

Report on
***An Analysis of Adoption of Blockchain Technology
in the Private Banking Sector of Bangladesh***

by

Khokan Kanti Saha

ID No.: 18282005

Masters in Procurement and Supply Management

BIGD, BRAC University

**An internship report submitted to the BRAC Institute of Governance and
Development in partial fulfillment of the requirements for the degree of
Masters in Procurement and Supply Management**

BRAC Institute of Governance and Development

BRAC University

January, 2021

**© 2021, BRAC University
All rights reserved.**

Declaration

It is hereby declared that

1. The internship report submitted is my own original work while completing degree at BRAC University.
2. The report does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The report does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

Student's Full Name & Signature:

Khokan Kanti Saha
ID: 18282005
MPSM, BIGD, BRAC University

Supervisor's Full Name & Signature:

Shanawez Hossain, Ph.D.
Director, Executive Development Center (EDC)
Head of Capacity Building & Partnership
Assistant Professor, BIGD, BRAC University

Mr. Shanawez Hossain
Director, Executive Development Center (EDC)
Head of Capacity Building & Partnership
& Assistant Professor, BIGD
BRAC University
66 Mohakhali, Dhaka-1212

Subject: Letter of Transmittal.

Dear Sir,

This is my pleasure to submit the final report on '**An analysis of adoption of blockchain technology in the private banking sector of Bangladesh**' for your kind evaluation as a part of the fulfillment of the requirements for the completion of the degree Masters in Procurement and Supply Chain, which I have been completed by your close supervision and guidance.

I have attempted my best to finish the report with the essential data and recommended proposition in a significant compact and comprehensive manner as possible.

I trust that the report will meet the desires.

Sincerely yours,

Khokan Kanti Saha

Student ID: 18282005

BRAC Institute of Governance and Development

BRAC University

January 25, 2021

Acknowledgement

First and foremost, all praises and gratefulness to the Almighty God for his immense blessings bestowed on me during the preparation of this seminar paper. I wish to provide my sincere appreciation to Mr. Shanawez Hossain, Ph.D., Director, Executive Development Center (EDC), Head of Capacity Building & Partnership and Assistant Professor, BIGD, BRAC University for his thoughtful, meticulous and enthusiastic supervision that guides me in the right direction to prepare this report. His keen observations and suggestions on different aspects of writing a report/practicum will be my asset in future while indulge in similar activities.

I am highly obliged in taking the opportunity of conveying my heartfelt acknowledgement to different officials of Standard Chartered Bangladesh, HSBC Bangladesh, Bank Asia Ltd. and Prime Bank Ltd. to assist me with their pertinent views on different discussion points of this report as well as in collecting data.

I would also like to place on record my cordial thanks and indebtedness to respected faculty members of BRAC Institute of Governance and Development, BRAC University and fellow friends, students of MPSM for their candid support and co-operation throughout the study.

Last but not the least, my sense of gratitude to my family for their perpetual encouragement and support that persuades me to complete this paper within the timeframe.

Sincerely yours,

Khokan Kanti Saha

Student ID: 18282005

BRAC Institute of Governance and Development

BRAC University

Abstract

Blockchain is a key digital technique for ensuring the transparency, speed and immutability of different banking transactions. The private banking sector of Bangladesh has started to adopt the blockchain technology in its banking service management to keep it compatible in the world of virtual transaction. A new technology should adopt robustly for ensuring scale of economies in scope and scalability to get designated efficiency and effective over the existing technology. The study investigates the adoption of blockchain technology in four commercial private banks of Bangladesh. It is a qualitative study for which data is collected mainly from secondary sources such as newspaper and journal articles, press release and un-structured interviews with the relevant bank officials. In this study it is found that the blockchain technology is adopted in a limited scale applying only for two banking services, Letter of Credit (LC) settlement and remittance. Though the scope and scalability of this technology adoption is still insignificant, the efficiency level is high in terms of streamlining processes, reducing duplicity, increasing transparency and trust, eliminating ambiguities and discrepancies, enhancing security, reducing paper works, saving costs and time, and providing services in real-time. The clients of the services rendered from the blockchain platform of the banks under the study expressed their ecstatic satisfaction about the service quality. However, the large scale adoption of blockchain technology needs to overcome the challenges of growing network, less collaboration, low comprehensiveness, absence of sound regulatory framework and inadequate skilled human resources. If the banking sector can mitigate these challenges, the blockchain technology will become the ‘future technology of banking services’.

Keywords: Peer-to-Peer (P2P), Distributed Ledger Technology (DLT), public and private keys, Letter of Credit (LC), Remittance, Immutability.

Table of Contents

Abstract	i
Table of Contents	ii
Abbreviations/Acronyms	iv
Figures and Tables	v
Chapter 1: Introduction	1
1.1 Background of the Study	1
1.2 Statement of the Problem	2
1.3 Objectives of the Study	5
1.4 Research Questions	5
1.5 Analytical Framework of the Study	5
1.6 Methodology of the Study	7
1.7 Significance of the Study	8
1.8 Limitations of the Study	9
1.9 Structure of the Study	10
Chapter 2: Theoretical Concepts of Blockchain Technology	11
2.1 Introduction	11
2.2 Blockchain-Definition	11
2.3 Blockchain-Types	12
2.4 Key Features of Blockchain	15
2.5 Blockchain Evolution	17
2.6 Blockchain Working Principles	18
2.7 Blockchain Applications	21
2.8 Blockchain in Banking Sector	23

Chapter 3: Findings and Discussions	26
3.1 Introduction	26
3.2 Blockchain Service Initiating Banks	26
3.3 Blockchain-enabled Banking Services	28
3.4 Standard Chartered Intra-bank Blockchain LC.....	29
3.5 HSBC Cross-Border Blockchain LC	29
3.6 Prime Bank Interbank Blockchain LC.....	30
3.7 Bank Asia’s Blockchain Remittance Transfer.....	31
3.8 Standard Chartered’s Blockchain Remittance Platform.....	32
3.9 Blockchain Technology Used in LC Trade Finance	32
3.10. Blockchain Technology Used in Remittance Transfer	33
3.11 A Comparison of Traditional and Blockchain LC Process	33
3.12 Traditional and Blockchain Remittance Transfer Comparison.....	38
3.13 Benefits of Blockchain LC Trade Finance.....	40
3.14 Benefits of Blockchain Remittance Transfer Process.....	43
3.15 Challenges of Blockchain Adoption in Banking Sector	45
 Chapter 4: Recommendations and Conclusion	 48
4.1 Introduction	48
4.2 Recommendations.....	48
4.3 Conclusion.....	50
 <i>References</i>	 51

Abbreviations/Acronyms

AgTech	Agriculture Technology
ATM	Automated Teller Machine
B2B	Business to Business
BEFTN	Bangladesh Electronic Fund Transfer Network
B/L	Bill of Lading
BlendTBS	Blockchain-enabled Decentralized Time-banking System
BPR	Business Process Reengineering
CBDC	Central Bank Digital Currency
CBS	Core Banking Software
CDM	Cash Deposit Machine
CEO	Chief Executive Officer
CSR	Corporate Social Responsibilities
D/A	Documents for Acceptance
DAG	Directed Acrylic Graph
DApps	Decentralized Applications
DLT	Distributed Ledger Technology
D/P	Documents for Payments
EVM	Ethereum Virtual Machine
€	Euro
FinTech	Financial Technology
GII	Global Innovation Index
HSBC	Hong Kong Shanghai Banking Corporation
ICOs	Initial Coin Offerings
ISO	International Standards for Organizations
IT	Information Technology
KYC	Know-Your-Customer
LC	Letter of Credit
MTO	Money Transfer Operator
NRB	Non-resident Bangladeshi
P2P	Peer-to-peer
POS	Point of Sales
PwC	PricewaterhouseCoopers
R&D	Research and Development
SME	Small and Medium Enterprise
SMS	Short Message Service
SWIFT	Society for Worldwide Interbank Financial Telecommunication
TSS	Time-stamp Service
UAE	United Arab Emirates
UCP	Uniform Customs and Practice for Documentary Credits
US \$	United States Dollars
WIPO	World Intellectual Property Rights

Figures

Fig. No.	Description	Page No.
Fig. 1.1	Trend in IT adoption in the banking sector of Bangladesh	4
Fig. 1.2	Analytical framework of the study	6
Fig. 2.1	Blockchain evolution	18
Fig. 2.2	Basic transaction principles of a blockchain	19
Fig. 2.3	Formation of a blockchain with blocks	20
Fig. 3.1	Prime bank executes first interbank blockchain LC	30
Fig. 3.2	Bank Asia's blockchain remittance transfer	31
Fig. 3.3	Basic flowchart of traditional Letter of Credit (LC)	34
Fig. 3.4	Basic flowchart for a blockchain Letter of Credit (LC)	37
Fig. 3.5	Existing remittance transfer flowchart	39
Fig. 3.6	Blockchain remittance transfer flowchart	40

Tables

Table No.	Description	Page No.
Table 1.1	Commercial banks for data collection	8
Table 2.1	Main types of blockchain on permission for access	14

Chapter 1

Introduction

An Analysis of the Adoption of Blockchain Technology in the Private Banking Sector of Bangladesh

1.1 Background of the Study

The fourth industrial revolution is now a reality due to breakthrough progress in the domain of information and communication technology. In this scenario, the role of the public sector is mere of a facilitator to regulate the process of enabling the environment to integrate the new digitization technology in the existing system suitable to core ingredients of the fourth industrial revolution. In contrast, the key player of the fourth industrial revolution is the private sector as a lion share of the investment and effort to industrialization will come from this sector. The Government of Bangladesh also realizes the fact and sets a target in the 7th Five Year Plan to draw about two-third of total investment from the private sector. It is the prime time for the private sector in Bangladesh to avail of this opportunity of investment in various diversified and deepened sectors of industry, trade and commerce by enlarging as well as developing their capacity in different dimensions of the digital transformation of the business transaction. The exchanges of the business world are very complicated and globalized due to the presence of multiple actors and a multitude of stages and generate interconnected complex links in the banking services, which is undoubtedly difficult to manage. In the digitization of this complex banking service regime for efficient management, blockchain is a key digital technique for ensuring the transparency, speed and immutability of different banking transactions. Blockchain is a distributed common digital ledger used by the actors of a transaction simultaneously. It is used to intra-bank activities, interbank or cross-border payments, digital currency deposit, trade finance, make payment in cryptocurrency, and complete any transaction in a synchronized and decentralized way in all banking services. The private banking sector of Bangladesh has started to adopt the blockchain technology in its banking service management to keep it compatible in the world of virtual transaction that will ensure its sustainability in the new business milieu of the fourth industrial revolution.

1.2 Statement of the Problem

Digital information technology brings a rapid and revolutionary change in almost sectors around the globe. The evolution ranges from analog to digital transformation followed by communication through digital medium. The latest foray is observed in the domain of transactions, especially due to the advent of blockchain technology. After the invention of a technology, the next stage is the acceptance and diffusion of it in the designated field. Some countries have required capacity, alertness and preparation to welcome a new technology, which are known as 'leapfrogs'. Conversely, some countries does not have adequate readiness to adopt a new technology due to the lack of adoption capability and foresightedness. These countries are known as 'laggards' and Bangladesh, similar to other third world countries, falls in this category, despite its envious economic growth for over a decades and policy interventions and success story in different areas of information and communication technology.

New Technology adoption heavily relies on the organizational culture, i.e., the norms, values and practices exist within an organization, which are the building blocks for entrepreneurial, flexible, dynamic, team building and result-oriented work environment. In a study it is found that the job satisfaction in the banking sector of Bangladesh is largely inclined to the factors, such as leadership traits, flow of information, assistive tendency to the subordinates, job security, and recognition system. Though the banking sector is trying to maintain a certain standard in this regard, there is still some rooms for improvement and suggests that genial professional experience and equal opportunities for all staff should be established in the banking sector for getting better contribution from the employees (Sultana et al. 2015).

The innovative practices in an organization flourish from the allocation in the research and development in the targeted field and create platform for long term existence of an organization. But the common trend in the private sector of third world countries is that the annual budget allocation for R&D is insignificant that arises mainly from fund deficiency of the organizations, risk-averting nature of the decision making bodies and the reluctance in adopting new technology. According to the Global Innovation Index, 2020 report, released by the World Intellectual Property Organization (WIPO), Bangladesh ranks 116th position among 131th economies (WIPO 2020). Out of seven GII assessment pillars, only in the infrastructure sector, the innovation performance of the country is above average and the performance in other six pillars including knowledge and

innovation outputs is below average in comparison to the innovation performance of other lower income countries. The transformational level of economic growth and development are correlated with the practices of technological innovation, but poor finance in Research and Development (R&D), both in public and private sectors, limits the capacity of adopting and inventing new technology, such as, blockchain for digital transactions.

Organizational set-up and human resource capabilities dominates the acceptance and diffusion process of new technology in an organization. The flat and flexible organization always promotes new concepts within an organization, whereas the hierarchical organization establishes stubborn and decelerates the pace of technology adoption. In a report it has been identified that the hierarchical decision making tiers in the private sector banks of Bangladesh range from 15 to 20 officers, conversely, the tiers range from 8 to 13 officers in case of foreign commercial banks being in operation in Bangladesh¹. Authoritarian hierarchical organization, which exists in the private banks in Bangladesh, leaves modest scope for creative and flexible work culture and innovation and new technology adoption is a far cry in this situation. The human resources need to groom with professional and technical skills to adept in preparing planning and implementation strategy for a new technology similar to blockchain and a dedicated expert team along with a separate department and exclusive responsibilities and facilities moves the goal of adopting a new technology efficiently. In a comparative study for assessing human resources practices of the private sector banks of Bangladesh, it was revealed that only 03 out of 5 commercial private banks have supportive programs for professional capacity building, upper level IT facilitation and career development (Rana & Hossain 2014). However, for an effective implementation of a new technology and building a sound and performing network, well-planned training and development program is a pre-requisite for developing new technology-related infrastructure and creating a skilled human resource pool for proper implementation, maintenance and upgradation.

The technology-driven vision, mission and strategy of the banking sector are necessary for blockchain implementation in the banking sector, as favorable strategic decision and patronage expedites the new technology adoption. Without a concrete adoption strategy, it is impossible to achieve a remarkable success in technology adoption with diffusion at all levels in a productive way. A thorough

¹ online home: Designations / Hierarchy in Banks of Bangladesh (reazrana.blogspot.com)

need analysis regarding process, people and technology demand can contribute a lot to formulate a comprehensive technology adoption strategy focusing on an efficient end-user solution. In a study conducted on different types of information technology (IT) adoption in the banking sector of Bangladesh, it was mentioned that different types of programming software, internet and mobile communication-based technology are adopted in the banking sector for easiness and quickness of transactions in a cost-effective manner. The automation of bank branches, utilization of core banking software (CBS), internet banking system, installation of ATM booths, POS transactions, mobile banking, electronic fund transfer (BEFTN) and application of management information system dazzles the outstanding success of banking sector for developing a IT-enabled banking system. Nevertheless, the banking sector is facing the challenges of poor long term perspective for technology adoption, improper planning and execution strategy, shortage of proficient manpower, limitations in business process reengineering (BPR) and inadequate high level training (Alam 2017).

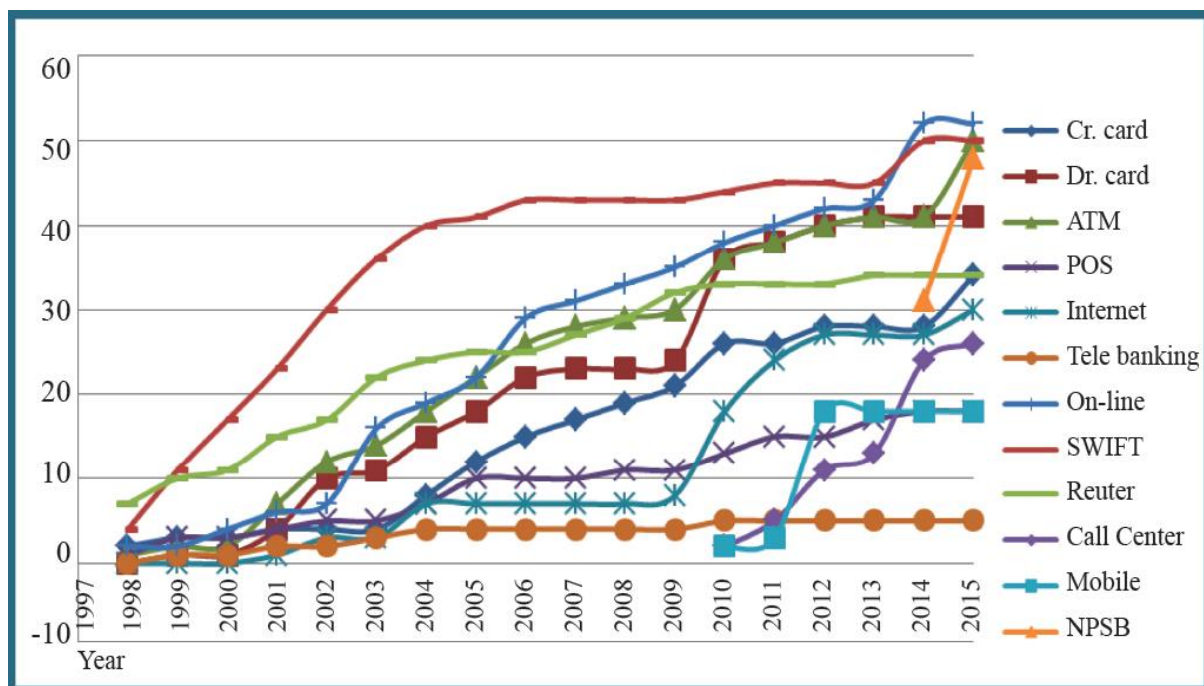


Fig. 1.1: Trends in IT adoption in the banking sector of Bangladesh
 (Source: Alam 2017)

Blockchain is a recently emerging digital transaction technology that has immense potential to replace or cover a lion share of the worldwide financial transaction in near future under the framework of peer-to-peer transaction substituting the present paper money. The banking sector of Bangladesh cannot isolate itself from the rest world and needs to develop the framework for adopting

the blockchain technology. But the private banking sector in Bangladesh has to overcome the prevailing challenges in the organizational structure, human resource capabilities, adoption friendly job culture, strategic planning and implementation for new technology adoption, and budgetary allocation in the banking sector as described above, for a well-planned preparedness to adopt blockchain technology in its technology hub.

1.3 Objectives of the Study

The objectives of this study are

1. To analyze the robustness of adopting blockchain technology in the private banking sector of Bangladesh.
2. To identify the enhancement of efficiency in providing financial services by the private sector banks after the adoption of blockchain technology.
2. To ascertain the satisfaction level of the customers about the financial services rendered from the blockchain platform.

1.4 Research Questions

This study will focus on getting clarification on the following research questions:

1. What is the state of adopting blockchain technology in the private banking sector of Bangladesh?
2. What are the positive service improving effects observed after the adoption of blockchain technology in the private banking sector of Bangladesh?
3. What is the satisfaction level of the customers about the financial services received from the blockchain network?

1.5 Analytical Framework of the Study

The efficacy of adopting a new technology largely relies on the robustness, efficiency and effectiveness of the adopted technology in improving service delivery system of the organization. Robustness is a measure of scale and scope of the adopted technology to the extent it has been diffused in the adopted sector and how the users access the technology with easiness. The scope of technology adoption determines the prioritize sectors in which the technology is applicable

and the scale indicates the proportional coverage area of the adopted technology of the total service providing periphery. In this study the present scale and scope of the adoption of blockchain technology in the banking sector of Bangladesh will be analyzed from the types of service delivery fields and the coverage area of the blockchain technology in the private banking sector.

Quality, time and cost are the three prongs of the efficiency achieved from the adoption of a new technology like blockchain. The reduction in service delivery time as well as lowering the costs than charged in getting service from the existing technology specifies the greater efficiency level of the adopted technology with comparison to the existing technology platform. A new technology is adopted primarily to remove the complexities, ambiguities and difficulties of the present system so that the services can be delivered smoothly and quickly without any flaw. In this study the efficiency of blockchain technology will be investigated in terms of reduction of time and costs required by the existing technology being used by the private banks in Bangladesh at present. The suitability of the blockchain technology in streamlining the existing processes of service delivery and eliminating discrepancies of the service delivery methods will also be studied for analyzing the efficiency level of the present financial technology domain used in the private banking sector of Bangladesh.

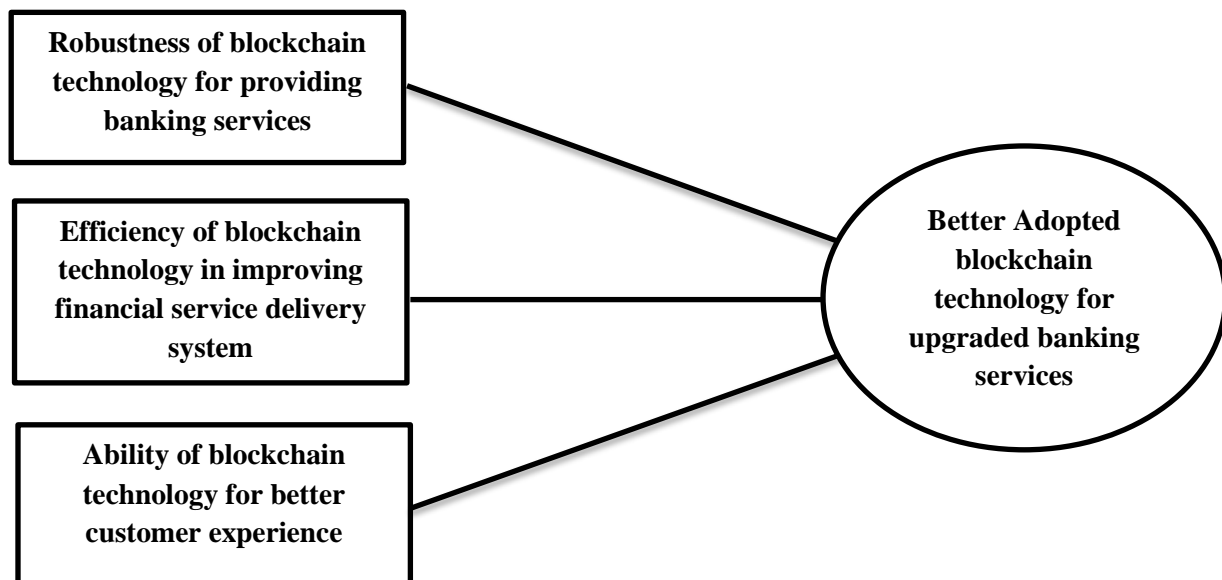


Fig. 1.2: Analytical framework of the study.

The newly adopted technology must be able to provide better service experience to the customers during interaction with the new technology for receiving the

services. The satisfaction level of the customers are identified in this study as a measurement of customer satisfaction level of the blockchain technology in rendering different financial services by the private banks of Bangladesh to their customers. These postulates the analytical framework of the study.

1.6 Methodology of the Study

1.6.1 Methodology

Research methodology is the process of conducting the study following scientific methods and styles with an aim to find out the solution of the research problem (Kothari 2004). In methodology the methods of study and approach, sampling and data collection methods, data analysis and presentation, etc. have been explained as described below:

1.6.2 Research Methods and Approach

For the theoretical aspects of the study, available and authentic literature on blockchain technology is studied. The literature review spans articles highlighting theoretical and practical concepts on blockchain technology, collected from manual journals, seminar papers, newspapers, etc. or downloaded from online resources. A number of books are also studied, which are widely used in the academic and research purposes for studying blockchain or other concepts relevant to the study. Apart from literature review, a qualitative research method was considered more appropriate for this study in order to satisfy the objectives of this study and realize the intrinsic reasons of the research questions. The study was exploratory and descriptive also to establish the validity of the qualitative findings.

1.6.3 Sampling and Data Collection Methods

Interview is a suitable qualitative method for exploring data related to the experience on a particular issue (Jha 2011). In this study, unstructured interviews were mainly conducted to get the expected data relevant to satisfy the questions designed for this study. Interviews of different level managers of 04 commercial private banks, especially those, who involve in the functions of blockchain technology adoption activities in these banks were taken following purposive sampling technique to collect data on blockchain technology adoption activities, future directions, and future implications for blockchain technology. As the timeframe of the study was very short and the response rate in interview was

satisfactory, this was helpful to gather relevant data quickly. The list of the commercial banks randomly selected for collecting data for this study are mentioned in the following table:

Sl. No.	Name of the Banks	Type
1.	Standard Chartered Bank	Multi-national Commercial
2.	HSBC Bangladesh	Multi-national Commercial
3.	Bank Asia	National Commercial
4.	Prime Bank Limited	National Commercial

Table 1.1: Commercial banks for data collection.

1.6.4 Data Analysis and Presentation

The data of the interviews was analyzed on the ground of their relevancy with different attributes of technology adoption, especially the strategic choice and implementation success of this banks in adopting blockchain technology as an alternative technological mode of financial transactions. In this study both primary and secondary data were used to validate the research questions, where sources of primary data were the interviews of 05 service delivery personnel of the banks covered by this study. The secondary data were extracted from the press release of these banks about blockchain adoption, newspapers articles, etc.

1.7 Significance of the Study

Blockchain technology is a trustworthy internet protocol basis digital transaction technology. This booming technology has strong possibilities of transforming the financial transaction system in different areas that are currently providing by the banking sector of Bangladesh. The usefulness can be seen in terms of improvement in the cost, efficiency and effectiveness of the existing financial transaction methods followed by the private banks of Bangladesh. At first the blockchain technology has a great potential to reduce the double spending in financial transaction (Ertz & Boily 2019). The role of intermediaries in the financial transaction using blockchain technology is less significant, for that the buyer and seller can perform the transaction at anytime from anywhere of the world. Absence of traditional banking hours does not delay the transaction, which will ensure the time value of money. As there is no requirement of intermediaries in financial transaction, one bank can transfer the money to another cross-border bank without using any third channel like SWIFT Code. So, blockchain can

minimize financial transaction costs, if the cost-benefit analysis of adopting this technology in the banking sector is favorable.

The blockchain is able to prevent fraud financial transaction and maintain the privacy of the parties involved in the transaction. In blockchain technology, public and private keys are used to complete the transaction with the encryption and decryption of data with hash system. So, it is almost impossible for the financial mischievous to perform any fake transaction, as there is no way to replicate the keys or blocks already generated. Moreover, the technology does not delete the transaction history and so the transaction can be verified anytime that helps to check any illegal financial transaction. These features of blockchain technology endorse its efficiency and effectiveness in financial service delivery. Service diversification is another aspect of blockchain technology that increases its acceptance to the financial sector service providers, for example, smart contracts can be useful in managing short and long term loan agreements, different insurance and venture capital.

Due to the lack of institutional capacity and innovation infrastructure, developing countries are merely adopters rather than innovators of new technologies. Blockchain technology is already invented by the developed world and its various application is visible in the financial sectors. Bangladesh as developing country can be one of the early adopters of this technology and private banking sector can play a crucial role in this regard, as a leading associates of prioritize private sector investment for the continuation of high economic growth saga of the country. To achieve this objective the preparedness of the banks operating in the private sector is vital, otherwise Bangladesh may lose the opportunity of reaping the benefits of blockchain technology as early adopters.

1.8 Limitations of the Study

Despite the significance of the study, it has several limitations as mentioned below:

Firstly, the study does not reflect the policy framework of the government of Bangladesh extensively for incentivizing the blockchain technology adoption in all related sectors including the state-operated banks.

Secondly, the study does not consider the comparative analysis of measures taken in other developing countries to adopt blockchain technology in financial transaction system.

Thirdly, blockchain is a new technology and its theoretical aspects is still developing to reach a solid shape. The application of this technology in financial transaction is also at the experimental stage in many cases.

Fourth, the expertise and understanding of the blockchain technology have not grown enough among private sector technology adopters functioning in the banking system of Bangladesh. Misconception may thwart the actual thoughts and perceptions of the respondents of the study about the importance and present status of the adoption of blockchain technology.

1.9 Structure of the Study

The study is composed of 04 chapters in total. In the first chapter, study background, objectives, problem statement, analytical framework, significance of the study and its limitations are discussed. In the second chapter concepts of blockchain, its types, basic technology, applications, etc. are illustrated.

In the third chapter, the data collected for this study from the primary and secondary sources are analyzed and findings of the study are elaborated. In the fourth chapter the recommendations and concluding remarks are provided for a strong foundation for adopting blockchain technology in the private banking sectors of Bangladesh.

Chapter 2

Theoretical Concepts of Blockchain Technology

2.1 Introduction

In the present trade and business world, partnerships are developed among a wide variety of interconnected actors with heterogeneous objectives and functional area. Moreover, the trade and commerce takes a global form in respect of sourcing of raw materials, location of production units and dispersed and segmented markets. This grows business networks with high complexity and keeping a good relationship is a great challenge for the business conglomerates. The challenge is also fierce for the financial sector entities, especially banking sectors, having operations in the global market and are committed to provide fast, secure and reliable financial services to their clients. In this age of technological boom, the FinTech industry has also embraced a large pool of applied technology that makes the service delivery system of banking sector more authentic, customer-centric and dependable. But relies on intermediaries, perishability, mutability and chance of fraud transactions shrinks the efficiency and effectiveness of these financial sector technologies. For example, mobile banking services have become popular within a short time in both rural and urban areas of Bangladesh, but the sector is susceptible to fraud transactions due to mutability of transaction procedures.

2.2 Blockchain-Definition

At its origin, blockchain is the technological way of recording transactions between parties on a peer-to-peer basis. The origin of the word 'blockchain' lies in its name. When a transaction or an event occurs in a digital platform using this technology, a block is generated with all the necessary information of transaction, which is validated in all nodes of the computer system connected to the transaction system. The consecutive transactions also create blocks that are added to the previous blocks sequentially depending on the time of validated transactions using the cryptographic hash originated from the information stored in the previous block.

PricewaterhouseCoopers (PwC) defines the blockchain technology as follows:

Blockchain is a technology that allows data to be stored and exchanged on a peer-to-peer (P2P) basis. Structurally, blockchain data can be consulted, shared and secured thanks to consensus-based algorithms. It is used in a decentralised manner and removes the need for intermediaries, or "trusted third parties" (PwC 2017).

Another definition of blockchain technology is as follows:

A blockchain is just another type of database for recording transactions-one that is copied to all of the computers in a participating network. A blockchain is thus referred to as 'a distributed ledger' (Deloitte 2015).

Mulligan (2016) conceptualizes blockchain in the following manner:

A blockchain allows untrusting parties with common interests to co-create a permanent, unchangeable and transparent record of exchange and processing without relying on a central authority.

In fact, each block of a blockchain that develops gradually with time due to transaction among participating parties of the network, consists of two basic elements: *header*. it contains the unique reference number, timestamp of block generation and connection to previous block, and *contents*. it contains information about sender, receiver and transacted amount or exchanged information for future records (Deloitte 2015). The whole technology works on two premium digital ideas: *asymmetrical cryptography*. In this encryption technology data are encrypted and decrypted with two separate keys known as public key and private key, and *distributed computer network*. it is a decentralized IT network, where the actors are interconnected with computers and permissioned to access, transfer and monitor data independently without any interruption of third parties (PwC 2015).

2.3 Blockchain-Types

The blockchain are primarily used for performing the transactions or exchanges of digital assets through a distributed secured network. But the working principles and usage of each blockchain are not similar. The composition of a blockchain generally relies on the type of network used in development, target clients, nature of transactions, access to the network and level of security. Considering these characteristics of blockchain design and development, the blockchains are categorized into the following four variants:

1. **Public blockchain:** Public blockchains are genesis blockchains, which can be accessed by anyone at any time if someone is connected in the network. The network of the public blockchain is decentralized and is not managed by any authorized entity. Prior permission is generally not required to access and use this type of blockchain. A blockchain user who has a node to a public blockchain has the authority to see present and past transaction records, authenticate a new transaction, perform proof-of-work and add transaction history to the global public append-only ledger as miners. Each transaction or exchange creates a block, which is then added to the previous block after being verified (OECD 2019; Manav 2017).

Bitcoin, Ethereum, Litecoin, etc. are the examples of public blockchains.

2. **Private blockchain:** Private blockchains are restrictive and permissioned blockchains that provide controlled access to the users connected to this type of blockchain network. One or more central authorities are assigned to manage the access of the participants to the network and maintain high security level of the network. Though the transactions in private blockchains are extremely secured, the reliance on third parties for its operation and management delimits the usefulness of blockchains in removing involvement of intermediaries in transactions or data exchanges. Another feature of the private blockchains is that the participants who are involved in a certain transaction can see the transaction data, but other participants do not have the access to this data. Financial service providers including banks usually use private blockchains within the organizations and branches for providing financial services (OECD 2019; Manav 2017).

Hyperledger Fabric, Multichain, etc. are examples of private blockchains.

3. **Consortium blockchain:** Consortium blockchains are designed and operated on shared platforms and shared resources principles. Unlike a public or private blockchain, consortium blockchains are governed by more than one organization. The organizations having similar business functions reach a consensus on blockchain platforms and share the expertise, finance and other resources to build a consortium blockchain. The main advantage of consortium blockchain is that the organizations reap the benefits of economies of scales (OECD 2019; Manav 2017). The highest number of blockchain consortia, which is 26 among 40 formed consortia, is found in the financial sectors (Gratzke et al. 2017).

Examples of consortium blockchains are **R3, Corda**, etc.

4. **Hybrid blockchain:** Hybrid blockchains are the combinations of the features of both public blockchain and private blockchain. Public blockchains provide access to all users around the globe, but it is time-consuming as large number of data needs to be computed for every node for the modification of ledger and also due to openness creates a lower security patch for the users. On the contrary, private blockchains are only accessed by permissioned users. As number of users is limited, speed and security for private blockchains are high, but these blockchains are administered by a central body to add or modify data. Hybrid blockchains utilize the advantageous features of public blockchain and private blockchain, in which anyone enjoys the open permission to access and use, but have a central control system to monitor the addition or alteration of data in the ledger. For that the hybrid blockchain is also termed as permissioned public blockchain (OECD 2019; Manav 2017).

Examples of hybrid blockchains are **XinFin, Ripple**, etc.

From the above discussion, it is evident that the blockchain technology has evolved with two fundamental types: public and private, whereas the consortium and hybrid blockchains are the extended versions of the public and private blockchains developed for service efficiency.

Types	Openness	Permission	Degree of Accessibility			
			Read	Write	Perform	Example
Public	Open	Global	Anyone	Anyone	Anyone	Bitcoin, Ethereum
Hybrid		Global	Anyone	Authorized users	Authorized users or its segment	XinFin, Ripple
Consortium	Closed	Restricted	Authorized users	Authorized users	Authorized users or its segment	R3, Corda
Private		Fully private or Restricted	Private or Authorized users	Network operator	Network operator	Hyperledger Fabric, Multichain

Table 2.1: Main types of blockchain on permission for access.

2.4 Key Features of Blockchain

Since the inception of practical application of blockchain technology, primarily as an alternative medium of currency exchange on P2P protocol, it brings some radical transformation in the history of transactions regarding security, transparency, verification, non-replicability and operational distribution and for that characteristics various sectors are now adopting this technology in a quick pace for executing divergent functions. The salient features of blockchain technology, described in scholarly articles (Atlam et al. 2018; Puthal et al. 2018; Deloitte 2017; Wu & Tran 2018), are mentioned below:

1. Distributed and Decentralized: Blockchain technology premises on the concepts of P2P network, where particular nodes are interconnected to each other without the presence of a central controlling authority. The processing capabilities of all participating nodes are utilized in transactions and data are shared among the blockchain participants that reduces the probability of single point of failure and the latency in transactions and enhances the scalability and robustness of data processed in the system.

2. Openness and Transparent: In blockchain technology, end-to-end encryption algorithm is used in preparing a block. All participating parties are aware of the open and transparent data processing methods and so mutual trust is irrelevant. The updated data of the ledger can be verified by the participants and transactions must be authenticated by the participants. This eliminates the chance of deception in transactions.

3. Trustless and Consensus-based: Consensus mechanism is pivotal to the existence of any blockchain network, which is the process of verifying and authenticating a transaction in the network based on approval of all participating parties. The rules of consensus mechanism are agreed upon by the parties before a transaction occurs and can be reset according to the requirement of transactions. It diminishes the reliance or keep trust on a third party to endorse the legitimacy of the transactions.

4. Immutability and Cryptographically-sealed: Immutability is a definitive feature of blockchain technology, which reflects the ability of this technology to keep the transaction data unaltered. This is succinctly achieved by the hash algorithm used to generate a block. A new block bears the present hash information and also the hash of the previous block, which is then coupled with the previous one after verified and accepted by the parties on mutual consensus.

This feature makes it almost improbable for an intruder to change the constituents of any block, as the attempt of changing the information of a block requires the hash information of all previous blocks.

5. Chronological and time-stamped: A blockchain comprises of a series of blocks that are created when a transaction occurs. A new block is the repository of data of transactions including the time of occurrence of transactions and it attaches to the previous block sequentially in chronological order to form the chain. It ensures the proof of integrity of each transactions and reduces the long term maintenance costs of data records.

6. Irreversible and auditable: The blockchain maintains the proof of record of each transaction made on it. As each transaction is made on mutual consensus of the parties, it is done permanently and cannot be reversed. Moreover, the information of transaction is made available to all parties of the network or a subset of the network users, who can audit the validity of the transactions. This feature mitigates the risks of double spending in transactions.

7. Digital and Real-time: The transactions in a blockchain are accomplished in digital form that is stored in the permanent digital ledger, no manual documentation is required for tracking the transactions. The transactions are also settled in a nearly real-time manner and the probability of non-payment disappears.

8. Better security: In blockchain technology the information of transactions is stored across a network of computers using public key infrastructure that makes it nearly impossible for the hackers to compromise data as it requires simultaneous alteration of data contained by each node of the network, show a pampered balance of digital currency or make a false transactions. The mutually agreed consensus mechanism ensures the better security in financial transactions through blockchain than the other existing methods of financial transactions.

9. No or fewer intermediaries: Blockchain is operated on the distributed ledger technology (DLT) platform, where mutual trust among the users are established through mutual consensus algorithm. This eliminates the necessity of the presence of a trusted third party or intermediary to authenticate or validate the transactions in a blockchain. However, the role of intermediaries in the blockchain renovates to a new dimension as a ‘Blockchain as a Service’ providers, who develops the distributed ledger technology structure for the blockchain adopting organizations (Chiu & Shang 2019).

10. **Censorship proof:** In the public blockchain, a group of independent users, who are known as miners, executes the validity of the transactions for which they are incentivized. This allows the blockchain to grow independently without any ownership. The presence of independent miners virtually resist a single authority to impose any censorship or embargo in transactions.

11. **Versatility:** The blockchain technology is applicable to various fields with necessary adjustments for adaption to the requirements. Banking, healthcare management, food industry, logistics, supply chain management, government documentation, contract management, transportation, insurance, education, capital market, etc. are the sectors, where blockchain technology proves its worthiness over the existing technology.

2.5 Blockchain Evolution

Blockchain technology brings a revolutionary change in the domain of secured transactions applying the model of cryptographic immutable distributed ledger in a decentralized computer network. The technology was shown its successful commercial application in 2009, when the first cryptocurrency, bitcoin blockchain network was introduced and it began the Blockchain 1.0 regime. Satoshi Nakamoto, a pseudonymous person, was regarded as the inventor of first known-ever blockchain for trading with bitcoin. He conceptualized the digital cash transaction system in his phenomenal paper, entitled 'Bitcoin: A Peer to Peer Electronic Cash System', published in 2008. He utilized the public or open key and private or secure key methods of digital signature to transfer bitcoin from one party to another on mutual consensus eradicating the trust on an intermediary (Nakamoto 2008). The transactions are timestamped with hash technology that cannot be altered without redoing the same proof-of-work and hence ensure the security of digital signature system. But the idea of digital signature with public key and private key was coined by Diffie and Hellman in 1976 in their work, 'New Directions in Cryptography'. The public or enciphering key is publicly disclosed, but the private or deciphering key allows only two individuals to communicate even though they are not known before, which reduces the need for a distribution channel of transaction keys (Diffie & Hellman 1976; Sarmah 2018). Later Goldwasser et al. (1988) proposed a theory of more secured digital signature to remove its vulnerability to chosen-message attacks. On the other hand, the concepts of digital time-stamp service (TSS) was devised by Haber and Stornetta (1990) using hash algorithm and digital signature to timestamp the

digital documents at the creation in a distributed network that makes it infeasible to stamp a back or forward date to an already stamped document (Sarmah 2018). ‘Electronic cash’, ‘Digital currency’, ‘b-money’ are some other attempts of implementing digital cryptocurrency before the launching of ‘bitcoin’ (Sarmah 2018). In 1998 Nick Szabo envisioned the idea of ‘bitgold’, where a string of bits is computed from a thread of challenge bits using ‘client puzzle function’, ‘proof of work function’ or ‘secure benchmark function’ (Szabo 2005).

The second-generation of blockchain hits the blockchain platform with the invention of ‘Ethereum’ in 2014 and then release for trading in 2015. Before the presence of Ethereum, the blockchain technology was confined only to the exchange of digital cash like bitcoin. But Ethereum makes it possible to expand the application of blockchain technology in other financial instruments like bonds or insurance, popularly known as ‘smart contracts’ and ‘Ethereum Virtual Machine (EVM)’ together with currency exchange (Marr 2018). The security of Blockchain 1.0 is confirmed by ‘proof-of-work’ method, in which a large group of miners uses the largest total computing power operated in the huge data centers to secure the transactions, but the security in blockchain 2.0 is based on ‘proof-of-stake’, where the block creator is determined on the value of stake hold by the creator and block creator gets a fee instead of reward given in ‘proof-of-work’ method (Gupta 2017). Recently, the third generation blockchain, Blockchain 3.0, such as the blockchain service and research organization, IOTA appears to resolve the issues of scalability, interoperability, transaction cost and speed faced by first two generations re-engineering the distributed ledger technology (DLT) on Directed Acrylic Graph (DAG) Technology and Blockchain 4.0 is focusing on industry-wide application of blockchain technology.

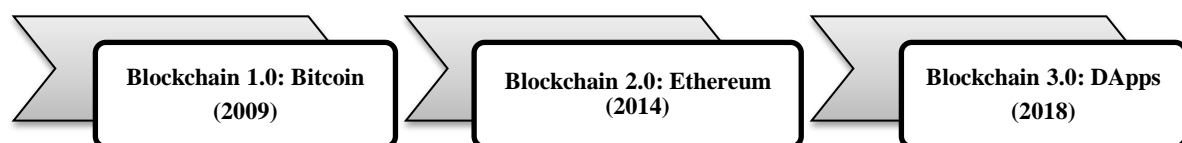


Fig. 2.1: Blockchain evolution.

2.6 Blockchain Working Principles

Blockchain technology employs asymmetric cryptographic algorithm to perform a digital transaction between two agreed parties connected in the distributed network. Each of the parties has the ownership of two keys: public key and private key. The sender uses the private secured key to generate a digitally signed document for sending transaction request to the receiver in an encrypted form.

The ownership of the enough cryptocurrency by the sender that requires to execute the transaction is validated by the miners and the receiver accepts the transaction after verifying and decrypting the sender's transaction request with the public open key and thereby the transaction is completed. The transaction data is kept in the permanent immutable digital ledger for future audits.

The basic steps of a digital currency transaction in a public blockchain is described below (Atlam & Wills 2018):

Step-1: A party decides to send money (digital currency) to the other party using a blockchain network. He possesses a cryptocurrency wallet, keys for digital signature and connects to the network with a node.

Step-2: The party uses the private key to create a block with cryptographic algorithm for the transaction, which is treated as time-stamped digitally signed document.

Step-3: The block is delivered to all nodes connected in the blockchain network.

Step-4: The transaction is verified by all participants of the blockchain network. At this point the miners validate the transaction solving a complex cryptographic hash algorithm.

Step-5: The verified block is then added to the global ledger, which cannot be altered, replicated or removed by any participant of the network.

Step-6: The money is received by the other party and the transaction is executed.

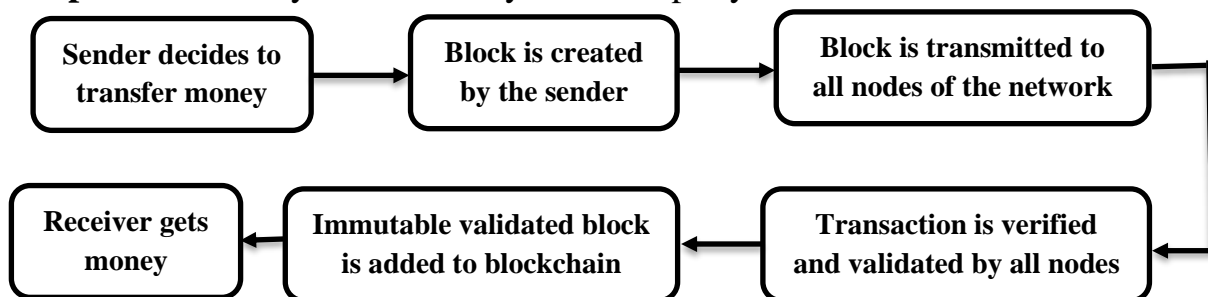


Fig. 2.2: Basic transaction principles of a blockchain.

In fact, the blockchain is a combination of different digital technology invented in different times and it consists of the following four building blocks in common (Fuchs 2019):

- **Authentication:** It is the method of verify the identity of a blockchain participant that is disclosed by himself.
- **Digital Signature:** It is a digital stamp to validate the activities of a participant in the blockchain network.

- **Encryption:** This technique makes a blockchain data unrecognizable without access permission and authentication.
- **Hash Algorithm:** Hashing is a unidirectional, unique and repeatable cryptographic algorithm that converts data into a thread of alphanumeric characters.

The fundamental element of a blockchain is the transaction, which can transfer of an asset or a hash file. When a transaction is digitally signed and timestamped, it is added to a block. Therefore, blocks work as the primary data storage component of a blockchain that contain one or several transactions. Beside the transactions, a block has a header with the following information (Atlam and Wills 2018):

- **Block version:** It characterizes the block with a unique number.
- **Previous block hash:** It sets the relationship between present and previous blocks.
- **Timestamp:** It indicates the time of block creation.
- **Merkle tree:** It represents the hash of all transactions stored in a block.

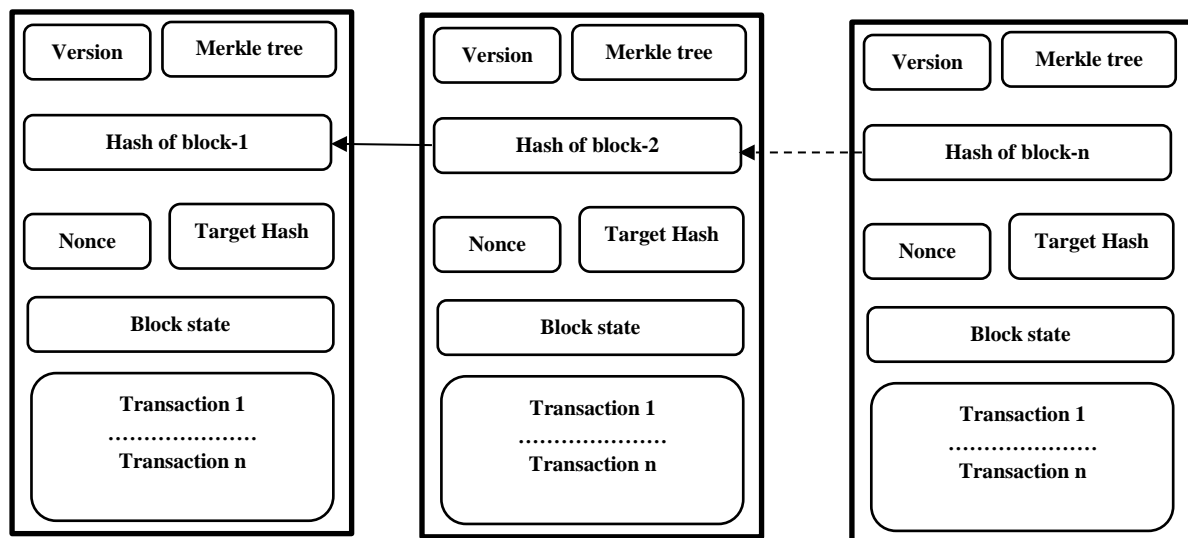


Fig. 2.3: Formation of a blockchain with blocks (source: Atlam & Wills 2018).

- **Target hash:** It is a numeric value that is used to set the difficulty level for miners in proof-of-work blockchain.
- **Nonce:** It is the shortened form of ‘number used only once’. The nonce is a 32-bit whole number, randomly selected by the miners to get the ‘golden nonce’, which is used to find the hash value of the block.

When a block is validated and timestamped, it is then added to the precedent block and gradually a chain of blocs is formed. The authenticated blocks are added to the chain in chronological order and hence create a digital ledger.

2.7 Blockchain Applications

At the beginning blockchain technology was applicable to the exchange the cryptocurrency between the parties in absence of a third party. This happens due to the shift of trust from a middle organization to the process of transaction. But the gradual development of this technology with the demand of the users, it is now utilized in various sectors. The major applications of blockchain technology are discussed below:

- **Financial service sector:** The application of blockchain technology in the financial service sectors is growing day by day. The transaction settlement, loan management, cross-border trade, bonds, insurance, swaps, inter-bank settlement, property management, central bank depository, capital market transactions, etc. are the major applications in financial service sectors.
- **Agriculture sector:** The uses of blockchain technology in agriculture sector are diversifying. The applications are extended to agriculture subsidy management, agriculture insurance management, modernizing farm management, fertilizer distribution, green bonds, agriculture goods supply, AgTech optimization, land record management, fair pricing, weather and disaster issues, protecting illegal fishing and deforestation, transparency and traceability in production, etc. (Sylvester 2019).
- **Health sector:** Some applications of blockchain in healthcare are health database management, traceability of drugs, genetic code preservation, information exchange and queries settlement, fees and service charge payment, precision medicine proliferation, etc.
- **Commerce and trade:** Blockchain technology ensures better trust, security and speed, and prevents fraud in trade and commerce. It is able to tackle know your customer (KYC) issues, tracking and traceability issues, double spending issues, fraud prevention, tariff issues, trade regulatory issues, etc.
- **Energy sector:** Blockchain technology applies in energy sector for resource management, storage management, distribution management, energy trading, exploration, transportation, upgrading energy grids, renewable energy

management, green environment issues, carbon emissions issues, exploration and transportation, etc.

- **Environment sector:** Sustainable environment issues can be resolved with the blockchain application in environmental management such as circular economy incentives, e.g., plastic bank, sustainable resource management, sustainable finance, carbon credit management, carbon audit, decreasing carbon emissions, water and land resource management (Herweijer & Swanborough 2018).
- **Social sector:** Blockchain technology are now utilizing in tracking human trafficking, child labor exploitation, curbing corruption, creating new employment opportunities, building trust among societal actors, redressing human abuses, illegal drug trading, etc.
- **Legal and regulatory sector:** Personal digital identification, voting and other human rights, judicial trial (e.g. CrowdJury), effective citizen services, proprietary documents, intellectual property rights, smart contracts, dispute resolution, notary public, mortgages, etc. are some potential applications of blockchain in legal and regulatory sector.
- **Supply chain management:** Blockchain technology increases transparency, speed, visibility, dependability, traceability, sustainability, and accountability, streamlines workflows, manages suppliers and customers as well as reduces time and cost in the supply chain management. It can be usable in planning, configuring, sourcing, procurement, manufacturing, processing, distribution, storage, transportation, end-to-end customer servicing stages of supply chain management. This technology is widely used in agriculture, food, pharmaceuticals and manufacturing supply chain globally.
- **Other sectors:** In media blockchain is utilizing to release the music and ensure the copyright. Smart tickets, drug testing, tokenizing players, match streaming are some uses of blockchain in sports. Resource planning and management, security confirmation can be done proficiently in the recent urbanization concept of smart cities.

Eventually the transparency, accuracy, swiftness, security and immutability of blockchain technology encourages the technology adopters to apply it in diverse sectors. Though large scale computing power is essential in public blockchain for which electricity consumption and investment is high, private and consortium

blockchain mitigates this disadvantage of blockchain and its application is growing at a quick pace in many new sectors.

2.8 Blockchain in Banking Sector

The global banking sector is experiencing a transformational change after the adoption of blockchain technology in executing different banking activities. Though the public blockchain challenged the role of banks as trust organization by replacing it with the process-trust based transaction system. But the legitimacy question in exchanging cryptocurrency without a perfect regulatory framework arises. Later the inception of private or consortium blockchain brings back the role of ‘facilitator’ of the banks due to the reliance on the banks for monitoring the validity of the digital asset transfer using blockchain. As a reliable technology regarding security, immutability, transparency, authenticity, speed, record management, a rising trend is observed in applying blockchain technology to execute different banking functions. Some notable functions of this technology in the banking sector are mentioned below:

Crypto banking. Crypto banking is the new banking regime to own and store cryptocurrencies and use these to settle payments like fiat currencies. A person can lend, borrow, store, gain and pay cryptocurrencies using crypto banking platforms to meet his regular money demand. The cryptocurrencies work on the principle of supply and demand differently from the traditional money that transacts on market and central bank regulations. Coinbase, Trust Wallet, CEX.IO, Coin loan are some popular crypto banking platforms, where people can also exchange cryptocurrencies like ethereum, bitcoin, litecoin, etc. from their crypto wallet with US dollar and other fiat currencies (Chatterjee 2020). The cryptocurrency market is growing fast, which is about US \$ 240 billion in 2019 almost double of US \$ 128 billion in 2018 and countries like United States, United Kingdom, Canada, India, Australia, Switzerland, Czech Republic, etc. are shaping regulatory frameworks for crypto banking (Gauhman 2020).

Smart contracts. Blockchain technology develops the concepts of ‘smart contract’ as an alternative but more efficient than manual contract enforcement. Smart contracts are self-effecting blockchain-based agreement between two parties, e. g., lessor and lessee in a house rent contract, which is executed when the terms and conditions of the contract meet. For example, smart contract is able to pay house rent from escrow account periodically as coded in the contract algorithm. Smart contracts reduce the legal fee, evade disputes and check

counterfeiting of contracts and ensures trust, security, accuracy, speed and simplicity in contract execution (Gopie 2018). JPMorgan Chase, IBM Blockchain, Polybius and Hyperledger are pioneers in the realm of smart contracts.

Interbank/cross-border transactions. Blockchain makes the interbank or cross-border monetary transactions secure, reliable, fast and accurate. Blockchain automates the interbank payment system and banks need not communicate in each transaction as trust is shifted to transaction process. Blockchain cross-border payment services settles within hours instead of several days and charges are much lower than usual banking channel. Ripple, R3 Corda, Santander, etc. are performing interbank payments with blockchain money transfer system (Gauhman 2020).

Trade finance. Blockchain is streamlining the trade finance eliminating the need for bulk paper documentation through automating the system, simplifying the present complexity of managing a large of trade finance actors and providing nearly real-time services. Blockchain is able to address double-invoicing, intermediaries, anti-money laundering, false personification and unreliable information issues of existing trade finance process. Blockchain-based trade finance decentralizes the process, authenticate ownership, curtails transaction costs and creates trustworthy audit trail. R3 Corda is well-known blockchain platform in trade finance (Dicaprio & Jessel 2018).

Loan syndication. Consortium blockchain technology enables the lenders to manage syndicate loan efficiently with enhanced security and real-time data access. The lenders are connected to the blockchain network with nodes in decentralized approach. The lenders are informed and tracked concurrently about the loan approval process and thereafter loan management and monitoring activities. BBVA, BNP Paribus and MUFJ was the first banking consortium to grant €150 million syndicate loan to Red Electrica Corporation (Karppinen 2018).

Customer database. Blockchain has the capacity to create a secure and genuine database from digital ledger for the clients about their spending trends, sources of money, asset value, business involvement, reputation etc. It fulfills the demand of Know-Your-Customer (KYC) perspective to design customer-focused business model and detect the risks of bad loan.

Time-banking. Time-banking is a new perception to social services provided by the community members as labor-hours in lieu of monetary value and also to

prevent antisocial activities. Time-banking system permits the citizens to indulge in benevolent activities for the welfare of the society that fosters a harmonious and cooperative relationship in the social life. Blockchain is utilizing to measure the time-value of the citizens in the societal functions through Blockchain-enabled Decentralized Time-banking System (BlendTBS) (Lin et al. 2019).

Crypto hedge funds. Cryptocurrencies like bitcoin and ethereum provide a platform for creating crypto hedge funds constituted to avert risk of volatile markets acting as insurance in the form of options, derivatives, etc. If stability and regulatory issues are solved, these funds will assist in capital formation and low-risk investment. About 150 crypto hedge funds are now circulating in the market (Madeo et al. 2020).

Central bank digital currency. Cryptocurrencies can be used as central bank digital currency (CBDC) in retail and wholesale monetary markets as an alternative to traditional paperback money for transactions and deposits. The CBDCs can exchange in a peer-to-peer manner without the presence of intermediaries. The central banks of Sweden, Cambodia, Bahamas, etc. have started to use CBDCs in parallel to traditional cash (Lannquist, A. 2019).

Venture capital. Blockchain-based Initial Coin Offerings (ICOs) encourage the entrepreneurs to raise funds for forming venture capital to invest in different sectors. Token or crypto coins are exchanged in ICOs for funding in capital investment. Tokens or coins can be traded directly to the mass people to raise fund that relieves the investors from the tiresome process of traditional venture capital formation process.

Securities. Blockchain can reduce the role of middlemen such as brokerage house to trade in the capital market with cryptocurrencies. The general public can trade in the capital market directly from their nodes in blockchain anywhere in the global financial markets.

Better Governance. Blockchain technology can improve the banking sector governance with respect to transparency, accountability, security, visibility and compliance. The banking headquarters can monitor the activities of branches in the blockchain platform. The intra-bank transactions can be done with less time and accuracy with enhanced interoperability.

It is evident from the above discussions that the blockchain technology can bring revolutionary improvement and diversification in the banking sector increasing the efficiency and effectiveness of the existing service delivery system and also offering innovative services devised on the new concepts of this technology.

Chapter 3

Findings and Discussions

3.1 Introduction

Blockchain technology is being adopted by the leading commercial banks having the operations at local or global financial service sector. The scale and scope of blockchain-based services is expanding very quickly, as a large pool of organizations and consortiums has been created with technological architecture to create digital network for adopting blockchain technology within the banks or in partnership with the other banks. At this moment the smart contracts, trade finance, interbank payment settlements, cross-border fund transfer, loan syndication, security enhancement and counterfeit transaction detection are the major blockchain-based services offering by the commercial banks in liaison with counterpart banks around the world. JPMorgan, Citigroup, Mitsubishi UFG Financial Group, Standard Chartered Bank, BNP Paribas, Deutsche Bank are some frontrunners in the global banking business to adopt blockchain technology for rendering different financial services to their customers incorporating multiple stakeholders in technological collaboration with blockchain technical support providers Ripple, R3 Corda, etc. to develop the online blockchain cloud computing network. The banking sector of Bangladesh has joined this blockchain technological shift riding on initiating some financial services to the clients in a limited scale. The blockchain platforms of four banks, initiated financial services, service improvement and challenges will be discussed in this chapter based on the data collected for the study.

3.2 Blockchain Service Initiating Banks

While collecting data for this study, it has been found that four private sector commercial banks have taken the appreciations of launching blockchain banking services in Bangladesh. Among these banks, two banks are foreign commercial banks operating in Bangladesh and the other two are the domestic commercial banks. The foreign banks are Standard Chartered, Bangladesh and HSBC Bangladesh and the local banks are Bank Asia Limited and Prime Bank Limited. A brief account of these banks are given below:

- *Standard Chartered, Bangladesh*². The Standard Chartered, Bangladesh is the first foreign bank in Bangladesh established in the year of 1948 at Chattogram, the commercial capital of Bangladesh. It is the Bangladesh subsidiary of the global Standard Chartered operated from the United Kingdom having its banking activities in 60 countries around the world. The bank has now 24 branches and booths around the country to provide manual and online banking services covering phone banking, SMS banking, mobile banking, ATM and CDM services, Islamic banking and swadeshi banking. The bank has introduced many milestone banking services first in the country including first international bank to offer credit lines after independent in 1971, first external international letter of credit (LC) in 1972, first ATM, first debit card, first credit card, first international debit card, first shariah-compliant credit card, first online banking platform and first cross-border acquisition finance. The bank has a good reputation in corporate social responsibilities (CSR), sustainability and community engagement. The bank has achieved many prestigious awards for its excellent performance in the banking sector of Bangladesh such as ‘Best Foreign Bank in Bangladesh’ by FinanceAsia in 2009, 2010, 2011, 2012, 2013, 2014, 2016, 2017 and 2018; Asiamoney Best Digital Bank in 2017, and Best International Bank in 2017, 2018 and 2019.
- *Hong Kong Sanghai Banking Corporation (HSBC)*³. The saga of HSBC is to usher the dream ‘A local bank to fulfill international needs’ that turns a local Hong Kong bank into one of the leading banks of the world having its activities in 65 countries around the globe. The bank started its banking services in 1996 and is providing different financial services including commercial banking, consumer banking, cash management, trade finance, and custody and clearing. The bank is offering different retail, commercial and global banking services to its Bangladeshi clients. The net profit of the bank in 2019 after tax of the bank is an outstanding Bangladeshi taka 4,911. It recognizes and promotes the business enterprises of the country with ‘HSBC Business Excellence Award’ for their contributions to the national economic growth.

²[Standard Chartered | Bangladesh \(sc.com\)](http://Standard Chartered | Bangladesh (sc.com))

³Corporate, Retail | HSBC Bank Bangladesh

- *Bank Asia Ltd.*⁴. Bank Asia Ltd., a leading local private commercial bank of Bangladesh, was established in 1999 and provides banking services to the whole society with its 129 branches. The bank has a dominant presence in both local money market and foreign money market and its investment in treasury bills and other securities is rising steeply. Bank Asia is channeling banking services at the doorsteps of rural people creating a strong network of ‘Agent Banking’ in the remote areas of the country with more than 3500 outlets. Besides retail banking, the bank are offering diversified services of corporate banking, SME banking, agri/rural banking, Islamic banking and digital banking. In line with its vision ‘For a better tomorrow’, the bank is working on developing first ever ‘digital banking’ platform for the future generation adopting modern technology in banking services.
- *Prime Bank Limited*⁵. Prime Bank Limited is one of the top-rankings second generation commercial bank in Bangladesh started its commercial operations in the year of 1995. The bank operates its functions all over the country with its 145 branches and 175 ATM booths. The bank is providing satisfactory banking services to its customers ranging from top level businessmen to vulnerable people. The banking services of the bank spans in consumer banking, wholesale banking, Islamic banking, SME banking, NRB banking, offshore banking and treasury functions. The bank has recently introduced digital account service first ever in Bangladesh.

3.3 Blockchain-enabled Banking Services

In this study the banking services presently provided by the four banks described above is examined from various perspectives: types of the services, blockchain technology platform, reasons for adopting blockchain technology, processes of utilizing blockchain technology, effect of blockchain technology in improving service efficiency in comparison to existing service delivery methods as well as the challenges need to be overcome for enhancing the effectiveness of blockchain technology to render different banking services from the blockchain platform. Among the banks covered in this study, the Standard Chartered Bank, Bangladesh has executed intra-bank Letter of Credit (LC), the HSBC Bangladesh has accomplished cross-border Letter of Credit (LC), the Prime Bank Ltd. has

⁴[Bank Asia Limited \(bankasia-bd.com\)](http://bankasia-bd.com)

⁵ [Prime Bank Limited](#)

performed inter-bank Letter of Credit (LC), and the Bank Asia has received remittance from the United Arab Emirates using their own blockchain platform. A brief description of the block-chain services of these banks is given in the following paragraphs.

3.4 Standard Chartered Intra-bank Blockchain LC

The Standard Chartered Bank, Bangladesh reaches another milestone by becoming first-ever bank in Bangladesh to execute a blockchain technology based LC in August 2020. The LC is an intra-bank LC in which the Standard Chartered Bank, Bangladesh acts as both the issuing bank for the buyer and the advising bank in favor of the seller. The beneficiary of the LC is the Viyellatex Ltd., which is one of the leading apparel sector enterprise of Bangladesh exporting different categories of high-quality ready-made garments as a trusted manufacturer for the world renowned apparel brands Puma, S Oliver, Espirit, Marks and Spencer, and Sainsbury with an annual turnover of about US\$ 300 million (Daily Star 2020). The LC was opened by the Viyellatex Ltd. for importing textile items as essential components of ready-made garments from the Viyellatex Spinning, a subsidiary of the Viyellatex Group. It should be noted here that any manufacturing component, sourced either from domestic market or international market for producing export-oriented ready-garments is treated as export items and must be acquired with LC and customs declaration following the provisions stipulated in the relevant laws. The Standard Chartered Bank, Bangladesh issues the LC for the applicant, Viyellatex Ltd. after validation and approval from the own banking channel in favor of the LC beneficiary, Viyellatex Group as the advising bank utilizing the blockchain technology. The Chief Executive Officer (CEO) of Standard Chartered, Bangladesh expressed his satisfaction after this very first successful blockchain LC transaction in Bangladesh, which occupies a major proportion of global trade finance: *'We are extremely proud to introduce Blockchain Technology in Bangladesh for trade transactions. It has been a privilege to partner with Viyellatex Group to initiate the first Blockchain enabled Letter of Credit in the country'* (Standard Chartered 2020).

3.5 HSBC Cross-Border Blockchain LC

The HSBC Bangladesh acclaims another milestone with the execution of first cross-border LC between Bangladesh and Singapore through their adopted blockchain technology for implementing different financial services for their

clients efficiently. The LC was opened by the United Mymensingh Power Limited, Bangladesh to procure 20,000 metric ton of oil fuel for the production of electricity. The power plant is located at Jamalpur, Bangladesh with a production capacity of 200 megawatt and has an agreement with Bangladesh Power Development Board to sell electricity used in the national grid (Financial Express 2020). The HSBC has taken necessary steps as the LC issuing bank in favor of the power plant mentioned earlier. This first cross-border blockchain based trade finance transaction annotates the bank’s commitment to adopt top-notch technology like blockchain in shaping the digital platform for offering different banking services, which is iterated by the Chief Executive Officer of HSBC Bangladesh: *‘I am very pleased that HSBC has pioneered Bangladesh’s first-ever cross-border Blockchain LC Transaction’*, whereas the United Group was also enthusiastic over the application of blockchain technology in settling the cross-border LC with this cutting-edge technology (HSBC 2020).

3.6 Prime Bank Interbank Blockchain LC

The Prime Bank Limited, one of the foremost second generation commercial banks in Bangladesh becomes the first bank to settle an interbank inland LC successfully in the blockchain technology platform. The bank serves the role of an LC issuing bank for their client Ananta Group, a world-class apparel manufacturer of Bangladesh for their clientele including GAP, ZARA, H&M, Jack & Jones, Next and Marks & Spenser. With the productive commencement of another blockchain banking services in the trade finance, the Chief Executive Officer of Prime Bank was very elated with the statement, *‘.....As Bangladesh is fast becoming a leading trading country, Prime Bank as a leading trade finance bank in Bangladesh, is exploring to get most benefits of digitization in trade frontiers.Today’s success will inspire us and banks in Bangladesh to adopt automation in trade finance to provide seamless services to their valued clients’* (Prime Bank 2020). Head of Transaction Banking and Structured Finance also added that the blockchain LC would increase value addition if the blockchain technology is widely diffused in the banking sector,



Fig. 3.1: Prime Bank executes first interbank blockchain LC (source: Prime Bank 2020)

business conglomerates and in the entire trade ecosystem. The LC was opened by Ananta Group for purchasing different raw materials required for the production of ready-made garments industry from another Bangladeshi textile enterprise, Tamisha Group, which is a customer of HSBC Bangladesh. HSBC participates in this landmark of blockchain inter-bank LC execution as the advising bank and also provides technological support for developing distributed ledger technology nodes within the Prime Bank. The executives of Ananta Group and Tamisha Group are also hopeful to reap the benefits of utilization of blockchain technology in end-to-end trade processes (Prime Bank 2020).

3.7 Bank Asia's Blockchain Remittance Transfer

Bangladesh is the 8th largest remittance earners in the world in the year of 2020 sending by the emigrants from different corners of the globe, especially from the middle-east countries. To make the interbank cross-border remittance transfer



Fig. 3.2: Bank Asia's blockchain remittance transfer (source: Bank Asia)

hassle-free and real-time, one of the major commercial banks of Bangladesh, Bank Asia bridges the partnership with the 9th largest commercial bank of the United Arab Emirates, RAKBank to develop a blockchain-oriented interbank payment solution in May 2020 (International Finance 2020). Bangladeshi emigrants lived in the UAE is being benefitted

from this blockchain-enabled payment service for the instant and secure transfer of hard-earning petrodollars. The bank mentioned in a press release, 'This new instant remittance solution to Bangladesh will be free during these difficult times, and customers can send money to their families back home quickly' (International Finance 2020). While discussing with the bank officials about the new blockchain-based payment gateway, it has been informed that remittances are sent from the UAE to Bangladesh successfully several times through this digital blockchain platform.

3.8 Standard Chartered's Blockchain Remittance Platform

Besides the blockchain trade finance for LC settlement, Standard Chartered, Bangladesh unlocked a blockchain remittance transfer network for Bangladeshi expatriates lived in Malaysia in September 2020. This is a quadrupole initiative of the bank tying up with China-based remittance service provider Ant Group, Bangladeshi mobile banking service provider, bKash and Malaysia origin fintech solver, Vallyou. The bank has already got necessary clearance from the central bank of Bangladesh in this purpose. The commercial experiment of the service is at the final stage and expected to go live soon. Standard Chartered, Bangladesh is the remittance settlement bank, which also acts as the regulatory approval entity for the clearance of remittance transfer. While in full operation, this blockchain-based remittance service will streamline the fund transfer, reduce settlement time, improve security and increase transparency of the whole process. *'With our partners bKash, Vallyou and Ant Group, we are delighted to be able to introduce a new-generation technology solution that will make the remittance experience simple and faster, by presenting the service available 24/7, including from the convenience of the remitters mobile phones'*, stated by the Chief Executive Officer of Standard Chartered, Bangladesh (Daily Star 2020).

3.9 Blockchain Technology Used in LC Trade Finance

The Standard Chartered Bangladesh, the HSBC Bangladesh and the Prime Bank Limited have designed their blockchain-oriented digital LC trade finance network with the technical support from Contour, a front running blockchain technology innovator and service provider of the world. Contour has been established in 2017 as Voltron and renamed in 2020 as Contour with an objective of digitizing the global trade finance using the blockchain technology (R3 2020). The Contour has created a distributed blockchain trade finance ecosystem exploring the potential of consortium blockchain. It assembles a global diversified network of networks interconnecting renowned banks, corporate houses and IT giants for the transformation of prevailing trade finance services from the blockchain podium ensuring real-time, transparent and trustworthy in services⁶. Standard Chartered and HSBC are the prominent members of Contour blockchain network and the banks has initiated the digital LC transaction from this platform and also started in Bangladesh in pilot basis as a part of global operations of digitizing LC transactions. The Prime Bank Limited has joined with HSCB blockchain platform

⁶[Contour | The Trusted Network for Global Trade](#)

with its technological support to execute interbank blockchain LC. To build the digital blockchain LC network, Contour depends on the R3's Corda Enterprise, which addresses the transaction security, speed and other traditional hassles of LC issuance (R3 2020). The whole network has been developed by CryptoBL⁷, a Hong Kong based blockchain or distributed ledger technology (DLT) software development, deployment and operational service providing company. It should be noted here that HSBC backed blockchain trade finance platform of Contour has gone live since October 2020 after successful beta testing in different regions of the world (Frost 2020).

3.10. Blockchain Technology Used in Remittance Transfer

It has been mentioned earlier that Bank Asia Ltd., a local commercial bank of Bangladesh has introduced blockchain remittance transfer process in partnership with RAKBank of the UAE. The RAKBank has transferred the blockchain technology from its own Ripple-designed remittance transfer platform. The RAKBank has also implemented the same blockchain technology in other countries such as Philippines to ease the hassles of wage earners in sending remittance to their home country. Ripple, which is a longstanding technology partner of Bank Asia develops the RippleNet for the instant transfer of money to the partner bank as a strategic choice for expanding the RAK Money Transfer system with the latest blockchain technology. Ripple is branded as the only ISO 20022 standard organization for its cutting-edge distributed ledger technology (DLT) and is committed to offer the best customer experience in global payment system (Coinspeaker 2020). On the other hand, the blockchain remittance transfer network is developed by Standard Chartered Bangladesh with technological support from China-based Ant Group.

3.11 A Comparison of Traditional and Blockchain LC Process

In its simplest form, a letter of credit (LC) is a legal documentary guarantee of payment from the buyer to the seller in exchange of goods. It is a common financial instrument in international trade to settle conditional payment obligations, though can also be used internally. The LC issuing bank or advising bank is obliged to pay the seller in full or partially, when the conditions of LC are met, depending on the types of LC and the banks receive a fee for LC processing. The 'Uniform Customs and Practice for

⁷[Cryptoblk](#)

Documentary Credits (UCP 600)' published by the International Chamber of Commerce last in 2007 stipulates the guidelines for issuing and using LCs in international trade. Since its inception the execution of LC was gone through a transition from fully paper-based postal correspondence to electronic paper-based correspondence and then the latest decentralized paperless blockchain transaction with the emergence of new digital technology. The existing online-based LC transaction and newly adopted blockchain-based LC transaction are described below considering the least required four actors for an LC settlement: the buyer (importer), the issuing bank, the seller (exporter) and the advising bank.

3.11.1 Traditional LC Settlement Process

To initiate an LC, the seller and the buyer reach an agreement for trading goods in which LC is set as the mode of transaction.

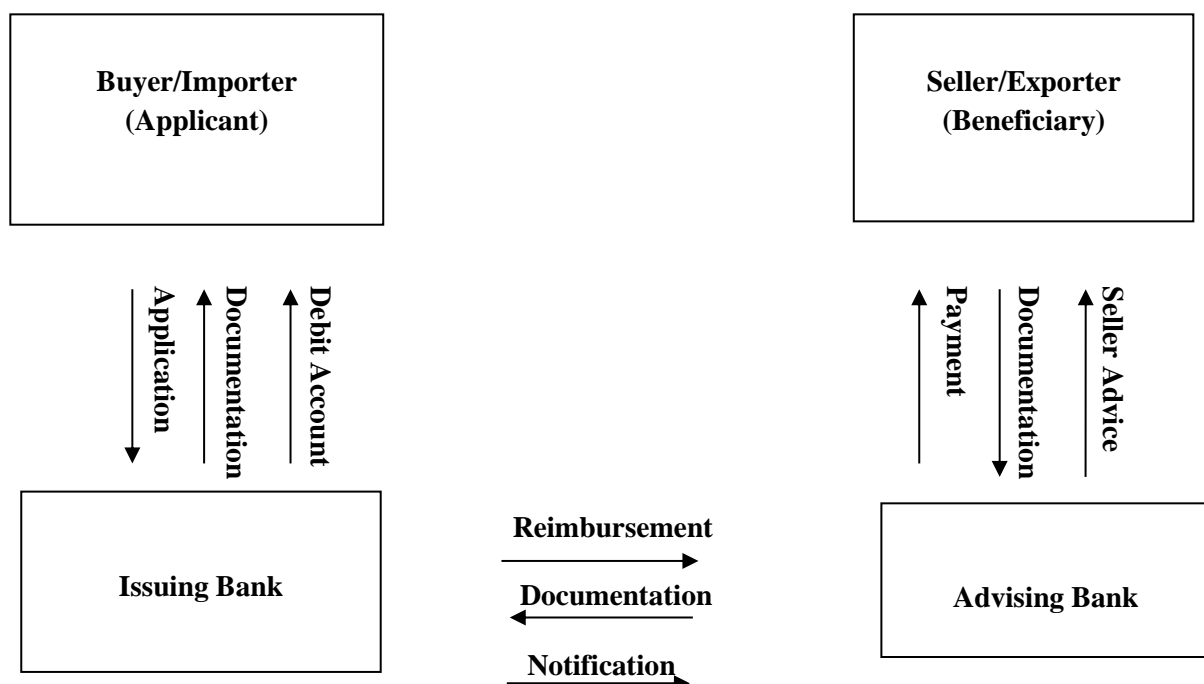


Fig. 3.3: Basic flowchart of traditional Letter of Credit (LC)⁸.

First, based on the agreement the buyer applies to the LC issuing bank for opening an LC describing the types of goods, payment method, type of LC, duration, advising bank information, shipment, etc. with relevant documents.

⁸[International Trade Toolkit | Letter of credit , a payment method worthwhile considering](#)

Second, the issuing bank verifies the documents and accepts the application if it is satisfactory. The first draft of LC is created which is delivered to the advising bank with assurance for reimbursement on behalf of the buyer.

Third, the advising bank checks the documentation and if found correct transmits it to the seller with buyer's requirements for documentation and validity period. The second version of LC is appeared.

Fourth, if the seller accepts the LC request, the shipment is accomplished with bill of lading and sends the consignment documents and invoice to the advising bank.

Fifth, the advising bank transfers the documents of the seller to the LC issuing bank for payment clearance and the third draft of LC is created.

Sixth, the issuing bank informs the seller about shipment, hands over the documents and settles the payment. However, if the advising bank is the confirming bank, it clears the payment after shipment document and invoice is submitted by the seller in correct version.

In this traditional LC process, documents are scrutinized by each party separately with its own discretion and corrects it by itself or sends back to the sender for modification. All parties have their own version of documents. Before getting the documents the parties are not aware of the actions taken by the precedent party. Moreover, different versions of LCs are created throughout the LC concluding process which makes the whole process complex and time-consuming.

3.11.2 Blockchain LC Process

Blockchain LC processes are developed on the basic principles of this technology, i.e., connecting all parties of LCs in a distributed online network through interconnected nodes following the tenets of private consortium blockchain. The fundamental phases of executing a blockchain LC with four common parties of LC mentioned in the previous section are as follows:

First, the buyer creates an application in the blockchain network to open an LC and the blockchain system automatically notifies it to the issuing bank.

Second, the issuing bank approves or rejects the application from its node. If the issuing bank rejects the application, the LC opening process is terminated. In case of acceptance of the application, the LC issuing opening process starts in the form

of a block with the initiation of creating necessary documents mentioning the requirements of LC.

Third, the advising bank accesses the LC requirements and again approves or rejects the LC request scrutinizing the requirements. If the advising bank denies the LC process, the system terminates the LC request. Conversely, if the advising bank approves the LC requests from the satisfactory LC requirements, it validates the LC and the seller is notified. If there is any modification or correction or any other change in the LC requirements, the issuing bank watches it in its node and needs to be validated by the relevant parties for finalizing the change.

Fourth, the seller views the LC requirements and accordingly shipment is made. The seller need not reject the LC without extraordinary cases as the documentation is completed following the terms of the agreement between the seller and the buyer. The seller completes the shipment, adds invoices for the consignment with other necessary documents in the blockchain network from its node.

Fifth, the advising bank automatically notifies about the documentation of the seller. For discrepancies or violation of LC requirements, the advising bank rejects it and the process is terminated. If the documentation of the seller is accepted by the advising bank, the validated documents are stored in the blockchain network.

Sixth, the issuing bank reviews the documents and requests the buyer to check discrepancies. If required, necessary corrections are made, the final and first most LC is issued, which is then settled and added to the distributed ledger permanently and cannot be alter anymore without the consent of all parties.

In the whole process of opening a blockchain LC, all parties are notified in real-time about the progress or change brought by any party. Any change must be validated by the relevant parties based on the permission given to a party to access to the network from its node. The process is unidirectional, as actions of a party are finalized after being validated from other parties. In this transparent way only a single version of final LC is created, which is then settled by the parties.

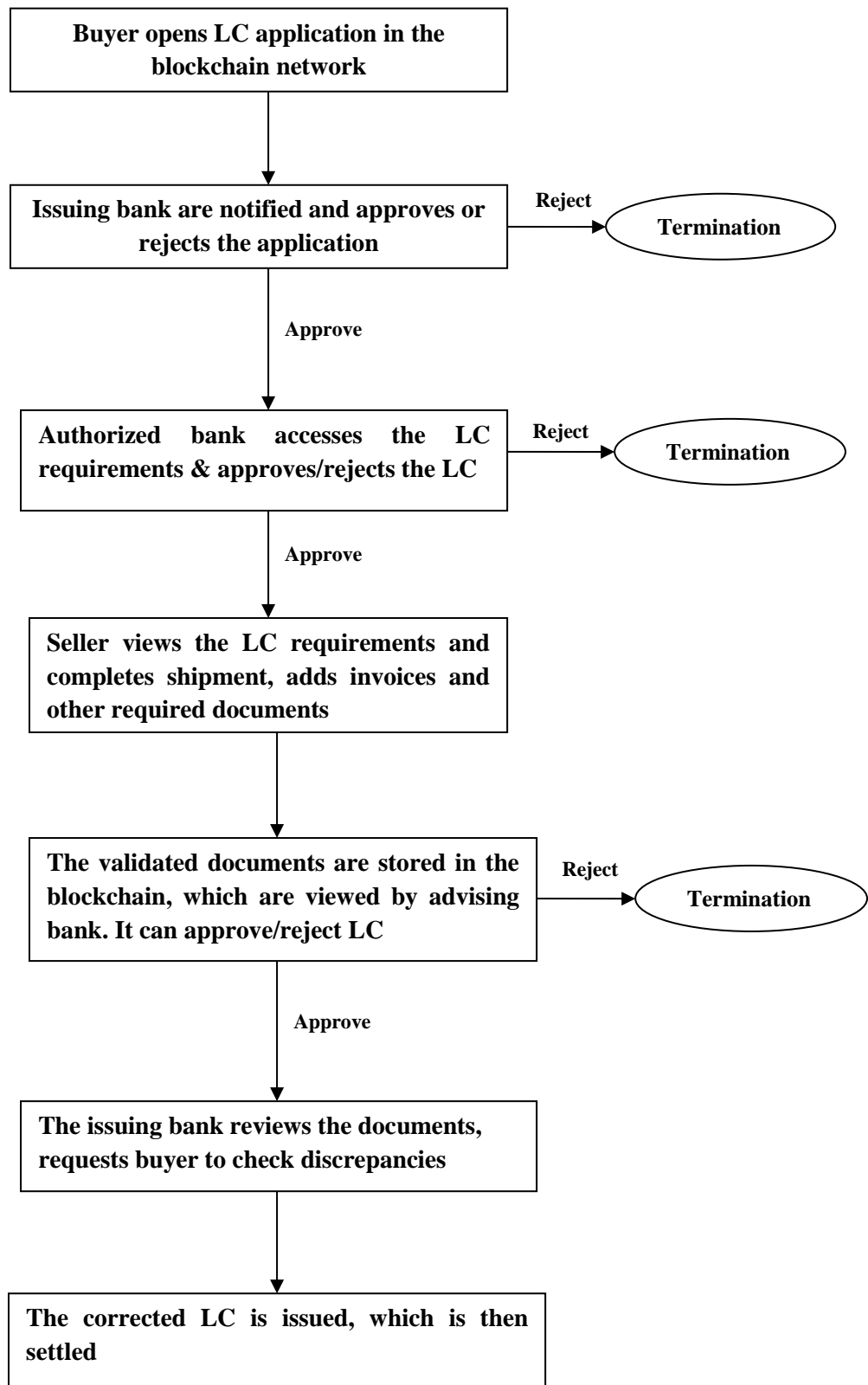


Fig. 3.4: Basic flowchart for a blockchain Letter of Credit (LC).

3.12 Traditional and Blockchain Remittance Transfer Comparison

The world remittance transfer market is continuously growing with the rapid increase in the number of migration especially from developing countries to developed countries. The expatriates send money to their families stay in their native countries using different currency transfer channel including Money Transfer Operators (MTOs) such as Western Union, Banks such as RAKBank of the UAE-the blockchain remittance transfer partner of Bank Asia covered by this study and money authentication channel such as Society for Worldwide Interbank Financial Telecommunication (SWIFT). For example, the Bangladeshi expatriates send US\$ 1.8 billion to Bangladesh as inward remittance in the year 2019-2020⁹. But the existing remittance transfer channel delays the transfer for slow speed, poor connectivity, counterfeiting and also the charge is very high with multiple fees. The blockchain-backed remittance transfer network has been emerged as a promising solution to these issues. The traditional remittance transfer process and the blockchain-enabled remittance transfer process are compared in the next two sections to find the justification of this demand.

3.12.1 Existing Remittance Transfer Process

The Money Transfer Operators (MTOs) via banking channel or the authorized banks directly are engaged in processing remittance cash flow from a foreign country to a home country in the existing remittance transfer tools, such as nostro account, an account denominated in foreign exchange in a foreign country and SWIFT code. In Bangladesh, the banks having the services of remittance transfer have legally permitted drawing rights from the central bank, Bangladesh Bank for inward or outward remittance clearance. In this system of remittance transfer, the common actors are the sender, the sender MTO, the sender bank, the receiver bank, the receiver MTO and the receiver or the beneficiary. The remittance transfer process is completed in several steps.

First, the expatriate deposits the foreign local currency or international currency to an MTO. Second, the MTO transfers the money to the sender bank charging a fee. Third, the sender bank transmits the money to the corresponding receiving bank taking processing fee and using nostro account and SWIFT channel with relevant documents and information especially in excel file as discussed with the Bank Asia Officials. Fourth, the receiving bank checks the documents, validates it, and converts the foreign currency into local currency imposing the processing

⁹ [Remittance\(Date wise\) \(bb.org.bd\)](https://www.bb.org.bd/remittance/date-wise)

fee. But if the discrepancies are found in the documents, the receiving bank sends back it to the sender bank for correction. Fifth, the remittance in local currency is then transferred to the local MTO for delivery to the beneficiary, where fees are charged again.

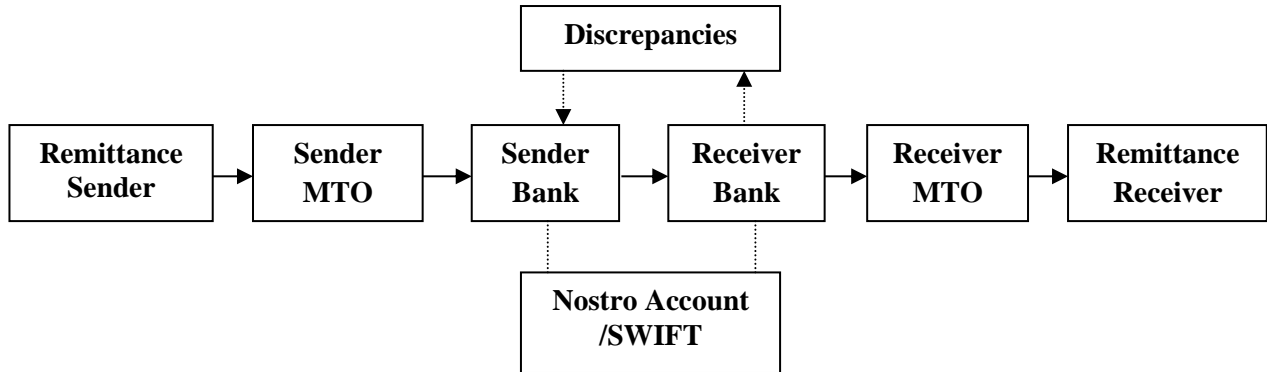


Fig. 3.5: Existing remittance transfer flowchart¹⁰.

The existing remittance transfer process is slow because of the presence of multiple intermediaries and a processing time is required for every actor. The process is not streamlined as each actor operates following its discretionary procedures. The chance of changing or counterfeiting the documents is also possible at any stage due to less transparency as the actions of a party are not accessed by another party. There are also possibilities of not sending the money due to non-compliance of the international or local regulations or denial of the payment due to lack of proper authentication. Moreover, the charge is very high in the existing remittance transfer processes as fees are charged several times.

3.12.2 Blockchain Remittance Transfer Process

The blockchain-based business-to-business (B2B) payment transfer process is advent as the panacea of this problem. The sender sends the remittance fast, secure and reliable way from the blockchain mobile wallets or in cash or from the bank account. In the conversation with Bank Asia officials it has been informed that the blockchain remittance transfer system is a one-to-one system by which remittance can be settled between two banks with just few clicks.

First, the money is received by or transferred to the sender bank from the sender. The sender bank opens a block for remittance transfer and the receiver bank is notified instantly in the private permissioned blockchain.

¹⁰ [How blockchain-based remittance services can boost financial inclusion \(itu.int\)](https://www.itu.int)

Second, the receiver bank checks the authentication of the documents simultaneously from its node, requests the sender bank if correction is necessary. Otherwise, it validates and accepts the transaction. The money is deposited to the sender bank.

Third, the remittance currency is then transferred to the beneficiary account instantly or delivered in cash or transferred to the bank account opened at other than the receiver bank through proper channel such as Bangladesh Electronic Fund Transfer Networks (BEFTN).

Fourth, the block with money transfer information is added to the blockchain ledger permanently and is almost impossible to bring any change.

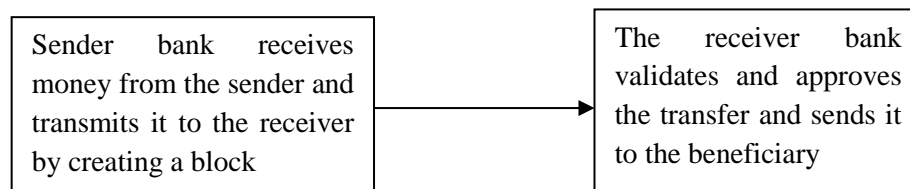


Fig. 3.6: Basic Blockchain remittance transfer flowchart.

In the blockchain remittance transfer process, the money is transferred in real-time without any lagging. The transaction process is verified and authenticated by each participant involved, which is then attached to the central immutable ledger that makes the system highly secured.

3.13 Benefits of Blockchain LC Trade Finance

The LCs are treated in the trade and commerce sector as the means of sustenance for the continuous and uneven flow of the world trade that keeps the growth world economy alive and vibrant. But the complexities and inefficiencies of the existing LC execution method always cause delay in LC settlement and incurs comparatively high costs directly and indirectly in the trade finance sector that force the LC users to opt for alternative ways to mitigate the ineptitudes in LC execution so that the LC execution process can be streamlined. The blockchain-enabled LC execution process developed from the principles of smart contracts, a unique contract settlement simplification method of blockchain technology, restructures the LC execution as a fully automated method that benefits the users in many ways as described below.

Streamlined Process Flow. The consensus-oriented blockchain LC system is unidirectional that streamlines the processes with the authorized responsibilities and uniformity of the system is confirmed. All tasks are accomplished in a creation-validation-approval approach that makes the system extremely efficient and effective in performing different functions. For this the Chairman of Voyellatex Group recognized this process smooth and hassle-free (Standard Chartered 2020).

Transparency and Visibility. The execution of LC in blockchain platform is one with high level of transparency. All parties related in the LC finalization notifies constantly what is done by each party in the distributed and decentralized computer network and all actions must be validated by all parties, otherwise the actions will not be performed. The authorized LC parties can access the blockchain network with his private key at any time and track the progress of the LC execution with greater visibility.

Paperless. The blockchain LC process eradicates the need for had copies of necessary documents. All applicable laws and protocols applied for LC such as UCP 600 codifies in the blockchain technology and uses with the acceptance of each parties. This reduces the need for preparing documents for acceptance (D/A) and documents for payments (D/P). In the Standard Chartered LC process, the applicant does not need to visit the issuing bank, which is also same for the beneficiary, all functions can be done from the home office accessing to the Contour site. The whole process is paperless done in a digital interface (Standard Chartered 2020).

Single LC. The different steps of blockchain LC processes are completed with the validation and approval of all parties involved in LC settlement. Once a step is completed utilizing the consensus mechanism of the distributed ledger technology (DLT). Following this procedure a single final version of LC is created at last which is accepted and used by all parties. In contrast, different versions of LCs are generated at different stages based on the responsibilities of the LC actors, for example, the issuing bank prepares a version of LC for the buyer, whereas the advising bank makes another version for the seller.

Reduce Ambiguities and Discrepancies. In the manual system of LC preparation, the terms and wordings are interpreted differently by different actors that causes delay and wastes of time and money in LC settlement. The term ‘by a week’ can

be interpreted as the last day of week by the seller, whereas it can be taken as day before last day of week. This also happens in interpreting the legal and regulatory terms. To remove the appearance of ambiguities and discrepancies during LC preparation, the discrete and specific terms are used and the codification of law has only a single acceptable version as all parties validate and approve the documentation before finalization of the outcome.

Speed and Real-time. One of the most beneficial feature of the blockchain LC technology is that it reduces the LC settlement time drastically from a minimum 5-10 days to within 24 hours. The participants of LC can access to the system at a time and complete the activities simultaneously with mutual validation and approval process and all actions are completed in real-time that accelerates the tasks completion rate with enhanced speed and real-time basis. Highlighting this advantage the Chairman of Voyellatex Group iterated, *'It is not cumbersome like normal ones. Besides it's time and cost-efficient'* (Standard Chartered 2020).

Security and Immutability. The data of LC created and finalized once are added to the distributed ledger permanently, theoretically, an LC as a new block is added to the previous block of the total blockchain in the form of merkle-tree algorithm. The block LC has only one version that is distributed to all parties engaged in the execution. It is almost impossible to create a replica or an alternate fake form of the LC as the same algorithm must be created with the same encryption or security key and the same change must be done in all nodes with a combined consensus. This feature makes a blockchain LC highly secured and non-replicable. The CEO of HSBC Bangladesh commented, *'I believe this will usher in a routing of international trade transactions as business and governments recognize transparency, security and swiftness in performing tasks using blockchain technology'* (HSBC Bangladesh 2020).

Cost Savings. In case of blockchain LC, all actions are done in a streamlined unidirectional system in a paperless cloud-based online platform with 'proof-of-concepts' of all participants. The uniformity and real-time nature of the system enhances its efficiency and makes it more economical. The reduction of redundancies and ambiguities of the works are obtained from the consensus-based mechanism. These features are contributed as a whole to reduce the LC settlement costs in comparison to existing method a lot.

Interoperability. In the present online LC processing system, the parties use their own network which are connected discretely. But the system compatibility may

be varied, which hampers the interoperability of the process and creates complexities in performing the tasks. However, the blockchain network is a distributed uniform network in which the parties are interconnected with the same interface and technological blueprint. This augments the interoperability of the system. For example, the Contour platform facilitates to build enhanced collaboration among the LC participants to generate and modify trade data in real-time (Standard Chartered 2020).

The benefits of blockchain LC technology illustrated above helps to reduce lack of integration, high friction and excessive administration of the present system. The CEO of Standard Chartered Bangladesh pointed out, *'If you want to name the top five advantage of this, they are paperless, real-time, low-cost, faster and error-free'* (Standard Chartered 2020). In fact, the blockchain LC system revolutionizes the global trade finance with all its top-notch advantages that persuade the LC users including banks around the world to adopt this technology for LC settlement.

3.14 Benefits of Blockchain Remittance Transfer Process

The blockchain remittance transfer process also reduces the hassles of the existing cross-border remittance transfer process. The painstaking presence of multiple intermediaries, excessive levies for sending money and most importantly the corrupt practices are mitigated in the hard-earning foreign currency transfer by the expatriates. The advantages of the blockchain-enabled money transfer system are described in the following paragraphs.

Remove Multiple Intermediaries. While discussing with the Bank Asia officials it has been informed that the blockchain remittance transfer system has been founded on a one-to-one network. The remittance sender transfers the money from the sender bank to the beneficiary bank directly that does not require any MTOs. Instead what the sender requires is to have a blockchain-enabled mobile wallet or deposit cash to the sender bank.

Prevent Fake Documentation. In the manual remittance transfer system, the information of the foreign currency transfer, the beneficiary particulars, amount of transferred money, etc. are delivered to the receiver bank in an excel file. Bank Asia officials informed that the data of the file can be modified by the scrupulous bank personnel with ill motive. But the blockchain-enabled remittance transfer system is distributed and all parties are notified about the actions instantly and

must be validated by all parties to complete an action. In this way the system automatically prevent the fraudulent practices.

Error-free. In a permissioned private blockchain network, e.g., RippleNet being used by RAKBank and Bank Asia for remittance transfer, the activities are accomplished after getting the nod from each participants and a single version of remittance transfer document is created, which is used by all participants to settle the cross-border money transfer. As the final document is produced on consensus of the parties, the probability of error is insignificant.

Real-time. The blockchain remittance transfer system can transfer the money instantly. No longer is the money transfer information included in the system by the sender bank, the receiver bank gets the notification message in its end and validates the transfer after checking the information provided by the sender. If the money transfer is validated and accepted by the receiver bank, the money is deposited to the beneficiary account at the same moment. Bank Asia officials said remittance in the blockchain system are transmitted with few clicks that reduces the money transfer time within hours in comparison to several days of the existing system.

Reduced Charges. In the existing remittance transfer process, the sender is charged an amount of fees to the each actors engaged in processing the money transfer. But the blockchain system charges all fees once, which is then distributed among the participants based on the consensus. In fact, the remittance transaction fees in blockchain system lies between 2-3% of the send money, which is more than 7% in the existing system.

Process Simplification. The processes of the blockchain are unidirectional, which is also true for the blockchain remittance transfer platform. The dual correspondence between the sender bank and the receiver bank are not essential in the blockchain system. The actions of each process are completed whether the consensus is reached between the parties.

Blockchain remittance transfer system minimizes the much-irritating high transaction fees, delays in payment transfer and hassles of intermediaries of the existing money transfer system streamlining the processes that makes the large remittance transfer services faster, cheaper and consistent.

3.15 Challenges of Blockchain Adoption in Banking Sector

The blockchain technology unlocks the enormous untapped potential of the financial services sectors including banking sector to revolutionize the efficacy and promptness of the system for that more and more banks are adopting the blockchain technology or connecting in the blockchain network. However, the technology faces some challenges in the path of wide application.

New Beta Application. The financial services provided now by the different banks in Bangladesh are experimental and being implemented on pilot basis or sometimes as a test case. So the blockchain technology in the banking sector of Bangladesh is considered to be in the acceptance stage of adoption and yet to be diffused in a large scale. Though some services went live, such as HSBC trade fiancé services, it will take time to determine the actual efficiency of the blockchain technology to gain mass customer satisfaction, though the initial performance is impressive as mentioned by Prime Bank officials during discussion about the status of adoption of the blockchain technology in this bank.

Small Network. The blockchain technology has only implemented in a fewer banks operating in Bangladesh. Again, the banks, which have adopted this technology so far, have initiated only one or two branches so far. To reap the maximum benefits for the adoption of blockchain technology, it should be introduced in all branches of a bank through the gradual expansion of the blockchain network and the existing process of rendering financial services should be replaced by the blockchain system after the transition period. Otherwise, the banks will have to face high running costs of multiple technological platform at the same time.

Less Collaboration. Interbank collaboration is vital for smooth operations of interbank or cross-border payment settlement, e.g., trade finance or remittance transfer discussed in this study as fields of blockchain application. But the collaboration among the banks in Bangladesh for establishing a concrete and wide network is still poor, as many banks are still planning or strategically thinking to adopt blockchain technology. Without this collaboration the scope of blockchain application cannot be widened. Not only the banks but also all relevant actors lay in the pipeline of providing banking services should include in the distributed network of blockchain technology for achieving maximum benefits. For example, the interbank LC is executed by Prime Bank through the blockchain platform, the money has been transferred by using SWIFT channel as the partnership does not

establish with SWIFT authority yet for the settlement of money transfer of LCs with the utilization of same blockchain network.

Less Comprehensive. The blockchain technology is competitive but lacks in comprehensiveness. It is only applicable in some segments of trade finance and other financial services sector till now. For example, the shipment of goods requires bill of lading (B/L) that uses the legal document for the carriage during transportation of goods by a carrier and describes quantity, types and destination, etc. of the goods vital for customs inspection and clearance. But the services of B/L is not incorporated in the blockchain domain yet and needs to be prepared using the existing system. This scalability issue in blockchain application minimizes comprehensiveness of blockchain technology, though the experiment is going on to devise the process for accomplishing B/L with blockchain technology.

Small Trained Personnel. The banks, which has adopted blockchain technology for banking services provides skill enhancement training with the help of external resources. But inter training arrangement is essential for the diffusion of this technology widely encompassing all working areas of the banks. The curriculum and other training materials, in-house trainers, etc. needs to be created by the banks for successful adoption of the technology in all spheres of its activities.

Regulatory Framework. The regulatory framework for blockchain technology from the public sector is not articulated till now. The central bank of Bangladesh does not permit to trade in cryptocurrencies due to regulatory problems. But the public-private partnership is crucial for adopting blockchain technology in the banking sector.

Service Diversification. The application of blockchain technology in the banking sector of Bangladesh is at the nascent stage and few services are being offered for the banking channel users at present. But the sustainability of this technology heavily relies on the diversification of its application in all financial services rendered from the banks, otherwise it remains as a peripheral technology, which cannot replace the existing technological facilities adopted by the banks.

Mass Acceptance. The maximum number of bank users in Bangladesh are general public live in rural and urban areas. They must be accustomed to use this technology in getting financial services. But as a new technology the understanding of blockchain technology among mass people is very poor. The banks should work on increasing the accessibility of mass people for this technology to ensure successful wide application.

It is evident from the above discussions that the scalability and scope of blockchain adoption in the banking sector of Bangladesh is not wide enough to create a robust network. The blockchain technology is adopted in a limited scale applying only for two banking services, Letter of Credit (LC) settlement and remittance transfer. Though the scope and scalability of this technology adoption is still insignificant, the efficiency level is high in terms of streamlining processes, reducing duplicity, increasing transparency and trust, eliminating ambiguities and discrepancies, enhancing security, reducing paper works, saving costs and time, and providing services in real-time. The clients of the services rendered from the blockchain platform of the banks under the study expressed their ecstatic satisfaction about the service quality that reflects the higher effectiveness of this technology comparatively to the existing technology. However, the large scale adoption of blockchain technology needs to overcome the challenges of growing network, less collaboration, low comprehensiveness, absence of sound regulatory framework and inadequate skilled human resources. However, despite the challenges existed in adopting blockchain technology in the banking sector of Bangladesh, the technology has immense potential to improve the service delivery system in terms of time, cost and quality that encourages the banking sector to adopt this emerging technology in accordance with the rest world.

Chapter 4

Recommendations and Conclusion

4.1 Introduction

The adoption of blockchain technology in the private banking sector of Bangladesh turns into a reality crossing the conceptualization and planning stages. The study covers four pioneer banks in implementing the blockchain technology to improve their banking services with this cutting-edge technology following the global trends set by the leading banks of the world to shift their service providing technology to blockchain as a preparedness of sustaining in the realm of fourth industrial revolution. In this study it has been revealed that the initial beta implementation of blockchain technology in the trade finance or cross-border interbank payment settlements is satisfactory and the adoption improves the service delivery system in many aspects such as increasing transparency, preventing fraud transactions, reducing time and costs, enhancing security, minimizing ambiguities and discrepancies, and above all streamlining and simplifying the trade finance process. The adoption of this technology will be more effective so long as all internal and external stakeholders are joined in the blockchain network and the diversification of the blockchain services is achieved under a solid regulatory framework. This chapter elaborates the recommendations for wider adoption of this technology in the banking sector of Bangladesh with concluding remarks.

4.2 Recommendations

- The banks can identify the requirements and demand of the blockchain technology conducting a comprehensive market analysis and articulate the course of actions as the strategic priority to adopt this technology in all banking functions. The market will help to identify the actual demand of the customers and define the suitability of the scope of this technology.
- The banks can consider to increase the budgetary allocation for adopting the blockchain technology. Though the implementation status is at the early stage, the increase in budgetary allocation accelerates to build a robust platform of this technology in a quick succession as well as explores new ideas to keep innovation momentum alive for improving service delivery system upgradation.

- The banks should be cautious in choosing the types of blockchain technology considering its appropriateness to the core operations of the bank. For example, permissioned consortium blockchain can be adopted for trade finance that enables error-free service delivery and at the same time will help the banks to monitor the activities of the participants so that legality dimension of the transactions can be achieved.
- The banks should consider the expansion of blockchain internally and externally to materialize the opportunities of economies of scale that will increase the benefits-costs ratio of a new technology adoption. Internally, all branches of the banks can be brought under the network of blockchain technology and as an external initiative the other banks, government institutes and other financial service providers will be connected in the decentralized network of blockchain.
- The banks should work on surveying the landscape of utilizing the blockchain technology in diversified banking services sectors in a user-friendly manner that will increase its acceptance to the general clients of the banking services. The diversification of blockchain services will enhance the scalability of this technology in the banking sector and the banks will be benefitted from replacing the existing technology fully and relieves from the maintenance costs of multiple technology at the same time.
- The sustenance of the blockchain technology in the banking sector will largely depend on the expertise of the personnel involved in the operations and maintenance of this technology. The banks should concentrate on creating an adequate amount of skilled human resources for the smooth and wide adoption of this technology with greater acceptance to the internal and external service clients. The in-house and abroad training facilities should be developed with sound curriculum and demo hands-on application of the technology in different banking services.
- The legal and regulatory framework of the government for initializing the blockchain technology is not crafted yet. Though the government of Bangladesh has adopted a national strategy for blockchain planning and implementation, its scope mainly focuses on the adoption of blockchain technology in different government services. The government may create a robust public-private partnership for adopting the blockchain technology in the financial sector in collaboration with the banks, corporate houses,

small and medium enterprises (SMEs) and other relevant stakeholders and may prefer to incentivize the banks for adopting this technology after formulating an enabling legal and regulatory framework.

4.3 Conclusion

The blockchain technology is treated as the ‘future technology of the banks’ as it shapes the third digital revolution, i.e., digital technology of transactions. It is commendable effort of the commercial banks of Bangladesh that starts the adoption of this technology in a limited scale but with vast advantages. It is now the demand of time to adopt the technology all over the banking sector collaborating all stakeholders to provide world-class banking services from Bangladesh.

References

Alam, M 2017, *The Digital Banking Revolution in Bangladesh*. Retrived from: The Digital Banking Revolution in Bangladesh - FinTech Magazine (fintechbd.com) [03 December 2020].

Atlam, H and Wills, G 2018, *Technical aspects of blockchain and IoT*. Retrieved from: Technical aspects of blockchain and IoT (researchgate.net) [18 December 2020].

Chaterjee, D 2020, *Crypto Banking: Traditional Banking's Competition or Ally?*. Retrieved from: Crypto Banking: Traditional Banking's Competition or Ally? - ReadWrite [20 December 2020].

Chiu, S and Shang, S 2019, *Can blockchain really remove all intermediaries? A multiple-case study in different countries*, AIS eLibrary, 2018. Retrieved from: AIS Electronic Library (AISeL) - International Conference on Information Systems Development (ISD): Can Blockchain Really Remove All Intermediaries? A Multiple-Case Study in Different Industries (aisnet.org) [17 December 2020].

Coinspeaker 2020, *Ripple helps RAKBank to expand RAKMoney transfer with RippleNet*. Retrieved from: Ripple Helps RAKBANK to Expand RAKMoney Transfer with RippleNet (coinspeaker.com) [30 December 2020].

Deloitte 2015, *What is a blockchain*. Retrieved from: <https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-what-is-blockchain-2016.pdf> [14 December 2020].

Dicaprio, A and Jessel, B 2018, *Can blockchain make trade finance more inclusive?*. Retrieved from: Can-Blockchain-Make-Trade-Finance-More-Inclusive-1.pdf (r3.com) [20 December 2020].

Diffie, W and Hellman, M 1976, *New directions in cryptography*. Retrieved from: 24.pdf (stanford.edu) [18 December 2020].

Ertz, M and Boily, E 2019, *The rise of the digital economy: Thoughts on blockchain technology and cryptocurrencies for the collaborative economy*, International Journal of Innovation Studies, vol. 3, issue 4, December 2019. Retrieved from: The rise of the digital economy: Thoughts on blockchain technology and cryptocurrencies for the collaborative economy - ScienceDirect [09 December 2020].

Frost, L 2020, *HSBC-backed trade finance platform contour goes live*, Decrypt. Retrieved from: HSBC-backed trade finance platform Contour goes live, Decrypt [30 December 2020].

Fuchs, P 2019, *Blockchain*. Retrieved from: gl-2019-blockchain-101-overview-mercero.pdf (mmc.com) [18 December 2020].

Haber, S and Stornetta, W 1990, *How to time-stamp a digital document*. Retrieved from: How to time-stamp a digital document | SpringerLink [18 December 2020].

Gauhan, L 2020, *The emergence of crypto banking: Who is poised for success?*. Fintech. Retrieved from: [The emergence of crypto banking: who is poised for success? | Venture Capital | Fintech Magazine](#) [20 December 2020].

Goldwasser, S et al. 1988, *A digital signature scheme secure against adaptive chosen message attacks*. Retrieved from: [paper-www.dvi \(mit.edu\)](#) [18 December 2020].

Gopie, N 2018, *What are smart contracts on blockchain*, IBM. Retrieved from: [What are smart contracts on blockchain? - Blockchain Pulse: IBM Blockchain Blog](#) [20 December 2020].

Gratzke et al. 2017, *Banding together for blockchain: Does it make sense for your company to join a consortium?*. Retrieved from: [https://www2.deloitte.com /us/en/insights/focus/signals-for-strategists/emergence-of-blockchain-consortia.html](https://www2.deloitte.com/us/en/insights/focus/signals-for-strategists/emergence-of-blockchain-consortia.html) [17 December 2020]

Gupta, V 2017, *A brief history of blockchain*. Retrieved from: [A Brief History of Blockchain \(hbr.org\)](#) [18 December 2020].

Herweijer, C and Swanborough, J 2018, *8 ways blockchain can be an environmental game-changer*, World Economic Forum. Retrieved from: [8 ways blockchain can be an environmental game-changer | World Economic Forum \(weforum.org\)](#) [19 December 2020].

HSBC, Bangladesh 2020, *HSBC drives Bangladesh's first crossborder blockchain LC transaction*. Retrieved from: [News and media - About HSBC | HSBC Bangladesh](#) [28 December 2020].

International Finance 2020, *RAKBank, Bank Asia drive cross-border payments using Ripple's blockchain*. Retrieved from: [RakBank, BankAsia drive cross-border payments using Ripple's blockchain \(internationalfinance.com\)](#) [28 December 2020].

Jha, A 2011, *Research methodology*, APH Publishing Corporation, New Delhi, India, pp. 155.

Karppinen, U 2018, *BBVA signs world first blockchain-based syndicated loan arrangement*. Retrieved from: [What was the world-first blockchain-based syndicated loan? \(bbva.com\)](#) [20 December 2020].

Kothari, C 2004, *Research methodology: Methods and techniques*, New Age International (P)Limited, Publishers, New Delhi. Retrieved from: <https://www.pdfdrive.com/research-methodology-e33404795.html> [05 December 2020].

Lannquist, A 2019, *10 ways central banks are experimenting with blockchain*, World Economic Forum. Retrieved from: [10 ways central banks are experimenting with blockchain | World Economic Forum \(weforum.org\)](#) [21 December 2020].

Lin, X et al. 2019, *A blockchain-enabled decentralized time banking for a new social value system*, IEEE Conference on Communications and Network Security (CNS). Retrieved from: [A Blockchain-Enabled Decentralized Time Banking for a New Social Value System - IEEE Conference Publication](#) [21 December 2020].

Madeo, S et al. 2020, *2020 Crypto hedge fund report*, PricewaterhouseCoopers. Retrieved from: [pwc-elwood-annual-crypto-hedge-fund-report-may-2020.pdf](#) [21 December 2020].

Manav, G 2017, *Blockchain for dummies*. IBM Limited Edition, John Wiley & Sons, Inc., New Jersey, USA. Retrieved from: [Blockchain For Dummies® IBM Limited Edition \(gunkelweb.com\)](#) [14 December 2020]

Marr, B 2018, *Blockchain: A short history of ethereum everyone should read*. Retrieved from: [Blockchain: A Very Short History Of Ethereum Everyone Should Read \(forbes.com\)](#) [18 December 2020].

Mulligan, C 2016, *Blockchain- a brief overview*. Retrieved from: [PowerPoint Presentation \(eventscloud.com\)](#) [14 December 2020]

Nakamoto, S 2008, *Bitcoin: A peer-to-peer electronic cash system*. Retrieved from: <https://bitcoin.org/bitcoin.pdf> [18 December 2020]

Organization for Economic Cooperation and Development (OECD) 2019, *OECD blockchain primer*. Retrieved from: [OECD-Blockchain-Primer.pdf](#) [14 December 2020]

PricewaterhouseCoopers 2017, *Blockchain: A catalyst for new approaches for insurance*. Retrieved from: <https://www.pwc.com/gx/en/insurance/assets/blockchain-a-catalyst.pdf> [14 December 2020].

Prime Bank Limited 2020, *Prime Bank becomes the first Bangladeshi Bank to execute first interbank blockchain LC transaction*. Retrieved from: [Interbank Blockchain LC Transaction/ \(primebank.com.bd\)](#) [28.12.2020].

Puthal, D, Malik, N and Mohanty, S 2018, *Everything you wanted to know about the blockchain: Its promise, components, processes and problems*, IEEE Consumer Electronics magazine, vol. 6, issue 14, July 2018. Retrieved from: [\(PDF\) Everything You Wanted to Know About the Blockchain: Its Promise, Components, Processes, and Problems \(researchgate.net\)](#) [17 December 2020]

R3 2020, *Contour case study: The network of networks digitizing trade finance*. Retrieved from: [Corda Contour CS R3 June2020.pdf](#) [30 December 2020].

Rana, M & Hossain, M 2014, *Human resource management (HRM) practices of the banking sector of Bangladesh: A comparative study*. Retrieved from: Microsoft Word - 02. BV Final.-14.doc (bv-f.org) [03 December 2020].

Sarmah, S 2018, *Understanding blockchain technology*. Retrieved from: [\(PDF\) Understanding Blockchain Technology \(researchgate.net\)](#) [18 December 2020].

Standard Chartered, Bangladesh 2020, *Standard Chartered Bank pioneers Bangladesh's first ever blockchain Letter of Credit*. Retrieved from: [bd-Press-Release-Bangladesh-Blockchain-LC.pdf \(sc.com\)](#) [28 December 2020].

Sultana, A, Kabir, M and Rahman, M 2015, *Organizational culture and job satisfaction in the banking sector of Bangladesh*. *J. Innov. Dev. Strategy*. 9(3), 1-6. Retrieved from: https://www.academia.edu/19878498/ORGANIZATIONAL_CULTURE_AND_JOB_SATISFACTION_IN_THE_BANKING_SECTOR_OF_BANGLADESH [01 December 2020].

Sylvester, G 2019, *Blockchain for agriculture: Opportunities and challenges*, Food and Agriculture Organization. Retrieved from: [E-agriculture in action: Blockchain for agriculture \(fao.org\)](https://www.fao.org/e-agriculture-in-action/blockchain-for-agriculture) [19 December 2020].

Szabo, N 2005, *Bit Gold*. Retrieved from: [Bit Gold | Satoshi Nakamoto Institute](https://satoshi.nakamoto.institute/bit-gold) [18 December 2020].

The Daily Star 2020, *StanChart executes Bangladesh's first-ever blockchain LC transaction*. Retrieved from: [StanChart executes Bangladesh's first-ever blockchain LC transaction | The Daily Star](https://www.dailystar.com.bd/news/2020/12/28/stan-chart-executes-bangladesh-s-first-ever-blockchain-lc-transaction) [28 December 2020].

The Daily Star 2020, *StanChart rolls out first blockchain remittance service*. Retrieved from: [StanChart rolls out first blockchain remittance service | The Daily Star](https://www.dailystar.com.bd/news/2020/12/28/stan-chart-rolls-out-first-blockchain-remittance-service) [28 December 2020].

The Financial Express 2020, *HSBC drives Bangladesh's first crossborder blockchain LC transaction*. Retrieved from: [HSBC drives Bangladesh's first crossborder blockchain LC transaction \(thefinancialexpress.com.bd\)](https://www.thefinancialexpress.com.bd/news/2020/12/28/hsbc-drives-bangladesh-s-first-crossborder-blockchain-lc-transaction) [28 December 2020].

World Intellectual Property Organization 2020, *Global Innovation Index, 2020*. Retrieved from: [wipo_pub_gii_2020.pdf](https://www.wipo.int/ipkb/publications/gii/2020/gii_2020.pdf) [01 December 2020].

Wu, J and Tran, N 2018, *Application of blockchain technology in sustainable energy systems: An overview*, Sustainability, MDPI. Retrieved from: [Application of Blockchain Technology in Sustainable Energy Systems: An Overview \(semanticscholar.org\)](https://www.semanticscholar.org/entry/Application-of-Blockchain-Technology-in-Sustainable-Energy-Systems-An-Overview) [17 December 2020]