TALLINN UNIVERSITY OF TECHNOLOGY
School of Business and Governance
Department of Business Administration

Abdul Haseeb Sahaak

Cost-Benefit Analysis of Blockchain-based Global Payments

Master's thesis

Programme International Business Administration

Supervisor: Mike Franz Wahl, PhD

Tallinn 2021

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Abdul Haseeb Sahaak ……………………………
(signature, date)
Student code: 184486TVTM
Student e-mail address: m.haseeb.sahaak@gmail.com

Supervisor: Mike Franz Wahl, PhD:
The paper conforms to requirements in force

……………………………………………
(signature, date)

Chairman of the Defence Committee:
Permitted to the defence
…………………………………
(name, signature, date)

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ABSTRACT

Since the introduction of money in the 11th century and the emergence of modern banking in the 17th century, the foundation of finance has witnessed very little innovation compared to other industries. Although the digital evolution has affected the finance sector in terms of providing their services efficiently to some extnet, the foundation still remains as brick and mortar; the financial institutions. Today's global economy requires international cross-border transactions, moving trillions of money per day, however, it is not yet as efficient as expected. Blockchain is found promising to replace the intermediaries and enable the fastest and cheapest global payments through distributed ledger technology and decentralisation of the current system. The purpose of this thesis is to explore blockchain's transformative role, determine the cost of implementing the technology, and analyse its benefits in the global payments system.

To achieve the purpose of this thesis, the author will introduce blockchain technology in general, describe the current state of global payments and role of blockchain in its transformation, discuss the cost-benefit analysis, and analyse the profitability of blockchain in global payments.

Keywords**:** benefit, blockchain, cost, decentralise, distributed ledger, financial institution, global payment

INTRODUCTION

This thesis assesses the field of finance and the trends that are shaping its upcoming prospect. Specifically, the technological trend of decentralised ledger technology, blockchain, is analysed in the global payments niche in terms of whether this evolution will be profitable. Profitability of the blockchain technological implementation is measured using well known cost-benefit analysis. On one hand, this topic has been chosen as the subject matter of the research based on personal interest in discovering the next mega trend in the financial industry that will transform the current traditional process. On the other hand, the world as we know it today has become highly dependent on international trade, and industries are always seeking for efficiency and cost reduction in their transactions. Thus, this thesis will provide a crucial output for international companies, especially financial institutions involved in international transactions, to make an informed decision about investing in a blockchain system.

This thesis is assessing the business aspect of blockchain technology and will not discuss deep technical application of it in global payments. Although, the role of blockchain technology in transforming the process of global payments will be described in this work. This thesis is broadly relevant to academics and business owners through literature review, key insights, analysis, and conclusion.

This thesis is arranged into three chapters: literature review and theoretical framework, methodology, and cost-benefit analysis. Firstly in n introduction, background of the thesis topic, the author’s motivation, and the research questions are explained. In Literature review and theoretical framework, theories such as economics of innovation, the fourth industrial revolution, and the internet of value are discussed. In methodology, the process and approach of the thesis are described. In cost-benefit analysis, using costs and benefits models, the research questions have been analysed and answered. Lastly in conclusion, a summary of the thesis and results have been presented with limitations of the research and future possible studies regarding blockchain-based global payments.

Central Research Question

According to a report by World Economic Forum (2016), existing distributed ledger technology research approach has been limited to top-down, addressing pain-points in financial service functions. World Economic Forum has conducted a bottom-up research approach, identifying transformative potential in financial service functions. However, World Economic Forum (2016) and the author have not found enough quantitative approach to researching distributed ledger technology. Thus, the aim of this thesis is to conduct a cost-benefit analysis of distributed ledger technology in one of the biggest financial service functions, global cross-border transactions.

The central research question (**CRQ**) of this thesis is: **What is the net profitability of blockchain-based global payments?**

The research question (**RQ1**): How is blockchain impacting global payments?

The research question (**RQ2**): Is blockchain ready to be implemented in global payments?

In order to answer the research questions, a cost-benefit analysis of blockchain-based payment systems will be conducted. To conduct the analysis, first base models for costs and benefits will be developed to quantify the net value of blockchain-based global payments and compare the results to the traditional payment systems.

Data of the research will be collected through records and reports of financial institutions providing global payment services to answer the central research question. Analysis of the data for the central research question will be carried out by cost-benefit ratio, alongside other profitability ratios. Expected results of this thesis is to provide evidence that implementing distributed ledger technology will benefit financial institutions in terms of reducing cost and improving efficiency.

1. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Cost-benefit analysis uses welfare economics and public finance principles to provide the basic theories for a framework within which costs and benefits are identified and evaluated from the perspective of a society (Nas, 2016, p. 3). Not only that, but cost-benefit analysis is also a way of thinking as it guides public policy makers in allocating resources equally and efficiently (Nas, 2016, p. 4). Cost-benefit analysis first appeared in the Flood Control Act in 1936 and after the Federal Interagency River Basin Committee's report published in 1950, cost-benefit analysis became a standard guide for planning water resources (Nas, 2016, p. 5).

A web search on Google Scholars of the subject matter of cost-benefit analysis, global payments, and blockchain, the author of this thesis concludes that cost-benefit analysis and global payments gained more popularity among academics during 2006 – 2015 but afterwards, the number of papers in those subject matters have decreased. However, blockchain was hardly a point of interest for academics until 2010 but afterwards, it has been heavily researched among them. Henceforth, blockchain is a very growing subject which has attracted the attention of many technological transformation enthusiasts.

Table 1 presents the total amount of academic articles written on the topics of cost-benefit analysis, global payments, and blockchain during 1990 – 2020.

Table 1. Web search of articles published in subject matters of this thesis

Subject matter	Period					
	2016-2020	2011-2015	2006-2010	2001-2005	1996-2000	1990-1995
Cost-benefit analysis	58,000	198,000	165,000	109,000	74,200	37,000
Global payments	108,000	197,000	181,000	134,000	74,000	26,700
Blockchain	65,500	3,210	781	459	341	54

Source: Author's research on Google Scholars, retrieved on 13.12.2020

As shown in table 1, the number of research involving cost-benefit analysis, global payments, and blockchain has been increasing since 1990. In the subject matter of cost-benefit analysis during 2016 - 2020, most cited authors are Pearce (2016); Johansson et al. (2018); and Nas (2016). In the subject matter of global payments during 2016 - 2020, most cited authors are Salzman et al. (2018); Ezzine-de-Blas et al. (2016); and Lokhava et al. (2019). In the subject matter of blockchain during 2016 – 2020, most cited authors are Yli-Huumo et al. (2016); Zheng et al. (2018); and Li et al. (2020). Literature of the subject matters of this thesis refers to some of the aforementioned authors and academic papers of other authors.

This research is based on the theory of economics of innovation which is a well-identified area of competence in economics specialised in analysing the effects of introducing new technologies, and mainly in understanding technological change as an endogenous process (Antonelli, 2009). Based on the author's Google Scholar web search, a total of 685,000 academic papers have been published regarding economics of innovation during 2016 – 2020 which demonstrates that the theory of economics of innovation is well relevant to this century. Using economics of innovation, this research will analyse the impact of distributed ledger technology on global payments as part of the financial service function.

Other theories such as the fourth industrial revolution (the idea that our economy is being transformed into physical manifestations of computing which consists of pervasive computing, AI, and robotics) and the Internet of Value (the idea that in future the Internet will allow exchange of value as it does information) will be discussed in this thesis. Based on the author's Google Scholar web search, a total of 71,000 and 1,090,000 academic papers have been published regarding the fourth industrial revolution and the Internet of value respectively during 2016 – 2020, which emphasises on the relevancy of these theories in economics in general and specifically in this thesis as it revolves around technological transformation.

1.1. Economics of Innovation and the Fourth Industrial Revolution

Economics of innovation was first introduced by Josseph Schumpeter in his book Capitalism, Socialism and Democracy back in 1942. The book examines a theory emphasising on entrepreneurship and innovation. This theory became more applicable after the technological evolution in the 19th century. In economics of innovation, the focus is on innovative capacity to create more effective processes based on technology. Innovation refers to "increases in quality and variety, or reductions in the cost, of goods and services provided by the market." (Broughel & Thierer, 2019, p. 4). It takes the forms of cost reductions, quality improvements, and increases in variety of goods, services, and methods of production. (Broughel & Thierer, 2019, p. 5).

Innovation contributes to wealth creation in many ways, as Adam Smith in the 1700s and John Rae in the 1800s suggested that innovation "lies at the heart of wealth creation." Innovations primarily occur for the aim of winning a competition, as Karl Marx in the 1800s suggested that innovation is an "essential part of a competitive battle." In the centre of competition and wealth creation lies the question of sustainability which was initiated by John Ruskin in the 1800s as whether innovation helps in achieving sustainability or is responsible for the unsustainable trajectory of economic development. Additionally, innovation sometimes raises questions about having unexpected side effects or having no effect as it would be expected (Swann, 2009, p. 18).

In another view, Eric von Hippel suggests that the "firm is not the only innovator in the economy." Innovation is not in the monopoly of the "innovative producer" but is rather widespread and passes through seemingly "unexpected channels" (Swann, 2009, p. 19). As recently evident, innovations are made publicly available so others can contribute to the idea and bring it to life. This truly applies to blockchain, which was built anonymously for Bitcoin and shared with the public who are implementing the technology in other economic fields.

New technologies have triggered the three industrial revolutions and have shifted life towards the use of engines, mass production, and digitalisation. The digital revolution has allowed us to develop our way of living continuously since the 1960s.

Despite the developments considered as part of the third industrial revolution, in his book, Klaus Schwab points out three reasons for an event of the fourth industrial revolution. First, the developments are evolving exponentially due to the fact that new technology facilitates the development of newer technology. Second, a combination of multiple technologies are building on the digital revolution which is defining the way we do things, and us as people. Third, the developments are transforming the entire systems of the economy, business, and society (Schwab, 2016). This technological revolution will impact economic, social, and cultural changes to an almost unimaginable scale and breadth. It will affect the economic growth by providing the ability to live longer, and increasing productivity. The effects of the changes will be also visible in employment as some labour will be substituted and requirements for skills will change. Besides, the nature of work will also be impacted as the purpose of work will be more important rather than just being part of the process. The fourth industrial revolution will impact the business by customer expectations, data-enhanced products, collaborative innovation, and new operating models. The changes will also be visible on national and global levels as governments have to adopt innovation-enabling regulations, improve international security as in cyber and autonomous warfare. Lastly, the society will be impacted by the changes as inequality in the communities will be unstable, and individual identity, morality and ethics would need to be defined around the new technologies. There have been 21 tipping points identified as the moments specific technological changes are introduced in society which will shape the future of this digital world.

Table 2 presents some of the tipping points expected to occur by 2025 as anticipated by the respondents of the World Economic Forum's report (Schwab, 2016, p. 28).

Table 2. Some of the tipping points expected to occur by 2025

Technological Changes	%
90% of people having unlimited and free storage	91.0
80% of people with a digital presence on the Internet	84.4
The first government to replace its census with big-data sources	82.9
90% of population using smartphones	80.7
90% of population with regular access to the Internet	78.8
30% of corporate audits performed by AI	75.4
Tax collected for the first time by a government via a blockchain	73.1
10% of global gross domestic product stored on blockchain technology	57.9
The first AI machine on a corporate board of directors	45.2

Source: Schwab, Klaus (2016), The Fourth Industrial Revolution, p. 30

As shown in Table 2, these tipping points provide a significant overview and likeliness of the fundamental changes that will occur in the near future and how best to be prepared for. In addition, most of the technological changes pave a path for a decentralised technology which delivers a strong promise over the next industrial revolution.

In the 1900s, the technological revolution introduced the concept of the Internet of Information which fostered creation of open standards and new business models. Similarly, the Internet of

Value uses these open standards to manage and share the value of several assets without the need of an intermediary. The vision of providing an Internet of Value is to create a new layer on top of the Internet, allowing transactions without the need of establishment of trust among the participants by a third party (Puertas & Teigland, 2018, p. 292).

The Internet of Value is an online space in which parties can instantly transfer value, such as a foreign currency payment, among each other without a third-party and third-party costs. The recent developments in the decentralised technology represent the main potential for it to become the Internet of Value, encouraging innovation and overtaking established industries which are not yet affected severely by the Internet (Puertas & Teigland, 2018, p. 303).

1.2. Blockchain

In 2008, a paper was published by alias Satoshi Nakamoto on a cryptography mailing list titled Bitcoin: A Peer-to-Peer Electronic Cash System. It referred to the notion chain of blocks as the underlying structure for the peer-to-peer electronic cash, Bitcoin. However the notion chain of blocks was first introduced in 1991 by Stuart Haber and W. Scott Stornetta (Narayanan, Bonneau, Felten, Miller, & Goldfeder, 2016), the paper by Nakamoto popularised it and throughout the years it evolved into the word blockchain. Blockchain is a peer-to-peer distributed ledger – it is not centrally controlled in the network, and all participants are directly connected and have access to the complete ledger; that is “cryptographically-secure” – it cannot be tampered with or misused; “append-only” – it adds timestamp to the data added to the ledger; immutable – it is almost impossible to change the data once added to the ledger; and “updateable only via consensus” – it is updated only after validation against defined criteria and reaching a consensus among all participants on the network (Bashir, 2018, pp. 16, 17). In business, blockchain is a platform where value is exchanged among peers without the involvement of a trusted intermediary.

The Fifth Science and Technology Basic Plan, a comprehensive science and technology advancement policy, endorsed by the Japanese Cabinet in 2016 reflects the Japanese Ministry of Economy, Trade, and Industry’s view that the new information technology incorporation into society is regarded as the Fourth Industrial Revolution. Since a few years ago, the most productive technological resource that has been introduced into the economy is data, and blockchain technology plays an important role in making efficient and fair use of data (Yano, Dai, Masuda, &

Kishimoto, 2020, p. 1). Blockchain due to its role in using data is a key component of the Fourth Industrial Revolution. Blockchain is one of the evolutionary new technologies that will greatly impact and create the foundation for the future of financial service infrastructure (World Economic Forum, 2016, p. 20).

1.2.1. Evolution and Types of Blockchain

Back in the 1980s, e-cash has been a point of interest which led David Chaum to introduce two cryptographic operations, blind signatures and secret sharing, to address the electronic cash issues of accountability and anonymity (Bashir, 2018, p. 14). Fast forward to 2008, Nakamoto published a paper focused on a peer-to-peer electronic cash system. In 2009, the first electronic cash system appeared as Bitcoin which provided a secure, controlled, and decentralised mechanism of mining digital currency. In his paper, Nakamoto introduced the term chain of blocks which together with the concepts of electronic cash and decentralised mechanism make the foundations of Bitcoin, which is now referred to as blockchain. Currently, blockchain is not only limited to Bitcoin but it has been adopted into many other sectors.

Figure 1 presents the trend in adapting and maturity of blockchain since 2013 and projected until 2025.

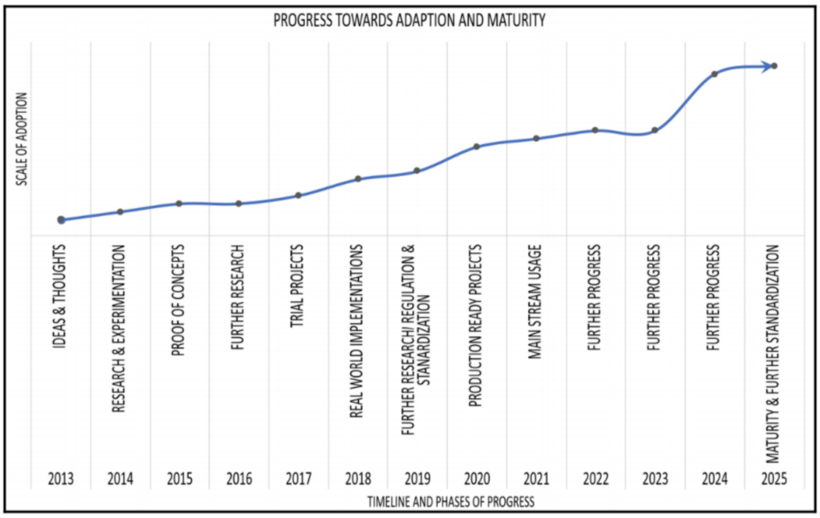

Figure 1. Blockchain's progress towards adoption and maturity
Source: Bashir, Imran (2018), Mastering Blockchain, p. 9

As shown in Figure 1, blockchain is still under development to be adopted into various projects. This decentralised technology is yet fresh and has great potential, which until its maturity until 2025 will transform several key sectors in societies.

Other than digital currencies, further applications of blockchain are numerous. One of the applications of blockchain is in the Internet of Things, which is a “network of computationally intelligent physical objects that are capable of connecting to the Internet, sensing real-world events…, reacting to those events…, and communicating it over the Internet” (Bashir, 2018, p. 526). Currently the Internet of Things has a centralised model which is susceptible to cyber threats, however, by introducing a decentralised blockchain to the model creates a secure environment for it. Another application of blockchain is in government functions. Especially in an e-government model, blockchain allows governments to implement transparent, auditable, and honest border control, voting, and citizen identification. Moreover, the health industry is benefiting from blockchain by processing claims faster, simplifying complex operational procedures, and preventing counterfeit medications (Bashir, 2018, p. 555). A major application of blockchain is visible in finance, especially in insurance claims, supply-chain finance, financial crime prevention, and payments. Lastly, other areas that benefit from blockchain are media, manufacturing, wholesale, and retail.

Blockchain enables value transactions in a decentralised secure manner, however, some institutions such as governments and banks are hesitant due to less control over the network. Thus, recently the idea of private blockchains has surged which offer more ability to control and scale. Private blockchain is partially decentralised, instead of providing access to the public, the transactions are only shared within a diversified network for verification (Puertas & Teigland, 2018). Benefits of a private blockchain is that the network can modify blockchain upon agreement, the parties in the network are known which makes audit easy, more transactions can be verified in less time by eliminating proof of work, and it provides greater privacy (Puertas & Teigland, 2018).

Despite the preference of the institutions, both public and private blockchain types have proven to complement each other through using tested protocols and the shared network to advance scalability, control, and privacy. In future, there is a possibility of the uprise of a hybrid ecosystem with various public and private blockchains interacting with each other (Puertas & Teigland, 2018). In order to understand blockchain further, cryptocurrencies as the first practical use of this technology and a few of its complementing components need to be reviewed.

1.2.2. Cryptocurrencies, Digital Wallets, and Smart Contracts

The first practical application of blockchain technology started with the creation of Bitcoin by Nakamoto back in 2008 which has gained massive popularity since then and is currently the most successful cryptocurrency in the world. Research in digital currencies dates back to the 1980s when David Chaum proposed to use blind signatures to create "untraceable" digital currency (Bashir, 2018, p. 130). Although many variations of the ideas have been proposed to create a digital currency, they were not stable enough to execute until Nakamoto built Bitcoin founded on a distributed ledger technology. A cryptocurrency is a digital coin which has no physical representation and its value is trusted and accepted as real by the participants of the distributed ledger, understanding the effort put into mining it, which makes it tradable (Furneaux, 2018).

Table 3 presents the valuation of the cryptocurrency market as of June 2020, including the top traded cryptocurrencies.

Table 3. Value of the most popular cryptocurrencies as of June 2020

Rank	Name	Market Cap	Price	Volume	Supply	Change (24h)
1	Bitcoin	$175,174,916,674	$9,517.15	$23,483,011,619	18,406,243	4.12%
2	Ethereum	$26,072,340,459	$234.10	$8,128,180,564	111,371,302	4.07%
3	Tether	$9,200,581,202	$1.00	$27,227,409,156	9,187,991,663	-0.05%
4	XRP	$8,479,246,814	$0.19	$1,248,570,039	44,257,803,618	2.86%
5	Litecoin	$2,849,255,227	$43.86	$1,946,034,724	64,962,826	2.28%
6	Binance Coin	$2,560,436,492	$16.46	$185,628,203	155,536,713	3.35%
7	EOS	$2,376,328,766	$2.55	$1,560,989,306	933,532,922	2.46%
8	Monero	$1,150,028,878	$65.37	$66,824,035	17,593,691	4.34%

Source: CoinMarketCap, Cryptocurrency Market Capitalisations, Retrieved on June 16, 2020

As of 2020 there are thousands of cryptocurrencies exchanged and traded in the market, most popular of which besides Bitcoin are Ether, Ripple (XRP), Litecoin, Tether, Monero, EOS, and Binance Coin (Reiff, 2020). As seen in Table 3, in June 2020, only these cryptocurrencies held a total market capitalisation of 227 Billion dollars.

Although cryptocurrencies are not yet completely fused into today's economy, the number of applications of cryptocurrencies in business is consistently on the rise and big companies and banks are already experimenting with it.

Cryptocurrencies as digital assets are exchanged electronically and need to be securely recorded to a specific party's account – also called a digital wallet. First instance of a digital wallet usage was seen in 1997 in Finland when Coca Cola was experimenting with vending machines that allowed payments through SMS (Dahlberg, Guo, & Ondrus, 2015, p. 265). Fast forward to 2008, the success of PayPal payments and invention of Apple smartphone boosted the digital wallets technology, establishing Apple Pay, Google Pay, Alipay, and hundreds of other digital wallets.

Usage of digital wallets has become popular over the years as such that according to a report by The Paypers (2019, p. 27) almost 2.1 billion consumers worldwide were estimated to use a digital wallet to make transactions by the end of 2019. Digital wallets are a "core infrastructural element" for cryptocurrencies which are the "mechanism for the secure holding and transfer" of "cryptographic asset." The wallet contains a party's address, public and private keys, and a record of cryptocurrency transactions (Swan, 2015). Today for recording cryptocurrency transactions, there are three main types of wallets – software such as MetaMask, web-based such as MyEtherWallet, and hardware such as Trezor (Yano, Dai, Masuda, & Kishimoto, 2020, p. 86). Choosing a wallet type is dependent on aspects such as ease of use, features availability, and most importantly security.

Cryptocurrency transations over blockchain network benefit from smart contracts. A contract in a legal view is a transaction agreement between two parties subject to absolute trust between them. A smart contract is similar to the traditional contracts except that the code is the binding trust and the law. Nick Szabo proposed the smart contracts notion for the first time back in 1994 who defined it as "a computerised transaction protocol that executes the terms of a contract" (Yano, Dai, Masuda, & Kishimoto, 2020, p. 79). Smart contracts are digital contracts bound by "decentralised consensus" which are "tamper-proof" and executed automatically through "self-enforcing" (Cong & He, 2019).

Smart contracts could have different implementations, not necessarily run on blockchain (Bashir, 2018, p. 53), such as an inheritance gift which is triggered in future contingent on confirmation of the death of the owner and age of the inheritor, and transactions which are triggered contingent on agreed events for example winning a match or reaching a fundraising goal (Swan, 2015), however, blockchain provides a secure standard decentralised platform for executing such smart contracts (Bashir, 2018, p. 53).

1.3. Global Payments

The impact of globalisation on our societies has been multidirectional, most evident of which has been global commerce - on the way corporations communicate and do transactions globally. According to The Paypers (2019, p. 9), global commerce was estimated to reach one trillion dollars in 2020 which makes 14.6% of the total sales in retail. The total value of global payments is rising by 5.6% each year (The Paypers, 2019, p. 37).

Figure 2 presents the total global payment transactions since 2010 and projected until 2022, as well as their share of GDP.

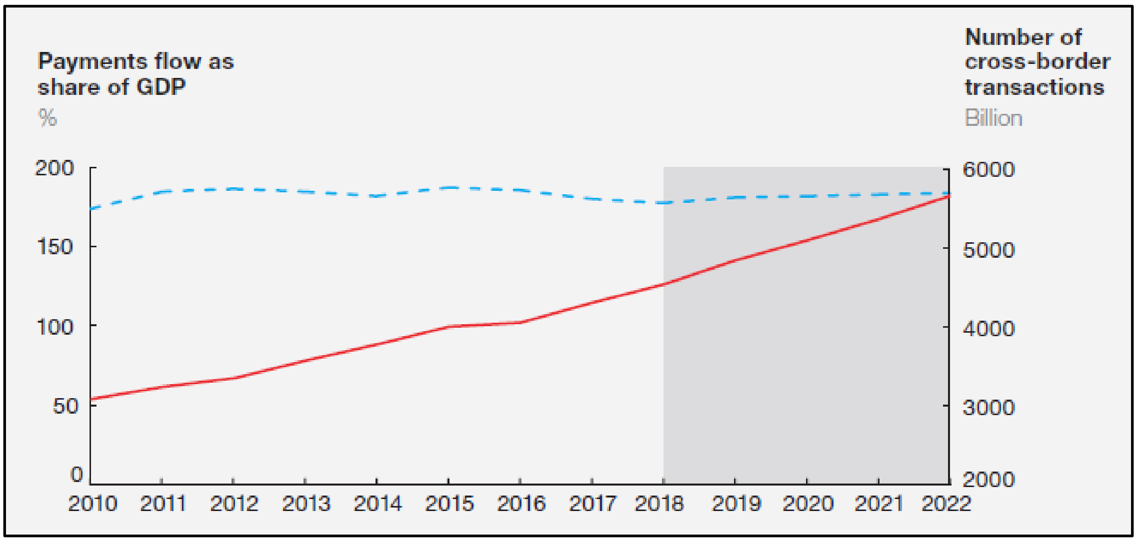

Figure 2. Global Payments Growth

Source: McKinsey & Company. (2018), A vision for the future of cross-border payments, p. 5

As shown in Figure 2, the volume of global payments have been constantly rising every year since 2010 and it is estimated that by 2022, it will rise up to 6000 billion transactions. These transactions however are not always executed in efficient manner and are expensive for the financial institutions, due to the outdated systems and numeros components involved in global payments.

1.3.1. Components of Global Payments

Global payments are one of the biggest activities of financial institutions which enable international companies to conduct their business across borders, exchanging values and assets. Global payments are also one of the oldest activities of financial institutions which have evolved and seen great developments over time. The very first occurrence of a transaction dates back to 300-600 BCE while the first electronic transaction of funds was enabled by Western Union back in 1872 when it introduced the wire transfer through its telegraph network (Laurence, 2019, pp. 105-106). The factors which have affected or have been affected by these developments are Anti-Money Laundering policies, clearing and settlement, nostro vostro accounts, foreign exchange, and so on.

Anti-Money Laundering is a set of legal controls which are enforced on financial institutions to avoid, identify, and report money laundering activities. One of the factors of Anti-Money Laundering is Know Your Customer (KYC) which are executed by financial institutions to verify the identity of their customers and risks involved in conducting business with them.

Once money has been deposited with a financial institution for a payment, it then goes through the process of clearing, which is “the preparation through matching, recording, and processing instructions of a transaction for settlement” (Loader, 2002). After the money has gone through the clearing process, it is ready for settlement, which is “the exchange of cash or assets in return for other assets or cash and transference of the ownership of those assets and cash” (Loader, 2002).

The process of clearing and settlement is currently manual, performed by employees of the financial institutions. Most often this process is time-consuming and prone to error, as it requires strict attention to details. Clearing and settlement is one of the highest cost drivers in global payments.

In international business and cross-border transactions, the need for external accounts with partner banks called nostro vostro emerges. Nostro vostro have originated from Latin in which the term nostro is referred to ‘our’ and vostro is referred to ‘your’ (Yamey, 2011). When a financial institution A uses the services of another financial institution B located overseas to make a transaction on their behalf, A deposits money to B, A records the transaction in nostro (our) account and B records in vostro (your) account.

Financial institution A deposits money in financial institution B’s currency, which makes A prone to foreign exchange fluctuations and its risks. Usage of nostro vostro accounts however make cross-border transactions possible, it also adds to the costs of the transactions by change in foreign exchange value and the reimbursement for such services, as well as it adds to the time of processing such transactions. Since the financial institutions around the world are not using a standard method and process, often services of third-parties like The Society for Worldwide Interbank Financial Telecommunication (SWIFT) are required to provide a standard information exchange platform for these financial institutions to make transactions. That is also an additional cost that the financial institutions have to bear.

A foreign exchange rate is “the price of one currency in terms of another” (O'Brien, 2013, p. 1). The volatility of the currencies depend on the market or official policy. If the change in a foreign exchange rate is influenced by government policy, e.g. central bank intervention, the change is defined as revaluation or devaluation. If the change in a foreign exchange rate is a result of other market factors, e.g. demand and supply for foreign exchange generated by internal trade and investing, the terms appreciation or depreciation are used (O'Brien, 2013, p. 10). Ask is the price at which the base currency can be purchased with the secondary currency. Bid is the price at which the secondary currency can be purchased with the base currency.

Table 4 presents the most popular foreign exchange rates in June 2020.

Table 4. Foreign Exchange Rates in June 2020

Symbol	USD	EUR	GBP	JPY	CHF	CAD	AUD
USD	1.0000	0.8857	0.8009	107.0900	0.9445	1.3530	1.4445
EUR	1.1291	1.0000	0.9042	120.8500	1.0663	1.5277	1.6309
GBP	1.2487	1.1058	1.0000	133.6400	1.1793	1.6894	1.8035
JPY	0.9343	0.8275	0.0075	1.0000	0.8824	0.0126	0.0135
CHF	1.0587	0.9377	0.8480	113.3200	1.0000	1.4325	1.5293
CAD	0.7391	0.6545	0.5920	79.1100	0.6981	1.0000	1.0676
AUD	0.6922	0.6131	0.5544	74.0900	0.6539	0.9365	1.0000

Source: Investing.com. (2020), Forex Rates Table, Retrieved on 23.06.2020

As shown in Table 4, the ask and bid prices of the currencies are volatile and allows the market to adjust the prices to their advantage and make profit. This volatility and uncertainty in foreign exchange rates creates risks for companies that receive funds and make payments in foreign currencies (O'Brien, 2013, p. 29).

Based on a survey by The World Bank (2020), in 2019 the foreign exchange margin applied by different firms around the world was on average 2%. Considering only one trillion in USD of global commerce by the end of 2019 makes twenty million spent on these global payments from the foreign exchange margin alone.

1.3.2. Current State of Global Payments

Current key stakeholders of global payments are the money sender and beneficiary, money transfer operator (MTO), sender bank, beneficiary bank, correspondent bank, SWIFT, local clearing network, and regulator.

Figure 3 presents key stakeholders involved in global payments in the current setting.

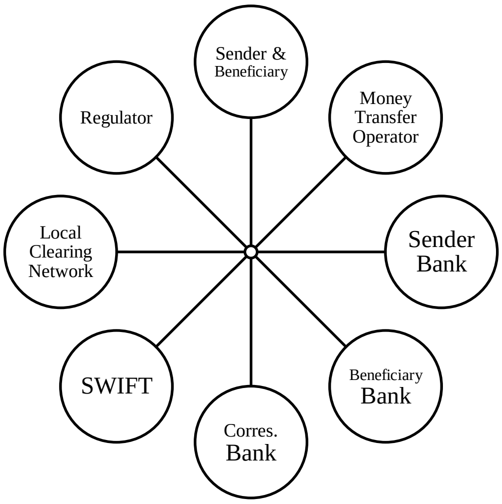

Figure 3. Key ecosystem stakeholders
Source: World Economic Forum (2016), The future of financial infrastructure, p. 47

As shown in Figure 3, out of these stakeholders, the core role holders are money sender and beneficiary, an individual or business transferring money (sender) to another individual or business (beneficiary); money transfer operator, non-bank companies transferring money through a global network of agents; sender bank; and beneficiary bank. Correspondent bank; a bank with access to foreign exchange market and enables the transfer; SWIFT, the global provider of secure financial messaging and settlement services; local clearing network, the local interbank network that enables financial messaging or settlement; and regulator, central banks and monetary authorities who control and monitor compliance to KYC and AML standards.

Figure 4 presents the current process of making a global payment, involving intermediaries.

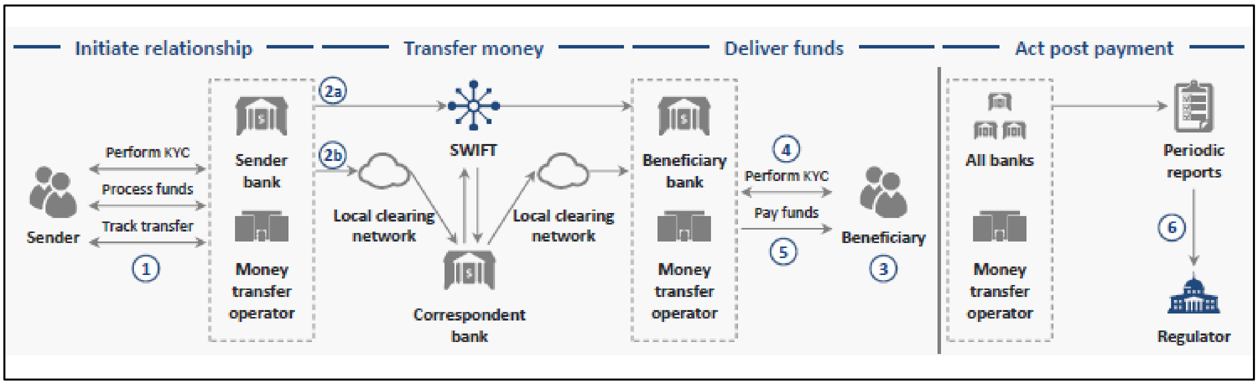

Figure 4. Current State of Global Payments
Source: World Economic Forum (2016), The future of financial infrastructure, p. 49

As shown in Figure 4, the current process of global payment starts with the sender approaching a bank or money transfer operator to send money to another country. The bank or money transfer operator performs KYC and AML activities, collects transfer money and charges, and occasionally supports transfer inquiries and disputes. Then, the bank or money transfer operator transfers money across borders through utilising SWIFT network or facilitating transfer through correspondent banks. The beneficiary gets a notification and is approaching a bank or money transfer operator. Beneficiary bank performs KYC if necessary and pays the amount in local currency. Additionally, the bank and money transfer operator provide periodic reports to regulators based on local regulations, comprising transaction details such as sender and beneficiary identities, currencies, transferred amount, and time of transactions.

The current process of global payments is not completely efficient and has some flaws. First of all, details about the sender and beneficiary are gathered manually and through mundane business processes. Control of accuracy of information and supporting documents is limited for KYC and AML processes, with different expiry guidelines across institutions. Transferring money is costly and consumes time subject to routes. The details for each transaction are checked in each bank which results in a high error rate. Holding funds in nostro accounts result in opportunity costs and loss due to foreign exchange. Lastly, providing reports to regulators requires expensive technology, complicated business processes, and multiple operation teams to support the process, because of the difference in data sources and channels.

1.3.3. Future State of Global Payments

Future state of global payments begin with establishing trust between sender and a bank or money transfer operator through digital identities or current KYC process. Ensuring the transfer of fund between sender and beneficiary is facilitated by a smart contract. The conversion of currency is enabled through fund providers on blockchain. The transactions are observed by the regulators in real time and AML red flags are shared with them through a smart contract. Transfer is automatically completed to the beneficiary's account through the smart contract or can be picked up after the KYC process. Additionally, the transaction is stored on blockchain and its history can be accessed by the regulators on demand.

Figure 5 presents the future of the global payment process by implementing blockchain technology.

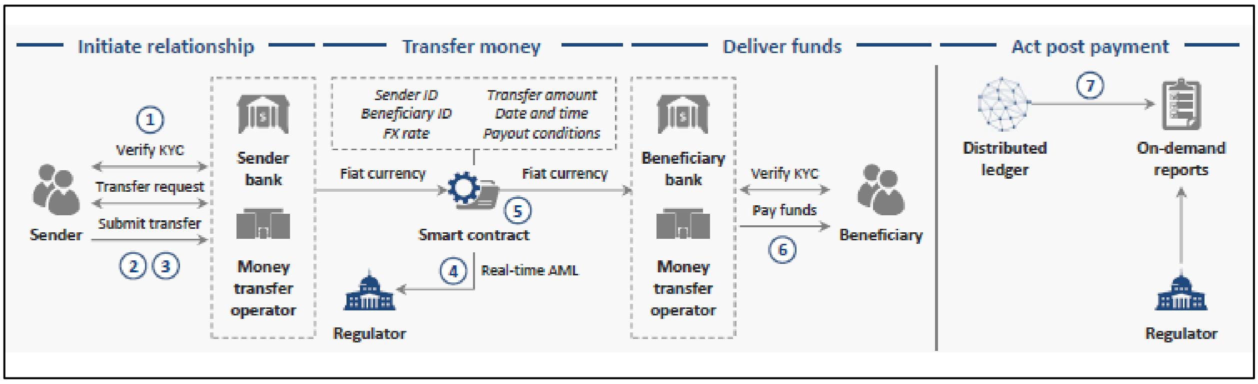

Figure 5. Future State of Global Payments
Source: World Economic Forum (2016), The future of financial infrastructure, p. 51

As shown in Figure 5, benefits of the future process of global payments include the usage of digital identities stored on blockchain which facilitates an efficient KYC. Foreign exchange can be obtained from participants of blockchain who are interested in enabling currency conversions. AML processes are executed in real time and regulators are automatically alerted according to specific smart contracts. The duration of global payments is highly reduced and can be done in real time. Eliminating most of the supporting stakeholders from the global payment process improves cost structure and generates value. Due to on demand access to the history of transactions, providing extra reports to the regulators is no more needed.

Figure 6 presents the estimated effect of blockchain implementation in global payments in terms of cost reduction.

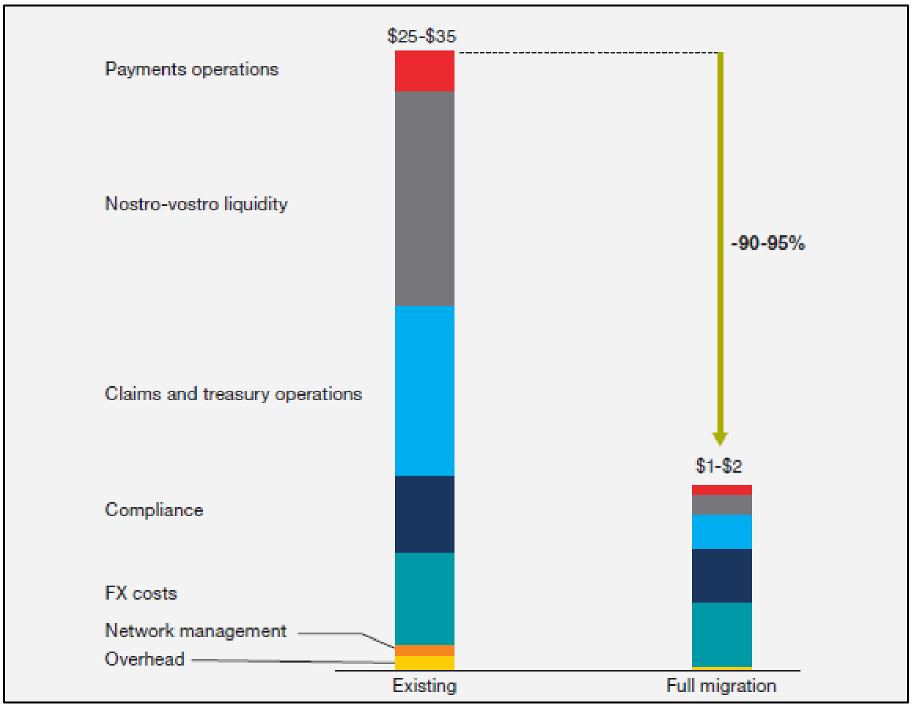

Figure 6. Costs per international payments transaction
Source: McKinsey & Company. (2018), A vision for the future of cross-border payments, p. 10

As shown in Figure 6, according to McKinsey & Company (2018, p. 10), by adopting new technologies costs per single international transaction could be reduced by almost 95%, from a total of $35 to $2 per transaction.

Blockchain is one the mega trends alongside other technological developments such as the Internet of Things and artificial intelligence, which promises a huge reduction in costs in different industries, especially global payments by restricting the influence of intermediaries. Blockchain is believed to contribute towards the fourth industrial revolution by introducing the notion of the Internet of Value, enabling seamless transactions online. Recent developments in blockchain such as cryptocurrencies, digital wallets, and smart contracts have paved the path to implementing the distributed ledger technology in one of the biggest activities of financial institutions, global payments. Blockchain supports global payments in harmonising anti-money laundering and know your customer activities, automates clearing and settlement processes, eliminates the need for nostro vastro accounts, and standardises foreign exchange rates.

The effect of blockchain on global payments is estimated to reduce costs up to 95%. From a technological perspective, blockchain-based global payments are currently under experiment by institutions developing private blockchain networks to perform transactions. Blockchain-based global payments from the governance and organizational perspectives are yet to mature as it hasn't been implemented in a distributed manner and its implementation in supply chains and organizational activities is yet in the discussion phase. From a societal perspective, blockchain is a widely attractive trend for start-ups and innovators, representing every industry and financed by venture capitals around the globe (Bayram, 2020).

2. METHODOLOGY

The purpose of this thesis is to evaluate the profitability of blockchain-based global payments by identifying the costs of adopting the new technology and evaluating the benefits of the technological transformation (World Economic Forum, 2016). A cost-benefit analysis will be exploited to fulfill the purpose of this thesis, answering the central research question.

Figure 7 illustrates the process of this thesis.

Figure 7. Research process of the thesis
Source: The author

As shown in Figure 7, the Central Research Question will be answered using the cost-benefit analysis approach. The analytical model of this thesis consists of descriptive and predictive forms. The research is categorised as quantitative, with an objective to draw a conclusion regarding the use of blockchain in global payments. The objective is achieved by applying mathematics and uses of numbers to investigate direction of decision making in terms of adopting this new technology. The data of this thesis is obtained into the research models in Appendix 1 and Appendix 2 mainly via reports published by respected financial, economical, and technological institutions. The process of this thesis is predetermined, however it might develop during the learning process and progress of the author. The research data is analysed using a cost-benefit analysis approach. The evolution of cost-benefit analysis and its approach is clarified in the following sections.

2.1. Cost-Benefit Analysis Approach

The earliest known origins of cost-benefit analysis is dated back to 1848 pioneered by a French engineer and economist, later in 1879 in the United States Army Corps of Engineers but formally appeared in the Flood Control Act in 1936. After the Federal Interagency River Basin Committee's report called Green Book published in 1950, cost-benefit analysis became a standard guide for planning water resources (Nas, 2016, p. 5).

Cost-benefit analysis is a method of systematic identification of all costs and benefits of solutions, converting them into monetary units, and ranking them on the basis of selection criteria to determine the efficiency and desirability of the proposed solutions (Nas, 2016, p. 2).

Figure 8 presents the cost-benefit analysis process used in this thesis.

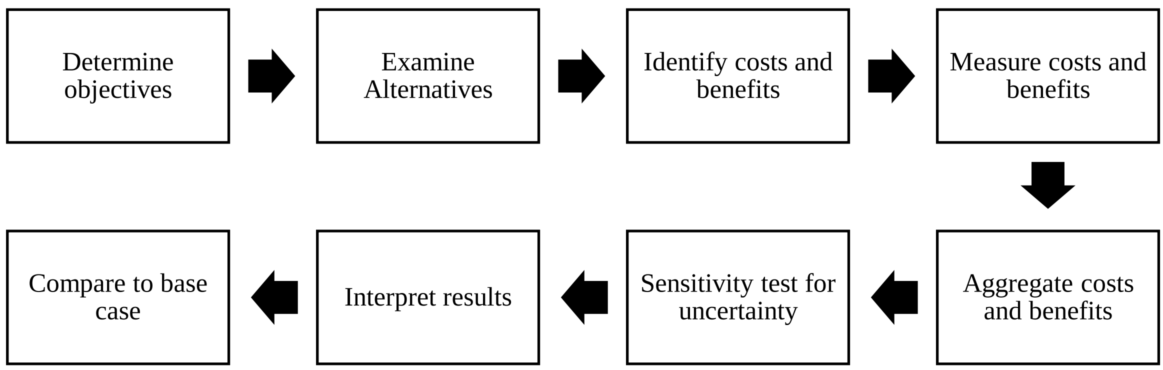

Figure 8. Cost-benefit analysis process
Source: The author

As illustrated in Figure 8, the cost benefit process will be used in this research, which is compiled from books on cost-benefit analysis by Ginés de Rus (2010) and Commonwealth of Australia (2006). The process starts with defining the objective - the problem to be solved. The objective needs to be specific and establish limits of the analysis. Next, alternative solutions need to be identified as it is essential to evaluate the relevant alternatives to allow the achievement of the objective. Then, the costs and benefits derived from implementing blockchain technology are identified.

After the costs and benefits are identified, they are measured in monetary units if possible, or through the means of shadow pricing, which is introducing some correction in prices to estimate the costs. Afterwards, since costs and benefits occur in different time periods, future costs and benefits are discounted to homogenise them and allow comparison. Followed by sensitivity test, the effects of errors in estimations are evaluated to provide the information to the decision-maker. Finally, a figure is derived from the analysis to summarise the courses of costs and benefits – the benefit-cost ratio – and is compared to the base case to conclude the results. Below are the descriptions of the ratios which are used to derive the results of this thesis.

Firstly, the net present value is calculated as sum of all annual benefits less costs of each year, and each annual net benefit discounted by the suitable discount rate to translate it into present value terms (Commonwealth of Australia, 2006) less initial investment.

$$\mathrm{NPV} = \sum_{\mathrm{t}=0}^{\mathrm{t}} \frac{(\mathrm{B_t} - \mathrm{C_t})}{(1+\mathrm{r})^{\mathrm{t}}} - i \qquad or \qquad \mathrm{NPV} = \sum_{\mathrm{t}=0}^{\mathrm{t}} \frac{(\mathrm{B_t})}{(1+\mathrm{r})^{\mathrm{t}}} - \sum_{\mathrm{t}=0}^{\mathrm{t}} \frac{(\mathrm{C_t})}{(1+\mathrm{r})^{\mathrm{t}}} - i$$

where
B - Benefits
C - Costs
i - Initial Investment
NPV - Net Present Value
r - Discount rate
t - Time period

Other decision ratios to measure profitability of blockchain-based global payments are return on investment (ROI), benefit-cost ratio (BCR), and payback period (Commonwealth of Australia, 2006).

Return on investment is calculated as the ratio of net return on investment to cost of investment.

$$\mathrm{ROI} = \frac{\sum_{t=0}^{t} (\mathrm{B_t} - \mathrm{C_t})/(1+\mathrm{r})^{\mathrm{t}}}{i}$$

where
ROI - Return on investment

Benefit-cost ratio is calculated as the ratio of discounted benefits to discounted costs (Commonwealth of Australia, 2006).

$$\mathrm{BCR} = \sum_{\mathrm{t}=0}^{\mathrm{t}} \frac{\mathrm{B_t}/(1+\mathrm{r})^{\mathrm{t}}}{\mathrm{C}_t/(1+\mathrm{r})^{t}+i}$$

Where

BCR - Benefit-cost ratio

Payback period is the time taken to pay back the initial investment.

Payback period = i / $\sum(\mathrm{B_t} - \mathrm{C_t})$

3. COST-BENEFIT ANALYSIS

As described in the cost-benefit analysis approach for this thesis, the following sections will define the objectives of the cost-benefit analysis and describe the alternatives for blockchain-based global payments. Afterwards, in order to identify and measure costs and benefits of blockchain-based global payments, the author will develop costs and benefits models that could be applied to incorporating the new technological system.

The author is evaluating costs and benefits of blockchain implementation in global payments within the next five years for feasibility of this thesis. To provide better information, the author will evaluate two scenarios for costs of blockchain, mainly assessing the development of private and public blockchain platforms. At the end, the costs and benefits will be timely aligned, sensitivity will be evaluated, and the results will be compared with the base case selected for the subject matter of this thesis.

3.1. Objective and Alternatives

Blockchain would fundamentally impact operations of financial institutions, offering cost savings up to 50% (Accenture & McLagan, 2017). Most financial institutions' operations revolve around cross-border transactions, thus, the partial objective of implementing blockchain in financial institutions is to reduce the price of international transactions – global payments.

Bringing efficiency and reducing prices in financial institutions are not novel quests. Since the inception of this crucial economical operation, the stakeholders have been involved in researching and developing new solutions and technologies to achieve just those. Alternatively, well-known corporations with years of experience such as The Society for Worldwide Interbank Financial Telecommunication (SWIFT), Western Union, MoneyGram, and other recent boomers such TransferWise, Revolut, and TransferGo are competing in providing cheapest prices for global payments. For example, the Society for Worldwide Interbank Financial Telecommunication

(SWIFT) launched SWIFT Global Payment Initiative (SWIFT gpi) in 2018, promising fast payments and reduced costs (SWIFT, 2019, p. 8). TransferWise too lowered prices from 0.73% to 0.67% in 2019 (TransferWise, 2019, p. 10).

This thesis will assess profitibality of Western Union and compare it to the results of a blockchain-based global payment system. Western Union has been chosen as the base case because it is leading the global payment services market, providing their customers with fast and reliable ways to make payments around the world (The Western Union Company, 2019).

3.2. Identifying and Measuring Costs

By compiling the models in the reports by Ernst & Young (2019) and Forrester (2018), the author has constructed the costs model adapted to a financial institution operating in global payments.

Figure 9 presents the costs model used in this thesis to measure the costs of blockchain-based global payments.

Figure 9. Model for measuring costs of blockchain-based global payments
Source: The author

As shown in Figure 9, costs associated with implementing blockchain in global payments consist of developing the blockchain platform, onboarding personnel to learn the usage of the new system, ongoing costs in the operations, platform maintenance costs, and costs incurred for monitoring of the operations. The total cost of implementing blockchain is attained by adding the costs in each segment of developing, onboarding, ongoing, maintaining, and monitoring.

Key inputs in measuring costs are full nodes, end users, increase in end users, annual user turnover, and annual transaction volume. Full nodes refers to the computers connected to blockchain that validates transactions over the system. End users are the stakeholders linked over the blockchain network who execute the transactions.

Table 5. Scenario I: Key inputs and cost drivers of private blockchain

Key Inputs/Cost Drivers	**Year**				
	1	**2**	**3**	**4**	**5**
Full nodes	10	10	10	10	10
End users	250	263	276	289	304
Increase in End users	5%	5%	5%	5%	5%
Annual user turnover	19%	19%	19%	19%	19%
Annual transaction volume	6,000,000	12,000,000	18,000,000	24,000,000	30,000,000

Source: Author's assumptions

As shown in Table 5, according to Ernst & Young (2019, p. 7), full nodes required for a private blockchain are 10 nodes, and end users involved in transactions start from 250 users in year 1 and increase by 5% every year. Annual turnover of the users is 19%. Annual transaction is calculated as below.

Annual transaction volume = Number of customers x number of transactions per customer

The author assumes that 1,500,000 new customers are gained due to blockchain every year for 5 years.

Table 6. Scenario II: Key inputs and cost drivers of public blockchain

Key Inputs/Cost Drivers	**Year**				
	1	**2**	**3**	**4**	**5**
Full nodes	0	0	0	0	0
End users	10	11	11	12	12
Increase in End users	5%	5%	5%	5%	5%
Annual user turnover	19%	19%	19%	19%	19%
Annual transaction volume	6,000,000	12,000,000	18,000,000	24,000,000	30,000,000

Source: Author's assumptions

Table 6 shows the cost drivers for Scenario II with the difference in full nodes and end users. Since Scenario II is a public blockchain, the system will not require separate nodes but rather function on available public networks. The end users needed for public blockchain are also fewer, starting from 10 in year 1 and increasing by 5% every year.

3.2.1. Platform Development Costs

Initial platform development costs vary depending on the type of blockchain. According to Forrester (2018, p. 47), full development of IBM blockchain for a private or permissioned system (Scenario I) is $1,500,000. However according to Ernst & Young (2019, p. 10) the initial platform development cost for a private blockchain system is $660,000, the highest cost of the two is selected for the analysis purpose of this thesis.

For Scenario II, cost of developing a public blockchain, Ernst & Young (2019, p. 11) has proposed $50,000 which is $610,000 less than the cost of private blockchain. In author's assumption, the cost of developing a public blockchain is estimated to be $1,000,000.

3.2.2. Onboarding Costs

Onboarding costs of implementing a blockchain system in global payments consist of training and documentation costs to grant necessary access to users on the network.

Table 7. Scenario I: Onboarding costs of private blockchain

Onboarding Costs	**Year**				
	1	2	3	4	5
Training hours per full node user	16	15	14	14	13
Decrease in training hours per full node user	-5%	-5%	-5%	-5%	-5%
Training hours per end user	4	4	4	3	3
Decrease in training hours per end user	-5%	-5%	-5%	-5%	-5%
Hourly instructor cost	$82	$78	$74	$70	$67
Decrease in hourly instructor cost	-5%	-5%	-5%	-5%	-5%
Documentation costs per user	$10	$10	$9	$9	$8
Decrease in documentation costs per user	-5%	-5%	-5%	-5%	-5%
Initial Education	$95,120	$3,749	$3,558	$3,376	$3,205
Documentation	$2,600	$119	$118	$118	$118
Total Onboarding Costs	**$97,720**	**$3,868**	**$3,676**	**$3,495**	**$3,323**

Source: Author's assumptions

As shown in Table 7, for Scenario I, private blockchain, key inputs for calculating training and documentation costs include training hours per full node user, which is estimated to start from 16 hours in first year and decrease by 5% in following years due to increase in capacity. Training hours per end user is another key input in onboarding costs, which starts with 4 hours per user and decreases 5% every following year.

According to Ernst & Young (2019), hourly instructor cost for training starts with $82 and decreases by 5% afterwards. And, documentation costs per user is initially $10 which also decreases by 5% in consecutive years.

Table 8. Scenario II: Onboarding costs of public blockchain

Onboarding Costs	**Year**				
	1	2	3	4	5
Training hours per full node user	0	0	0	0	0
Decrease in training hours per full node user	-5%	-5%	-5%	-5%	-5%
Training hours per end user	4	4	4	3	3
Decrease in training hours per end user	-5%	-5%	-5%	-5%	-5%
Hourly instructor cost	$82	$78	$74	$70	$67
Decrease in hourly instructor cost	-5%	-5%	-5%	-5%	-5%
Documentation costs per user	$11	$10	$10	$9	$9
Decrease in documentation costs per user	-5%	-5%	-5%	-5%	-5%
Initial Education	$3,280	$150	$142	$135	$128
Documentation	$110	$5	$5	$5	$5
Total Onboarding Costs	**$3,390**	**$155**	**$148**	**$140**	**$133**

Source: Author's assumptions

As shown in Table 8, the difference in key inputs for Scenario II, public blockchain, is that training for full node users is not required as there are no separate nodes in public blockchain. Also, documentation costs start with $11 due to the third party blockchain network.

3.2.3. Ongoing Costs

Ongoing costs of blockchain-based global payment system consist of blockchain service provider license fee, internal governance model, blockchain technical support full time employee (FTE), and ongoing education.

Table 9. Scenario I: Ongoing costs of private blockchain

Ongoing Costs	Year				
	1	2	3	4	5
Blockchain service provider license fee	$20,000	$20,000	$20,000	$20,000	$20,000
Internal governance model	$200,000	$200,000	$200,000	$200,000	$200,000
Blockchain technical support FTE	$98,000	$98,000	$98,000	$98,000	$98,000
Ongoing education costs per user	$164	$156	$148	$141	$134
Decrease in ongoing education costs per user	-5%	-5%	-5%	-5%	-5%
Ongoing Education	$42,640	$42,456	$42,275	$42,099	$41,927
Total ongoing Costs	**$360,640**	**$360,456**	**$360,275**	**$360,099**	**$359,927**

Source: Author's assumptions

As shown in Table 9 for Scenario I, private blockchain, according to Forrester (2018, p. 47), IBM blockchain license fee is $20,000 per year and the cost of developing governance model - involving contract negotiations, legal, business owners, IT management – is $200,000 per year. And, according to Ernst $ Young (2019), annual costs of a blockchain technical support is $98,000.

Key inputs for ongoing education consist of ongoing education costs per user which according to Ernst & Young (2019) is 2 hours per year ($82 training cost per hour), thus starts with $164 initially and decreases 5% in following years.

Table 10. Scenario II: Ongoing costs of public blockchain

Ongoing Costs	Year				
	1	2	3	4	5
Blockchain service provider license fee	$20,000	$20,000	$20,000	$20,000	$20,000
Internal governance model	$200,000	$200,000	$200,000	$200,000	$200,000
Blockchain technical support FTE	$-	$-	$-	$-	$-
Ongoing education costs per user	$164	$156	$148	$141	$134
Decrease in ongoing education costs per user	-5%	-5%	-5%	-5%	-5%
Ongoing Education	$1,640	$1,636	$1,632	$1,628	$1,624
Total ongoing Costs	**$221,640**	**$221,636**	**$221,632**	**$221,628**	**$221,624**

Source: Author's assumptions

As shown in Table 10, the difference in costs for Scenario II, public blockchain, is that a blockchain technical support is not required, and, due to few numbers of full nodes and end users, the ongoing education is lower.

3.2.4. Maintenance Costs

Costs related to maintenance costs depend on the annual cost of virtual machines (VM), which is an emulation of a computer system used by full nodes to verify blockchain transactions.

Table 11. Scenario I: Maintenance costs of private blockchain

Maintenance Costs	**Year**				
	1	2	3	4	5
Cloud VM per full node	1	0,95	0,90	0,86	0,81
Decrease in cloud VM per full node	-5%	-5%	-5%	-5%	-5%
Annual cloud VM cost	$2,000	$1,800	$1,620	$1,458	$1,312
Decrease annual cloud VM cost	-10%	-10%	-10%	-10%	-10%
Total Maintenance Costs	**$20,000**	**$17,100**	**$14,621**	**$12,501**	**$10,688**

Source: Author's assumptions

As shown in Table 11 for Scenario I, the inputs required to calculate annual cost of cloud virtual machines are virtual machines needed per full node which starts with 1 in first year and decreases by 5% in following years due to improvement in computational power of those virtual machines.

According to Ernst & Young (2019), the annual cost of a virtual machine starts with $2,000 in first year and then decreases by 10% in consecutive years.

Table 12. Scenario II: Maintenance costs of public blockchain

Maintenance Costs	**Year**				
	1	2	3	4	5
Cloud VM per full node	1	0,95	0,90	0,86	0,81
Decrease in cloud VM per full node	-5%	-5%	-5%	-5%	-5%
Annual cloud VM cost	$2,300	$2,070	$1,863	$1,677	$1,509
Decrease annual cloud VM cost	-10%	-10%	-10%	-10%	-10%
Total Maintenance Costs	**$ 8,799**	**$8,359**	**$7,941**	**$7,544**	**$7,167**

Source: Author's assumptions

As shown in Table 12 for Scenario II, the difference in annual virtual machine per full node starts with $2,300. Also, the total maintenance costs are less in a public blockchain due to the few number of full node users. However full nodes required in a public blockchain is zero, an access to the virtual machine is required in order to execute transactions, and according to Ernst & Young (2019), regardless of number of nodes, minimum annual cost for virtual machine is $8,799.

3.2.5. Monitoring Costs

Monitoring costs of a blockchain-based global payment system consist of transaction review and network assessment.

Table 13. Scenario I: Monitoring costs of private blockchain

Monitoring Costs	Year				
	1	2	3	4	5
Costs per 100,000 transactions	$15	$14	$14	$13	$12
Decrease in costs per 100,000 transactions	-5%	-5%	-5%	-5%	-5%
Transaction Review	$900	$1 710	$2 437	$3 087	$3 665
Network Assessment	$1,495	$1,495	$1,495	$, 495	$1,495
Decrease in network assessment	0%	0%	0%	0%	0%
Total Monitoring Costs	**$2,395**	**$3,205**	**$3,932**	**$4,582**	**$5,160**

Source: Author's assumptions

As shown in Table 13 for Scenario I, private blockchain, key input in costs associated with network assessment is costs per 100,000 transactions which according to Ernst & Young (2019) starts with $15 in first year and decreases by 5% in following years. Network assessment starts with a fixed cost of $1,495 per year and stays constant in following years.

Table 14. Scenario II: Monitoring costs of public blockchain

Monitoring Costs	Year				
	1	2	3	4	5
Costs per 100,000 transactions	$17	$16	$15	$15	$14
Decrease in costs per 100,000 transactions	-5%	-5%	-5%	-5%	-5%
Transaction Review	$1,020	$1,938	$2,762	$3,498	$4,154
Network Assessment	$1,719	$1,719	$1,719	$1,719	$1,719
Decrease in network assessment	0%	0%	0%	0%	0%
Total Monitoring Costs	**$2,739**	**$3,657**	**$4,481**	**$5,217**	**$5,873**

Source: Author's assumptions

As shown in Table 14 for Scenario II, public blockchain, the difference is in costs per 100,000 transactions which according to Ernst & Young (2019) starts with $17 in first year. Also, network assessment's fixed annual cost is $1,719 for all five years.

3.3. Identifying and Measuring Benefits

By compiling the models in the reports by Ernst & Young (2019) and Forrester (2018), the author has constructed the benefits model adapted to a financial institution operating in global payments.

Figure 10 presents the benefits model used in this thesis to measure the benefits of blockchain-based global payments.

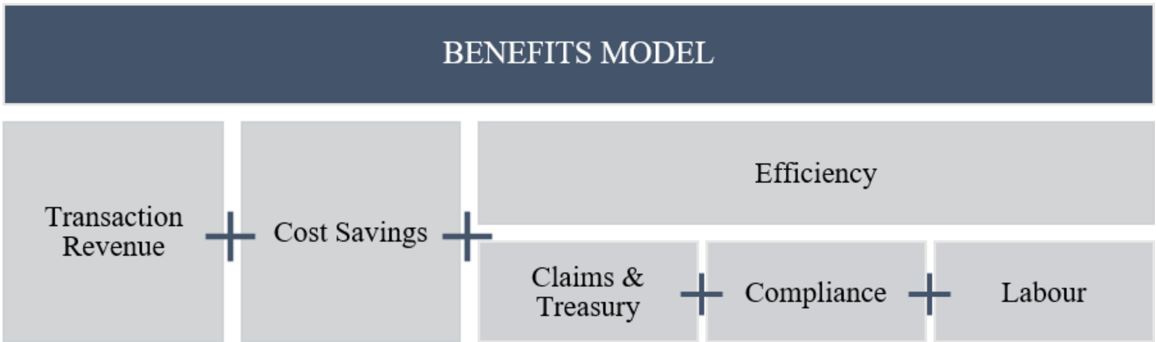

Figure 10. Model for measuring benefits of blockchain-based global payments
Source: The author

As shown in Figure 10, benefits gained by implementing blockchain in global payments include revenue from transactions made on the new platform, cost savings due to blockchain's added value, and efficiency in claims, treasury and compliance operations and cost savings from efficiency in labour. The total benefit gained by implementing blockchain is attained by adding the benefits in each segment of transaction value, cost savings, claims and treasury, compliance, and labour.

3.3.1. Transaction Revenue

Transaction revenue refers to revenue earned for each transaction made by customers on a blockchain network.

Table 15. Benefit from transaction revenue due to blockchain

Transaction Revenue	Year				
	1	2	3	4	5
Number of customers	1,500,000	3,000,000	4,500,000	6,000,000	7,500,000
Number of annual transactions per customer	4	4	4	4	4

Price per transaction (fee + X rate margin)	$1	$1	$1	$1	$1
Percentage of fee per blockchain transaction	19%	19%	19%	19%	19%
Decrease in fee per blockchain transaction	-3%	-3%	-3%	-3%	-3%
Fee per blockchain transaction	19%	18%	18%	17%	17%
Transaction revenue	**$1,140,000**	**$2,211,600**	**$3,217,878**	**$4,161,789**	**$5,046,169**

Source: Author's assumptions

As shown in Table 15, key inputs in calculating transaction revenue are number of customers and number of annual transactions made by these customers. According to Forrester (2018), a mid-level business can gain 1.5 million customers in the first year who would use the blockchain technology, increasing by 1.5 million every consecutive year.

Forrester (2018) also estimates a total of four transactions per customer every year. Price per each transaction is estimated to be $2 according to Forrester (2018), however, in order to compete in the market with other global payment service providers, adjusting price per transaction to $1 is more reasonable. Especially because an extra 19% is charged as (Forrester, 2018) fee for transactions over the blockchain network, however this fee is estimated to decrease by 3% every consecutive year.

3.3.2. Cost Savings

Cost savings due to blockchain implementation in global payments consist of savings in capital expenditure (CapEx) and operational expenditure (OpEx).

Table 16. Benefit from cost savings due to blockchain

Cost Savings	Year				
	1	2	3	4	5
CapEx avoided	$5,000,000			$5,000,000	
Avoided additional infrastructure costs	$1,000,000	$-	$-	$1,000,000	$-
Subtotal: CapEx Savings	$6,000,000	$-	$-	$6,000,000	$-
Total cumulative CapEx costs	$6,000,000	$6,000,000	$6,000,000	$12,000,000	$12,000,000
OpEx required as a percentage of CapEx	20%	20%	20%	20%	20%
Subtotal: OpEx Savings	$1,200,000	$1,200,000	$1,200,000	$2,400,000	$2,400,000
CapEx and OpEx Savings	**$7,200,000**	**$1,200,000**	**$1,200,000**	**$8,400,000**	**$2,400,000**

Source: Author's assumptions

As shown in Table 16, Forrester (2018) suggests that IBM's subject companies will avoid $5 million capital expenditure spent on technological projects and $1 million for additional infrastructure costs in first year followed by the same amount in fourth year.

Also, according to Forrester (2018), operational expenditure is assumed to be 20% of the cumulative capital expenditure avoided each year.

3.3.3. Efficiency

Efficiency refers to improving processes to yield more profit with less resources. According to Forrester (2018), IBM's subject companies reported efficiency generated by implementing blockchain in areas such as claims and treasury operations, compliance procedures, and labour costs.

3.3.3.1. Efficient Claims and Treasury operations

Saving costs through efficient claims and treasury operations consist of reducing the number of claims resolution and reducing cost of treasury operations.

Table 17. Benefit from efficiency in claims and treasury operations due to blockchain

Claims and treasury operations	Year				
	1	2	3	4	5
Total conflicting records	50,000	50,000	50,000	50,000	50,000
Percentage of claims	7%	7%	7%	7%	7%
Number of claims that require resolution	3,500	3,500	3,500	3,500	3,500
Average cost to resolve a dispute	$250	$250	$250	$250	$250
Projected reduction in claims with blockchain	100%	100%	100%	100%	100%
Savings due to reduction in claims	$875,000	$875,000	$875,000	$875,000	$875,000
Average cost for treasury operations	$22	$22	$22	$22	$22
Reduction in cost per record	30%	30%	30%	30%	30%
Savings due to reduction in cost of treasury operations	$330,000	$330,000	$330,000	$330,000	$330,000
Savings for claims and treasury operations	**$1,205,000**	**$1,205,000**	**$1,205,000**	**$1,205,000**	**$1,205,000**

Source: Author's assumptions

As shown in Table 17, key inputs in calculating savings for claims and treasury operations are total conflicting records, percentage claims, and average cost to resolve those claims. And, other key inputs are average cost for treasury operations and the percentage of costs reduced due to blockchain implementation.

According to Forrester (2018), total conflicting records for IBM's subject companies are estimated to be 50,000 per year, 7% of which will have claim cases. Average cost of resolving the claims is estimated to be $250 per claim (Forrester, 2018). Furthermore, average cost for treasury operations is estimated to be $22 and blockchain implementation will reduce the cost by 30% each year (Forrester, 2018).

3.3.3.2. Efficient Compliance Procedures

Saving costs through efficient compliance procedures after implementing blockchain consist of the fixed cost of complying with regulations set by authorities.

Table 18. Benefit from efficiency in compliance procedures due to blockchain

Reduced Compliance Procedures	Year				
	1	2	3	4	5
Compliance procedures cost	$200,000	$200,000	$200,000	$200,000	$200,000
Percentage of compliance procedures replaced by Blockchain	10%	50%	80%	100%	100%
Compliance procedures savings	**$20,000**	**$100,000**	**$160,000**	**$200,000**	**$200,000**

Source: Author's assumptions

As shown in Table 18, according to Forrester (2018), the cost of compliance procedures is $200,000 per year and stays constant throughout the year. After implementing blockchain in the global payment system, 10% of compliance procedures cost is avoided, followed by 50% and 80% in consecutive years. Eventually in the 4th year, 100% of the cost is avoided by implementing blockchain and then stays constant at that rate in following years.

3.3.3.3. Efficient Labour Costs

By implementing blockchain in the global payments system, labour costs are avoided or reduced which consist of a number of finance and legal full-time employees resolving conflicting records.

Table 19. Benefit from efficiency in labour costs due to blockchain

Reduced Labour Costs	Year				
	1	2	3	4	5
Number of finance FTEs resolving conflicting records	5	5	5	5	5
Finance FTEs annual compensation	$75,000	$75,000	$75,000	$75,000	$75,000

Reduction to finance resources	20%	40%	60%	80%	80%
Savings due to reduction in finance FTEs	$75,000	$150,000	$225,000	$300,000	$300,000
Number of legal FTEs resolving conflicting records	3	3	3	3	3
Legal FTEs annual compensation	$200,000	$200,000	$200,000	$200,000	$200,000
Reduction to legal resources	0%	30%	50%	70%	70%
Savings due to reduction in legal FTEs	$-	$180,000	$300,000	$420,000	$420,000
Labour cost savings	**$75,000**	**$330,000**	**$525,000**	**$720,000**	**$720,000**

Source: Author's assumptions

As shown in Table 19, key inputs in reduced labour costs are the number of finance full-time employees, their annual compensation, number of legal full-time employees, and their annual compensation, including the percentage of reduction in resources every year.

According to Forrester (2018), for a mid-level company, the number of finance full-time employees involved in resolving conflicting records is 5 and their annual compensation is $75,000, of which 20% is reduced in the first year followed by 40%, 60% and a constant 80% in consecutive years. Forrester (2018) suggests 3 legal full-time employees resolving conflicting records with an annual compensation of $200,000, of which there is no reduction in year 1 but year 2 has a reduction of 30% followed by 50% and a constant 70% in consecutive years.

3.4. Net Present Value and Sensitivity Test

Companies usually use discount rates between 8% and 16% (Forrester, 2018). The author has selected the discount rate based on worldwide average interest rate since the cost and benefit of blockchain are analysed in global payments, which is 11.23% (The Global Economy, 2020).

Table 20. NPV of benefits of blockchain-based global payments

Benefits	Year				
	1	2	3	4	5
Transaction revenue	$1,140,000	$2,211,600	$3,217,878	$4,161,789	$5,046,169
CapEx and OpEx Savings	$7,200,000	$1,200,000	$1,200,000	$8,400,000	$2,400,000
Savings for claims and treasury operations	$1,205,000	$1,205,000	$1,205,000	$1,205,000	$1,205,000
Compliance procedures savings	$20,000	$100,000	$160,000	$200,000	$200,000
Labour cost savings	$75,000	$330,000	$525,000	$720,000	$720,000
Total Benefit	**$9,640,000**	**$5,046,600**	**$6,307,878**	**$14,686,789**	**$9,571,169**

Present Value	$8,666,727	$4,079,012	$4,583,714	$9,594,870	$5,621,540
Discount rate	11.23%				
Net Present Value	**$32,545,863**				

Source: Author's calculations

As shown in Table 20, the benefits of blockchain-based global payments have been added up for each year and then discounted to present values using an 11.23% discount rate which results in a net present value of benefits of $35.5 million.

Table 21. NPV of costs of private blockchain-based global payments

Scenario I: Private Blockchain Costs	Year					
	Initial	1	2	3	4	5
Initial platform development	$1,500,000					
Total Onboarding Costs		$97,720	$3,868	$3,676	$3,495	$3,323
Total Maintenance Costs		$20,000	$17,100	$14,621	$12,501	$10,688
Total ongoing Costs		$360,640	$360,456	$360,275	$360,099	$359,927
Total Monitoring Costs		$2,395	$3,205	$3,932	$4,582	$5,160
Total Costs	**$1,500,000**	**$480,755**	**$384,628**	**$382,504**	**$380,676**	**$379,099**
Present Value	$1,500,000	$432,217	$310,883	$277,952	$248,695	$222,660
Discount rate	11.23%					
Net Present Value	**$2,992,408**					

Source: Author's calculations

As shown in Table 21, the costs of private blockchain-based global payments have been added up for each year and then discounted to present values using an 11.23% discount rate which results in a net present value of costs in Scenario I of $2.99 million, including the initial investment of $1.5 million.

Table 22. NPV of costs of public blockchain-based global payments

Scenario II: Public Blockchain Costs	Year					
	Initial	1	2	3	4	5
Initial platform development	$1,000,000					
Total Onboarding Costs		$3,390	$155	$148	$140	$133
Total Maintenance Costs		$8,799	$8,359	$7,941	$7,544	$7,167
Total ongoing Costs		$221,640	$221,636	$221,632	$221,628	$221,624
Total Monitoring Costs		$2,739	$3,657	$4,481	$5,217	$5,873

Total Costs	$1,000,000	$236,568	$233,807	$234,201	$234,529	$234,797
Present Value	$1,000,000	$212,684	$188,979	$170,186	$153,218	$137,906
Discount rate	11.23%					
Net Present Value	**$1,862,972**					

Source: Author’s calculations

As shown in Table 22, the costs of public blockchain-based global payments have been added up for each year and then discounted to present values using an 11.23% discount rate which results in a net present value for costs in Scenario I of $1.86 million, including the initial investment of $1 million.

For sensitivity test, the author considers 50% increase or descrease in the total number of customers to observe the impact on the cost and benefit values. A 50% increase in customers, 2,250,000 in first year with the addition of 2,250,000 in consecutive years will impact the net present value of benefits drastically, increasing it to $52,164,660. Although, the affect of 50% increase in customers on costs are minimal, as net present value of private blockchain costs increase to $3,006,948 and public blockchain to $1,879,451.

Furthermore, a 50% decrease in the total number of customers, 750,000 in first year with the addition of 750,000 in consecutive years will impact the net present value of benefits by decreasing it to $24,788,636. Yet, the affect of 50% descrease in customers on costs stay minimal, as net present value of private blockchain costs decrease to $2,986,606 and public blockchain to $1,856,396.

3.5. Results and Comparison

Based on the calculations above, NPV, ROI, BCR, and payback period of implementing blockchain in global payments are as below in the two scenarios.

Scenario I: Private blockchain

$NPV_{(I)} = NPV_B - NPV_{C(I)} - i$ = \$32.55 – \$1.49 – \$1.5 = \$29.55 *(million)*

$ROI_{(I)} = (NPV_B - NPV_{C(I)}) / i$ = (\$32.55 – \$1.49) / \$1.5 = 20.70

$BCR_{(I)} = NPV_B / (NPV_{C(I)} + i) = \$32.55 / (\$1.49 + \$1.5) = 10.88$

$\text{Payback period}_{(I)} = i / (NPV_B – NPV_{C(I)}) = \$1.5 / (\$32.55 – \$1.49) = 0.05$

As shown above, implementing a private blockchain in global payments will yield NPV of $29.55 million and since it is a positive figure, this project is profitable. Furthermore, ROI is 20.70 which suggests that each $1 investment yields $20.70 profit, and BCR of 10.88, which means that each $1 cost incurred yields $10.88 profit. Also, the payback period for implementing private blockchain is 0.05 years, which means that the initial investment amount is paid back in less than a year.

Scenario II: Public blockchain

$NPV_{(II)} = NPV_B – NPV_{C(II)} – i = \$32.55 - \$0.86 - \$1 = \$30.68$ *(million)*

$ROI_{(II)} = (NPV_B – NPV_{C(II)}) / i = (\$32.55 – \$0.86) / \$1 = 31.68$

$BCR_{(II)} = NPV_B / (NPV_{C(II)} + i) = \$32.55 / (\$0.86 + \$1) = 17.47$

$\text{Payback period}_{(II)} = i / (NPV_B – NPV_{C(II)}) = \$1 / (\$32.55 - \$0.86) = 0.03$

As shown above, implementing a public blockchain in global payments will yield NPV of $30.68 million and since it is a positive figure, this scenario is profitable too. Furthermore, ROI is 31.68 which suggests that each $1 investment yields $31.68 profit, and BCR of 17.47, which means that each $1 cost incurred yields $17.47 profit. Also, the payback period for implementing private blockchain is 0.03 years, which means that the initial investment amount is paid back in less than a year in Scenario II too.

In order to compare the findings of this thesis with the base case, Western Union's ratios are calculated based on the data taken from their annual reports for years 2015 to 2019 (The Western Union Company, 2019). In order to align the valuation with the cost-benefit scenarios, the future values of Western Union's cash flows need to be calculated using below formula.

$$NFV = \sum_{t=0}^{t} B_t(1+r)^t - \sum_{t=0}^{t} C_t(1+r)^t$$

Table 23. NFV of benefits of Western Union

Benefits of WU	Year				
	2019	2018	2017	2016	2015
Revenues	$5,292,100,000	$5,589,900,000	$5,524,300,000	$5,422,900,000	$5,483,700,000
Other income, net	$8,500,000	$14,100,000	$8,900,000	$7,000,000	$1,200,000
Gain on divestitures of businesses	$524,600,000	$ 0	$ 0	$ 0	$ 0
Interest income	$ 0	$ 0	$ 0	$3,500,000	$10,900,000
Total benefits	**$5,825,200,000**	**$5,604,000,000**	**$5,533,200,000**	**$5,433,400,000**	**$5,495,800,000**
Future value of Benefits	$5,970,830,000	$5,887,702,500	$5,958,651,206	$5,997,456,960	$6,217,993,256
Risk free rate	2.5%				
Net future value of Benefits	**$30,032,633,923**				

Source: Author’s calculations

Table 24. NFV of costs of Western Union

Costs of WU	Year				
	2019	2018	2017	2016	2015
Cost of services.	$3,086,500,000	$3,300,800,000	$3,353,000,000	$3,270,000,000	$3,199,400,000
Selling, general, and administrative	$1,271,600,000	$1,167,000,000	$1,231,500,000	$1,669,200,000	$1,174,900,000
Goodwill impairment charge	$ 0	$ 0	$464,000,000	$ 0	$ 0
Other expense	$ 0	$ 0	$ 0	$ 0	$11,800,000
Interest expense	$ 0	$ 0	$ 0	$152,500,000	$167,900,000
Provision for income taxes	$263,100,000	$139,500,000	$904,600,000	$88,500,000	$104,000,000
Total costs	$4,621,200 000	$4,607,300,000	$5,953,100,000	$5,180,200,000	$4,658,000,000
Future value of Costs	$4,736,730,000	$4,840,544,563	$6,410,837,580	$5,717,971,536	$5,270,099,456
Risk free rate	2.5%				
Net future value of Costs	**$26,976,183,134**				

Source: Author’s calculations

As shown in Table 23 and Table 24 above, the benefits and costs of each year have been added and then their future values have been calculated using the risk free rate of 2.5% used in Western

Union's forecasts and predictions in their reports (The Western Union Company, 2019). Thus, the future value of Western Union's benefits sum up to \$30 billion and costs to \$27 billion.

Since an estimate of the initial investment of Western Union's system's adoption is not available and their cash flows are in billions, higher than the results in above cost-benefit analysis, a standard BCR ratio of the two systems is compared below.

$BCR_{(WU)} = NFV_B / NFV_C = \$30 / \$27 = 1.11$

Above calculation suggests that Western Union earns only \$1.11 for each \$1 cost they incur, which in comparison to the lowest blockchain implemented system's BCR (Scenario I) of 10.88 (10.88/1.11) is 9.8 times lesser, and thus not as profitable as a blockchain-based global payment system.

CONCLUSION

This thesis is conducted in the subject matter of blockchain technology and its effects on the financial industry, especially in global payments niche, by reviewing different academic literature and respected financial institutions' reports. The purpose of this thesis is analysing the profitability of implementing blockchain technology in global payments. The research strategy of this thesis is collecting quantitative figures for costs and benefits of blockchain-based global payments, and drawing conclusions based on cost-benefit analysis. This research is relevant to the author due to high interest in the finance field and developin an overview of the future of finance affected by various technologies. The research is one of the first attempts in analysing the profitability of blockchain implementation in global payments which complement other existing researches.

Through literature review the author has found out that blockchain technology will initiate the innovation of the Internet of Value and trigger the fourth industrial revolution. Blockchain is one of the mega trends which has seen a tremendous progress in adoption within academic and business communities. Blockchain together with technologies such as cryptocurrencies, digital wallets, and smart contracts will enable secure and immutable value transactions without the need of intermediary institutions, reducing the transaction costs up to 95%. Blockchain will greatly change the current state of global payments by improving the process of anti-money laundering, clearing and settlement, reducing or eliminating the use of nostro vostro accounts, and standardising foreign exchange rate fluctuations to reduce risks taken by international businesses.

Currently blockchains are developed in two types of public and private based on the preference of the financial institutions in amount of control, privacy, and scalability. While blockchain was first introduced as a decentralised technology through which transactions can be verified by the public, a hybrid ecosystem consisting both public and private blockchain is more likely to be witnessed in future. However blockchain is yet in the experiment phase and is not mature, finance and blockchain giants such as KPMG, Ernst & Young, Deloitte, and Ripple are heavily investing in this technology and its implementation in global payments.

The leading financial institutions are already capitalising on blockchain technology. Blockchain has started moving to production and is being adopted across variant industries. Blockchain will enable industries to become independent of current intermediaries, especially the finance industry with respect to global payments.

The analysis approach in this thesis has been carried out through the cost-benefit model as first objective and alternatives have been determined, then costs and benefits have been identified and measured, next aggregated results have been interpreted, and lastly the findings were compared to the base case - Western Union. The quantitative approach for collecting cost and benefit figures has been carried out through the costs model comprised of developing, onboarding, ongoing, maintaining, and monitoring costs, and benefits model comprised of transaction revenue, cost savings, and efficiency in claims and treasure, compliance, and labour.

To answer the central research question (CRQ), by using cost-benefit analysis and calculating different decision ratios such as net present values (NPV), return on investment (ROI), benefit to cost ratio (BCR), and payback period, the author has concluded that implementing a public blockchain system in global payments is more profitable than implementing a private blockchain system, however, both of these scenarios yield more profitability than current traditional systems such as the base case in this thesis, Western Union. Investing in blockchain will yield a profit of $20 - $32 for each $1 invested depending on the type of blockchain technology implemented. Blockchain-based global payments yields $10 - $18 of revenue for each $1 cost incurred, depending on the type of blockchain, which is almost ten times more than what Western Union currently earns.

To answer the research question (RQ1), blockchain will transform the current global payment system by substituting intermediaries such as SWIFT and correspondent banks. By the usage of digital identities stored on blockchain and smart contracts enabled on the network, transactions will be delivered seamlessly across the world, with a possiblity to automate most of the payment processes. Through the blockchain network, anti-money laundering and Know Your Customer activities are managed with higher efficiency and regulatory reports are available for stakeholders in real-time and on demand. This transformation by blockchain will reduce the cost of transactions for financial institutions tremendously and result in a drastic time-saving.

To answer the research question (RQ2), from the author's perspective, implementing blockchain certainly brings advantages in securing payment transactions and making them reliable enough to eliminate the need for current intermediaries such as SWIFT, reducing the costs tremendously. However, blockchain has a long way to mature and be ready to be fully implemented and integrated to current business models.

The limitation of quantitative analysis in blockchain implementation consists of limited real life case studies to draw realistic projections of the technology's future progress. This shortcoming can be addressed by consulting blockchain technology and business experts, and utilising available data for similar technologies and business models.

Further studies in blockchain-based global payments consist of analysing social cost and benefits of the technology, evaluating indirect effects blockchain might have on the society, and developing an implementation roadmap to a functional blockchain-based global payments. Blockchain: Blueprint for a new economy (2015) by Melanie Swan provides a thorough understanding of the technology and its implementation in an economical framework, and makes a good starting point for further research in the subject matter.

The author acknowledges that writing the thesis on cost-benefit analysis of blockchain-based global payments was a satisfying experience, especially since the subject matter of new technologies in the finance industry is of high personal relevance. This has been a great addition to the academics and the best way to complete the master's programme of International Business Administration at Tallinn University of Technology.

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APPENDICES

Appendix 1. Blockchain-based global payments costs model

	Year					
	Initial	1	2	3	4	5
Full nodes						
End users						
Increase in End users						
Annual user turnover						
Annual transaction volume						
Onboarding Costs						
Initial Platform Build						
Training hours per full node user						
Decrease in training hours per full node user						
Training hours per end user						
Decrease in training hours per end user						
Hourly instructor cost						
Decrease in hourly instructor cost						
Documentation costs per user						
Decrease in documentation costs per user						
Initial Education						
Documentation						
Total Onboarding Costs						
Maintenance Costs						
Cloud VM per full node						
Decrease in cloud VM per full node						
Annual cloud VM cost						
Decrease annual cloud VM cost						
Total Maintenance Costs						
On-Going Costs						

Blockchain service provider license fee						
Internal governance model						
Blockchain technical support FTE						
On-going education costs per user						
Decrease in on-going education costs per user						
On-going Education						
Total on-going Costs						
Monitoring Costs						
Costs per 100,000 transactions						
Decrease in costs per 100,000 transactions						
Transaction Review						
Network Assessment						
Decrease in network assessment						
Total Monitoring Costs						
TOTAL COSTS						

Source: Sahaak (2020), author’s design

Appendix 2. Blockchain-based global payments benefits model

	Year				
	1	2	3	4	5
Transaction Revenue					
Number of customers					
Number of annual transactions per customer					
Price per transaction (fee + X rate margin)					
Original percentage of founder charge per transaction					
Decrease in founder revenue per transaction					
Found revenue per transaction					
Transaction revenue					
Cost Savings					
CapEx avoided					
Avoided additional infrastructure costs					
Subtotal: CapEx Savings					
Total CapEx costs avoided (cumulative for five years)					
OpEx required as a percentage of CapEx					
Subtotal: OpEx Savings					
CapEx and OpEx Savings					
Efficiency - Claims and treasury operations					
Total conflicting records					
Percentage of claims					
Number of claims that require resolution					
Average cost to resolve a dispute					
Projected reduction in claims with blockchain					
Savings due to reduction in claims					
Average cost for treasury operations					
Reduction in cost per record					
Savings due to reduction in cost of treasury operations					
Savings for claims and treasury operations					
Efficiency - Reduced Compliance Procedures					

Compliance procedures cost					
Percentage of compliance procedures replaced by Blockchain					
Compliance procedures savings					
Efficiency - Labour Cost Reduction					
Number of finance FTEs resolving conflicting records prior to blockchain					
Finance FTEs annual compensation					
Reduction to finance resources dedicated to resolving conflicting records from us of blockchain					
Savings due to reduction in finance FTEs					
Number of legal FTEs resolving conflicting records prior to blockchain					
Legal FTEs annual compensation					
Reduction to legal resources resolving conflicting records with blockchain					
Savings due to reduction in legal FTEs					
Labour cost savings					
TOTAL BENEFIT					

Source: Sahaak (2020), author's design

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