serve as a source of reference for not only banks but management in general, who are starting to engage in blockchain applications, expecting to understand about blockchain and use it to assist their system.

Recommendation

For management, this paper proposes the basic knowledge about blockchain, the technology behind it that supports blockchain's unique features, from the basis of blocks to DLT and smart contracts technology as the core components, consensus mechanism as an element of blockchain technology's characteristics. From that on, the overall benefits of blockchain is realized, including its decentralization, immutability properties, efficiency, safety and security features. These benefits are not only limited in this case of banking industry, but also valuable for other industries which are seeking for a decentralized solution of ledgers or automated contracts to support different aspects in their business.

However, despite the hype in this new technology, this paper also suggests that before applying blockchain, management should consider where it can be useful in each case, understand the specific problems they can solve in order to choose how to apply it effectively. In the case of banking sector, which is the main focus of this research, the specific problems and potential benefits are suggested throughout the paper, supplying a source for management to consider different aspects that blockchain can benefit banks. With the specific problems related to payments, especially international payments, banks can make use of blockchain technology to facilitate a more effective, simplified system and reduce costs, save time for not only banks but also the customers, thus, if applied widely can even support the growth of the whole economy. Moreover, banks can see benefits in improving its current limited information system, promoting financial inclusion to attract customers and support the sustainable goal. As the technology is gaining its popularity in the current financial market, a threat of replacement is visible for banks, however, banks can also see this as an opportunity instead of threat, since it pushes the engagement of banks in new technologies in order to develop a more effective system, benefiting the growth of banking industry and customers-the end user of financial services.

The research also analyzes and give examples in how to apply blockchain technology in banks. The sample cases can act as a reference for management before actually applying blockchain in their system. Taking the use cases' purpose for application along with the impacts perceived into consideration, management could compare with their own system and identify the optimal use in their own case.

Beside the mentioned advantages and some use cases with their general benefits, the future researches can focus on other aspects, for example, the drawbacks, which is not yet mentioned in this work, or a more throughout analysis of current initiatives to identify which one is the most potential example for application in banking.

Limitations

The main focus of this paper is purely on the advantages, the positive impacts of blockchain technology on the specific banking industry. In collecting relevant information, the disadvantages are overlooked, only benefits are taken into consideration since they are directly relevant to the questions.

Furthermore, due to the fact that blockchain is a relatively new technology, the literature sources are limited, other resources are retrieved such as white paper, organization websites, magazines. The exclusion criteria are also applied, some paper are excluded despite of their relevant topics based on this criteria.

Due to the nature of this paper, with the main method used is literature review, it is mainly theoretical and serves as a template of reference for readers, assisting them in achieving their own answer.

Chapter 7: Reflection

Through researching on this topic, I achieved a substantial knowledge regarding blockchain technology, which was once not familiar to my understanding. By collecting data for this topic, I learned about the various advantages and application opportunities of blockchain, not only in banking sector but also in various fields, with many recent efforts from companies to actively engage in this new trend. There are still aspects of this technology's application which have not yet been discovered by firms. Currently, the papers about this topic is limited since it only got noticed in the recent years, however, it is still a developing area where future researches are expected.

My work is focused on a specific field of blockchain application, which is in the banking industry. It offers some benefits of blockchain, but not all of them, which are related to solving the existing problems in banking. The example cases are mentioned but only with general information instead of being analyzed thoroughly, since the context of this paper doesn't require for a deep analysis and moreover, future researches can be generated from these underdeveloped areas.

With the present knowledge, next time of researching, I would like to investigate other industries and fields in which papers have not yet been conducted to discover new potentials of blockchain technology in comparison to the current used methods, since I believe blockchain can be developed more and can go beyond its initial application field.

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Appendix

The overview of relationship network and operation of distributed ledger