Digitizing Trade Finance Using Blockchain Technology Illustration of Letter of Credit Process

Munaf Asad Khalil
College of Science and Engineering, Hamad Bin Khalifa University
Doha, Qatar
mkhalil@hbku.edu.qa

Laoucine Kerbache
Engineering Management and Decision Sciences,
College of Science and Engineering, Hamad Bin Khalifa University, and HEC Paris in Qatar
Doha, Qatar
lakerbache@hbku.edu.qa

Adel El Omri
Engineering Management and Decision Sciences,
College of Science and Engineering, Hamad Bin Khalifa University
Doha, Qatar
aelomri@hbku.edu.qa

ABSTRACT

This research aims to study the issues derived from the current trade finance processes, followed by evaluating the available technological solutions proposed by researchers and FinTechs. The purpose of seeking technological solutions is to replace the current obsolete processes of traditional trade finance, which rely heavily on manual monotonous labor and paperwork. In this research, the impact of blockchain technology on the Trade Finance processes is examined using three simulation models, Paper Letter of Credit, Bank Payment Obligation (BPO), and Blockchain Letter of Credit. The research findings observed a significant increase in process efficiency up to 94% while conducting processes under Blockchain Platform and 74% using BPO.
Moreover, the study demonstrates how the efficiency gained from applying blockchain technology to the trade finance processes could increase productivity and significantly reduce processing costs. The research findings provided an essential awareness to banks, corporates, and governmental authorities about the importance of blockchain technology in trade finance and highlighted the need for an urgent digital transformation. Researchers can extend studies by applying proof of concept of Blockchain implementation to other trade finance processes such as Documentary Collections and Guarantees. Future work can include more parties from the entire trade ecosystem such as Shippers, Insurers, and Governmental authorities.

Keywords
Trade Ecosystem, Trade Finance, Blockchain, Letter of Credit, Business Process Simulation

1. Introduction
As the World undergoes a considerable paradigm shift and it is for definite applying a recent technology towards digitalization and automation of any of the trade finance processes will significantly enhance efficiency for all stakeholders, banks, corporates, government entities, and other parties involved in trade finance processes. Moreover, COVID-19 accelerated the urge for digitization and digitalization in ways that were unimaginable before to COVID-19. Trade finance processes depend almost entirely on physical paper documentation to process payments and clear the underlying of goods to buyers. COVID-19 pandemic which has caused a painful impact on the trade processes and created historical Trade Finance market disruptions. In most countries, government authorities reduced the number of employees present in the office and increased the number of employees to work remotely from their homes. Also,

business hours in many countries were reduced. The requirement of documentation exchanged by the parties under trade finance processes and the paper nature of all documents creates inefficient and heavy activities. Manual checking, monitoring, and circulation of physical documents causes money and time waste (Romain 2018).
Even though most recent studies focus on discussions of how the Blockchain, and other digital solutions may help trade finance business operations reduce processing time, most of them do not quantitatively demonstrate such gain. This research quantitatively determines the impact of Blockchain technology on the trade finance L/C processes in respect of processing time and cost and compare it with the bank payment obligation (BPO). The conceptual framework of this study is supported by the illustration of the trade finance processes in three frames, the current paper-based, the blockchain-based, and bank payment obligation (BPO)-based. It evaluates the shifting to digital trade by conducting two ways comparison, current paper-based process with blockchain-based process and current paper-based process with another digital solution, bank payment obligation (BPO).
The study brings an essential contribution to banks, corporates, and governmental authorities using the study's findings to realize the importance of digital technology in trade finance and the need for an urgent digital shift.

2.Research Methodology

An illustration of three cases, current paper-based, bank payment obligation (BPO) based, and blockchain-based, is done to quantitatively figure out the impact of blockchain technology on the trade finance processes regarding processing time and cost. The conceptual framework is analyzed and validated by three simulation models developed in AnyLogic simulation software. The purpose of these models is to determine the processing time required to process six hundred thousand paper-based L/Cs and six hundred thousand blockchain-based L/Cs and six hundred thousand bank payment obligations (BPO).

2.1 Data Collection

Existing paper process and BPO data were taken from the assumption of the actual existing process already in practice and used by banks worldwide and validated by the International Chamber of Commerce (ICC). While blockchain process illustration data collected from actual blockchain processes conducted by Contour FinTech. Paper complexity and data exchange between parties of the letter of credit transactions were derived from reports published by Boston Consulting Group (BCG) and ICC. Primary data of the research were collected from simulation software, Any Logic, after input needed secondary data to simulate the current paper-based process, BPO, and the blockchain-based one. The primary data collected has been used to numerically analyze and compare the benefits of blockchain implementation in the letter of credit processes regarding processing time and costs.

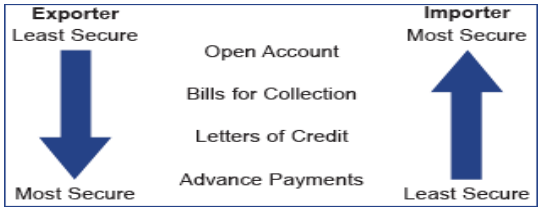
3. Trade Finance Processes - Overview

Trade finance products create trust, and they are key financial instruments used by corporates to settle their trade activities. "Some 80 to 90 percent of world trade relies on trade finance..." World Trade Organization (wto.org). A Trade Finance process is basically how the parties interact with each other within credit operations. A typical documentary credit (L/C) cycle follows at least nine essential steps. If a change or correction is needed by any of the parties in the Process, it will require one or more steps to be repeated, which will cause process delay and affect the total processing time of the transaction.

3.1 Payment Methods

The buyer and the seller will agree to use one of the payment methods defined in Figure 1. The risk ladder defines the reality that security level in terms of payment has an inverse relationship between buyer and seller (Cowdell et al. 2014).

Figure 1: Payment Risk Ladder



3.2 Letter of Credit L/C (Documentary credit)

L/C is an irrevocable bank undertaking to make payment of the goods or services if the bank receives within the L/C validity of all documents in full compliance with the L/C terms and conditions (Cowdell et al. 2014). In a simple illustration, the issuing bank will receive the physical documentations as shown in Table 1. The issuing bank will check the face value of the documents if complying with the L/C to make immediate or deferred payment as per the L/C terms and conditions. Majority of L/Cs are subject to UCP 600 "Uniform Customs and Practice for Documentary Credits 600 published by ICC in 2007" which governs more than ninety percent of the L/Cs worldwide. Few countries developed their own rules and regulations to govern the letters of credit, for example, SKBDN (Surat Kredit Berdokumen Dalam Negeri) rules which govern L/Cs issued in Indonesia. Research has proven that the L/C is the most trusted payment mode in international trade finance though it is expensive (Basimanyane 2016)

Table 1: Key documents - Letter of Credits

Shipping Documents	Insurance Documents	Commercial Documents	Other Documents	Financial Documents
Bill of Lading (B/L)	Insurance Policy	Commercial Invoice	Certificate of Analysis	Draft
Air Waybill	Insurance Certificate	Inspection Certificates	Quality Certificate	Bill of Exchange
Road or Rail Transport Document		Certificate of Origin	Health Veterinary Certificate	

4. Traditional Trade Finance Issues

A trade finance transaction might require the involvement of more than 20 parties, and those parties create data field 'interactions'. As anticipated by (ICC), 4 billion papers are created under trade finance processes each year. A study by Boston Consulting Group (BCG) showed: "interactions between a small number of parties in trade finance transaction could involve 5,000 data field interactions perhaps 200 billion globally, adding only 1% in value" (Ramachandran et al. 2017) Trade finance inefficiencies occur because of the need for paper and physical delivery of trade documents which requires excessive workforce and human intervention between all parties, such as presenting a bill of lading for the ownership of goods. Transfers of documents via courier and mail increase uncertainty and decrease actual traceability. (Chang et al. 2020) provided an evidence of the potential for blockchain technology to improve traditional L/C payment and traceability.

Another issue with existing trade finance and letter of credits processes is the fraud and authenticity due to the manual processing and circulating of physical documents between the parties while processing a trade finance transaction. Some banks request the exporter to issue two sets of documents to overcome the risk of lost documents or even fraudulent ones. Two years ago, Standard Chartered Plc lost nearly two hundred million due to fraud. Then Standard Chartered Plc and DBS bank joined an alliance to create a blockchain platform that uses electronic recording similar to the bitcoin concept.(Chanjaroen and Boey 2016)

Also, responsiveness to errors, amendments, and changes under these long and heavy paper-based processes is very low because of the physical process, which causes considerable delays to the process. For example, any deviation in any of documents presented will return the process to the seller to modify the document and send it back to its bank then buyer's bank and then again to buyer. Following section will discuss and evaluate the available technological solutions proposed by researchers and FinTechs to overcome traditional trade finance issues.

5. Digital Technologies

5.1 SWIFT for corporate (MT798)

MT798 is an attempt to create an interconnection between banks and corporate using Swift messages. This technology enjoyed only limited success because the bank does not focus on encouraging corporates to adopt these technologies. So, corporates are not interested in having limited access to the process which creates low level of traceability.

5.3 Electronic Letter of Credit (e-LC)

e-LC is a digital transformation of the paper L/C to digital L/C by using scanning technologies to transform documents from paper-based to electronic based. It was not widely used due to regulatory restrictions on digital documents. The other reason for e-LC's less adoption is the requirements to present paper documents by many government authorities even though some rules were developed to deal with electronic documents. Also, e-LC is a digital solution to transform documents from paper to digital from and it does not provide full digital process.

5.3 Bank Payment Obligation (BPO)

BPO resulted from the cooperation of (SWIFT), the ICC, and a consortium of banks to complement open account trade. The bank payment obligation (BPO) was developed to enable data to be sent by a trade services management (TSMT) message and to match electronically in ISO 20022 XML format using a transaction matching application (TMA). In comparison to traditional trade finance process such the documentary credit L/C, BPO is an irrevocable payment undertaking between the buyer's bank (Obligor bank) and the seller's bank (Recipient bank) to settle the BPO amount once the electronic matching of data or acceptance mismatch is completed, while under L/C the payment undertaking between the Issuing bank and the Seller (SWIFT 2016). Many researchers have highlighted the importance of the benefits of applying this technology, but few has shown the reasons that refrained many banks from adopting it. For instance, (Susmus and Baslangic 2015) found that BPO was not encouraged by corporates in Turkey as it is bank focused.

5.4 Blockchain Technology

Blockchain was created in 2008 as a decentralized platform for transferring bitcoins, which is different in two main features, i.e., accessibility and transparency. It is the core option of the bitcoin technology and enables the bookkeeping of digital transactions on blocks (Wright 2008) . The blockchain may support more auditability and transparency as it is a distributed network with a unique agreement structure. (Wang et al. 2019).
In their research, (Chang et al. 2020) explored how the shift to blockchain should be done through case studies. The results illuminated the potential future application of blockchain finance and provided an illustrative example of other finance-related capabilities. They presented comprehensive classification for applications developed on the blockchain platform in different sectors such as trade, business services, IoT, and medical.

5.4.1 Smart Contract and Blockchain

A smart contract is a digital contract that requires the buyer and seller to set the terms of the agreement, which will be later transformed into codes distributed under a decentralized blockchain network (Frankenfield 2021). Chang et al (2020) argued that when the blockchain is linked with the implementation of smart contracts, it creates security, auditability, and transparency to trade finance stakeholders (banks, importers, exporters, insurers, etc.). Another issue that was not mentioned by the previously discussed papers that each blockchain platform has a unique design and adding new parties will require them to approve and adopt the same protocols under the same platform.

5.4.2 Blockchain Benefits in Digitizing Business Processes

Increased efficiency, cost reduction, enhanced transparency, establishing trust-free processes, and accountability are essential features for blockchain adoption reported by researchers. (Gausdal et al. 2018). Trust is one of many factors making blockchain a leading digital solution. "Trust refers to the trustworthiness of the information provided by stakeholders and the safety and security of the data managed by a central authority" (Wang et al. 2019). Moreover, Chang et al (2020) in their study concluded that blockchain-based L/C ease trade processes and eliminate annoying excessive paper workload under the traditional L/C processes. A paradigm shift from a centralized process to a distributed collaborative network available with the blockchain may enable the practice of value transfer via a centralized, transparent ecosystem and the facilitation of process automation.
Wang et al (2019) illustrated blockchain technology's key points, which are essential for supply chain practices and rules. Their systematic review of 29 articles on the practitioner supply chain and academics showed how blockchain could add value to multiple supply chains, pharmaceutical, agri-food, and global manufacturing supply chains.

6. Shifting to digital trade - Letter of Credit process

This section of the study examines the impact of blockchain technology on the trade finance processes by demonstrating and simulating processes in three different cases, current paper-based, bank payment obligation (BPO)-based, and blockchain-based.

6.1 Current paper-based Letter of credit (L/C) process

Table 2 below details the required processing time for each step required under the current paper-based L/C process; the assumed data are used later as inputs in the simulation model. Current paper-based process reads ten major steps starting from the time the seller and the buyer sign or agree on a trade contract and ending by the collection of documents needed to access the goods by the buyer. The calculation of the steps' time has been set in days.
The current paper-based L/C process involves six to ten parties to complete one L/C issuance and settlement. However, the illustration in this study took into consideration the four main parties only, beneficiary (seller), applicant (buyer), issuing bank, and advising bank.

The total processing time 15 to 30.5 days showing in Table 2 is not taking into consideration any changes, and it presents the issuance and settlement of one L/C process without the requirement of any change., while the simulation model will take into consideration, any change might be required as per the last column of Table 2.

Table 2: Current paper-based L/C

Step	Details	Processing time (Days)	Requirement of change
1	The establishment of a sale contract between an applicant (buyer) and a beneficiary (seller).	0	No
2	Buyer asks their bank to issue an L/C to the seller's bank	1	Yes
3	Issuing bank (buyer's bank) issues the L/C to the advising bank. The advising bank is usually located in the Seller's country	0.5 to 1.5	No
4	The advising bank (seller's bank) then advises the L/C to the beneficiary (Seller)	1 to 3	Yes
5	The beneficiary (seller) ships the goods and presents documents to the nominated bank (Issuing bank or advising bank).	1 to 3	Yes
6	The nominated bank examines the documents against the L/C terms and conditions and makes settlement as specified in the credit.	3 to 7	Yes
7	The nominated bank then forwards the documents to the issuing bank.	5 to 7	No
8	If the issuing bank determines that the documents comply, they will reimburse the nominated bank in the manner specified in the documentary credit or as expressly requested by the nominated bank.	3 to 7	Yes
9	The issuing bank then releases the documents to the buyer to take possession of the goods.	0.5 to 1	Yes
10	The buyer presents the document to the shipping company to take possession of the goods	0	No
	Total Days	15 to 30.5	

6.1.1 Simulation of Paper L/C Process

All data from Table 2, along with the sequence of the steps were inputted to AnyLogic simulation software The study considers only a sequence of instant discrete events in the model for all paper-based, blockchain-based and BPO. At the same time, nothing happens in between and no continuous-time processes, then the model time jumps from one event to another considering any required change. So, the process will be repeated from the preceding event, if needed, from more than one preceding event. Paper Process Simulation Outputs are listed in Table 3.

The number of simulated processes was derived from ICC Trade Register Report 2019 (ICC 2020). Thirty-two million trade and financial transactions are analyzed by the report with a total exposure of US$ 15 trillion. Trade Register represents 28% of traditional trade finance flows worldwide and 11% of trade flows. So over 6 million L/Cs were processed between 2008 and 2018, which is, on average, 600,000 L/Cs per year from these 25 banks, so around 1,800,000 L/Cs worldwide.

Based on this data and the assumption that the number of L/Cs transaction will be increased and at least stays at the current average level, The study considered average processing of six hundred thousand L/Cs per year which are illustrated in the L/C process simulation for all models paper-based, blockchain-based and BPO. This study aimed to reap the potential benefits of implementing blockchain technology concerning processing time for one year.

Table 3: Paper Process Simulation Outputs

From	To	PDF(hits)	CDF(cum hits)
10.3	16.7	304,201	304,201
16.7	23.1	214,442	518,643
23.1	29.5	59,179	577,822
29.5	35.9	16,050	593,872
35.9	42.3	4,469	598,341
42.3	48.7	1,183	599,524
48.7	55.1	354	599,878
55.1	61.5	82	599,960
61.5	67.9	28	599,988
67.9	74.3	9	599,997
74.3	80.7	3	600,000

Count	600,000
Mean	18.283
Min	10.36
Max	77.857
Deviation	4.815

6.2 Bank Payment Obligation (BPO) Process

Also, for the proposed bank payment obligation (BPO) process, Table 4 details the required processing time for each step required under the BPO process. BPO process reads ten major steps starting from the time the seller and the buyer sign or agree on a trade contract and agree to process through BPO and ending by the collection of documents needed to access the goods by the buyer. The steps and all timings were generated from Swift and ICC. The calculation of time has been set in minutes for each step. At the end of the process, minutes were converted into days for further comparison with the current paper-based and blockchain-based processes. The BPO process involves four parties to complete one BPO issuance and settlement. As per ICC rules (URBPO), the four parties are defined in the trade finance process as follows: seller, buyer, obligor bank represents the buyer, and recipient bank represents the seller.

Table 4: Bank Payment Obligation (BPO)

Step	Details	Processing time (Minutes)	Requirement of change
1	The buyer and seller agree on the terms the payment via bank payment obligation (BPO).	0	No
2	The buyer submits the data from the purchase order and the BPO agreement to the buyer's bank (Obligor bank).	60 to 180	Yes
3	Seller's bank (Recipient bank) receives the BPO from the obligor bank and send it to the seller.	60 - 120	Yes
4	Seller confirms the data from the purchase order and send its acceptance of the BPO conditions to the recipient bank.	60 - 120	Yes
5	The baseline is established once buyer's and seller's data are matched on the transaction matching application (TMA), and the seller can ship the goods.	0	Yes
6	The shipment data and invoice data presented by the seller to its bank, then the recipient bank submits to TMA for matching.	120 to 240	Yes
7	The buyer receives a match report from obligor bank. The buyer is invited to accept any mismatches, if any.	60 to 180	Yes
8	The recipient bank then informs the seller about the successful data-set match.	60 to 180	No

9	The seller sends the original trade documents directly to the buyer. The buyer will clear goods from the customs with these documents.	4320 to 7200	Yes
10	On the due date, the obligor bank debits the proceeds from the buyer's account.	0	Yes
	Total Minutes	4740 to 8220	
	Total Hours	79 to 137	
	Total in Days	3.29 to 5.70	

The total processing time of 3.29 to 5.70 days, as shown in Table 4, has not considered any changes, and it presents the issuance and settlement of one BPO process without any change requirements. In contrast, the simulation model will consider the necessary change as per the last column of Table 4.

6.2.1 Simulation of Bank Payment Obligation (BPO) Process

All data from Table 4 and the sequence of the steps were inputted to AnyLogic simulation software. The simulation procedure of the BPO model also similar to the paper-based model, as discussed in section 6.1.1. The number of processes to be simulated, as discussed earlier, will be six hundred thousand. The processing time for the BPO model will be in minutes since it consists of many events that require less than an hour to be processed. BPO Simulation Process Outputs are shown in table 5.

Table 5: BPO Simulation Process Outputs

From	To	PDF(hits)	CDF(cum hits)
4,868.60	5,191	1,480	1,480
5,191	5,513.40	18,117	19,597
5,513.40	5,835.80	43,828	63,425
5,835.80	6,158.20	72,503	135,928
6,158.20	6,480.60	101,658	237,586
6,480.60	6,803	116,717	354,303
6,803	7,125.40	99,711	454,014
7,770.20	8,092.60	18,050	592,353
8,092.60	8,415	5,391	597,744
8,737.40	9,059.80	484	599,807
9,704.60	10,027	14	599,993
10,349.40	10,671.80	6	600,000

Count	600,000
Mean	6,663.94
Min	4,992.42
Max	10,654.11
Deviation	643.145

6.3 Blockchain L/C Process

Table 6 details the required processing time for each step required under the L/C process conducted on a blockchain platform. Data of the blockchain L/C process were assumed from real liv pilot trade finance letter of credit (L/C) transactions conducted on contour blockchain platform, reflecting the processing time required to process digital process based on blockchain. Contour platform blockchain-based network started with twelve participants, and now they have more than 50 corporates and banks using this platform. The blockchain-based process reads eleven major steps starting from the time the seller and the buyer sign on a trade contract and ending by collecting documents needed to access the goods by the Buyer.

The calculation of time has been set in minutes for each step. At the end of the process, minutes were converted into days for further comparison with the paper-based and BPO models. Also, the blockchain-based L/C process might involve more than four parties to complete one L/C issuance and settlement. This study considered the four main parties, beneficiary (seller), applicant (buyer), issuing bank, and advising bank.

The only difference in terms of parties involved is that step number eight requires the action of one other party. The Shipper will issue the electronic bill of lading (eBL) and upload it to the L/C transaction under the blockchain platform once the shipper receives the goods from the seller. In the current process and as per the ICC rules, the four parties are defined in the trade finance process: the beneficiary is the Seller, the applicant is the buyer, issuing bank represents the buyer and the advising bank represents the seller.

Table 6: Blockchain L/C

Step	Details	Processing Time (Minutes)	Requirement of change
1	On a specialized contracting platform, the company agrees to the purchase of goods. Once the buyer and seller agree on the terms, the buyer can automatically transfer the contract data using Contour's API.	0	No
2	The buyer makes final changes to the application which has been prefilled using the contract data. The buyer can choose what documents will be required under this application, including several digital alternatives to Paper and Submit L/C request.	60 to 180	Yes
3	buyer's bank receive L/C request.	0	No
4	buyer's bank approves the L/C request then L/C is issued.	120 to 240	Yes
5	The Letter of Credit is issued, shared and advised directly to the advising Bank on the platform. seller's bank receive the L/C through the blockchain platform.	0	Yes
6	seller's bank approves the L/C request then L/C is advised.	120 to 240	Yes
7	Now that the L/C is issued and advised, the seller is able to ship the goods.	0	No
8	eBL: When that ship leaves, an electronic bill of lading (eBL) is created from the shipping company via essDOCS and shared electronically with the seller.	0	Yes
9	The seller adds all other trade documents to create a set of electronic documents (eSet) for the demand presentation on the platform.	120 to 240	No
10	The banks can access this eSet of documents on the blockchain platform and process them under the electronic rules of UCP.	120 to 240	No
11	Once accepted by the issuing bank, the buyer can access their goods using the eSet.	120 to 240	No
	Total Minute	600 to 1380	
	Total Hours	10 to 23	
	Total in Days	0.41 to 0.95	

6.3.1 Simulation of L/C Blockchain Process

All data from Table 6, along with the sequence of the steps were inputted to AnyLogic simulation software. The simulation procedure of the blockchain-based model also similar to the paper-based and BPO models, as discussed in section 6.1.1. The number of processes to be simulated, as discussed earlier, will be six hundred thousand. The processing time for the blockchain-based model will be in minutes since it consists of many events that require less than half an hour to be processed. Blockchain simulation process outputs are shown in table 7.

Table 7: Blockchain simulation process outputs

From	To	PDF(hits)	CDF(cum hits)
766.7	1,329.90	343,411	343,411
1,329.90	1,893.10	177,678	521,089
1,893.10	2,456.30	55,153	576,242
2,456.30	3,019.50	16,477	592,719
3,019.50	3,582.70	5,090	597,809
3,582.70	4,145.90	1,542	599,351
4,145.90	4,709.10	459	599,810
4,709.10	5,272.30	129	599,939
5,272.30	5,835.50	48	599,987
6,398.70	6,961.90	5	599,999
6,961.90	7,525.10	1	600,000

Count	600,000
Mean	1,377.26
Min	766.77
Max	7,000.44
Deviation	485.534

7.Results Analysis

We have simulated 1,800,000 trade finance processes in three cases, current paper-based L/C, blockchain-based L/C and bank payment obligation (BPO) to quantitatively reflect the effect of the implementation of blockchain technology to digitalize trade finance processes. The simulation software, AnyLogic, has generated significant results, analyzed in the following sections regarding the processing time and costs.

7.1 Benefits

Most industry leaders from banking, FinTech, and corporates have qualitatively believed that smart contract and blockchain technology could bring many benefits to supply chain and trade finance processes. However, this research supports their assumptions numerically in terms of processing time efficiency and cost reductions as per the following analysis.

7.1.1 Process Efficiency

Simulation results of six hundred thousand paper-based L/C and the same number of transactions under blockchain-based L/C and BPOs have shown average processing time reduction from 18.28 days to 4.62 days under BPO and 0.95 days under blockchain L/C per one transaction. The expected saving in average processing time while shifting from complete paper process to digital process via BPO is 13.66 days, and 17.33 days via blockchain-based platform. More than 94% efficiency gained while shifting to digital process using blockchain-based platform and 74% efficiency gain using BPO. In fact, this ratio matches with the expert assumption, BCG assumes that more than 90% of the data field interactions in the trade finance process could be simplified or eliminated altogether through effective digitization that matches the expert's assumptions (Sukand et al. 2017).

A leading bank in the trade ecosystem can have many opportunities to invest this gained efficiency to increase its professional trade finance labor productivity by increasing the volume of L/Cs they can issue. Alternatively, the excess in labor to process other products can be focused on increasing the range of products offered.

Numerical Example

A leading international bank with more than 25 branches worldwide can issue and settle up-to 4,000 paper L/Cs a year with 20 Professional trade finance employees. If the research considers an efficiency gain of 94% applies in equal percentage, the same team of 20 employees can issue at least 62,000 blockchain L/Cs instead of 4000 paper L/Cs, which is considered a significant increase in labor productivity. So, the bank can have the option to increase its customer base to handle more transactions and use excess labor to introduce more products. Demand for trade finance payment solutions can be increased as the digital solutions enhance the internal efficiency of banks and lower the bank service costs, which is a win-win scenario for both banks and corporates. (Sukand et al., 2017). It is an essential aspect of the trade industry to understand the operational efficiencies of blockchain by creating opportunities for new products enabled by blockchain technology.

7.1.2 Responsiveness

Responsiveness is a very important element in today's processes, especially after the whole World has witnessed the outbreak ("COVID-19"), which created a serious risk interrupting business processes and raises concerns beyond banks' control. Simulation modeling indicated 397,405 rewinds were required to process 600,000 paper-based L/Cs, 591,106 rewinds to process 600,000 blockchain-based L/Cs and 336,540 to process the BPOs. Rewinds in the paper process cause the delay in days to return the documents by post or courier between upstream or downstream in the chain while it takes minutes under the blockchain process. "Making one stage more responsive allows other stages in the supply chain to focus on becoming more efficient" (Chopra and Meindl 2016).

7.1.3 Costs

Digital trade finance has the potential to reduce costs between US$ 2.5 billion and US$ 6 billion, around 35% in the medium-term period of three to five years as estimated by BCG (Sukand et al., 2017). Manual paper-based processing in the traditional trade finance ecosystem handles many costs in terms of required labor for manual processing and circulation of documents with more than 20 parties involved in one traditional letter of credit issuance and settlement. Indeed, implementing blockchain technology will eliminate the need for the excessive labor required for the processing of documents, in addition to the costs imposed while circulating L/C documents forward and backward between parties.

Labor Costs

Manual Paper-based procedures are significantly reduced under blockchain technology, as shown by many researchers. Also, blockchain can almost eliminate most of the time and the professional labor needed for document processing. The paper assumes that each trade finance professional costs an international bank around US$ 50,000 yearly. The bank can save at least the need of 18 trade finance professionals to process the same number of L/Cs using a blockchain platform, i.e., the bank can save US$ 900,000 yearly. In previous discussion of processing time efficiency, the study demonstrated how the technology implementation could help the bank achieve process efficiency and high productivity using an excess skilled workforce. The benefit of skilled workforce optimization is an advantage to all parties involved in any industry. For instance, shippers also need an excessively skilled workforce to process shipping documents, and then E-bill will eliminate most of this need.

Courier Costs

Referring to the current paper L/C process and steps explicitly 5, 6, 7, 8, there are at least three stages where documents have to be sent by courier, which is eliminated in the 100% blockchain process. Adopting blockchain technology gives the potential to avoid such costs from postal and courier expenses, errors in documents, and document fraud (Civelek & Nagehan Uca, 2015). Some L/C processes with many amendments might require the documents to go forward and backward more than five times in case of rewind and resubmit discrepant documents and most banks, require these documents to be sent in two lots (First mail) and (Second mail) to avoid the risk of losing such vital documents (Rami Al-Sabri, 2018). However, to reflect a fair illustration of the costs, the study considers three courier patches on average as the physical paper documents prepared and gathered by the seller/exporter and moved, usually by courier, from its facility to the negotiating Bank then to the confirming or issuing bank for a second examination and payment, finally hand over to the buyer/importer. As it was assumed that an average courier charge for dispatching one set of documents is US$ 50, there will be an amount of US$ 150 courier costs involved in each L/C process. The average total number of 1,800,000 L/Cs processed every year will sum up to US$ 270 million. In other words, US$ 270 million are being saved while moving to a digital solution such as blockchain. While under BPOs, courier costs are not eliminated as the seller still has to dispatch the original set of documents by post or courier to the buyer once seller receives a notification from recipient bank of the successful data-set match.

7.1.4 Traceability

Traceability is the main feature in the blockchain-based L/C. The blockchain simulated L/C presented in this paper illustrates how the Process is decentralized, and all parties track the process flow and get near-real-time notifications. For example, in step no. 2 Table 6 under the blockchain-based L/C process, buyer's bank will be notified electronically of buyer's request and start processing the L/C, then the buyer can electronically trace the request for all upcoming steps. Moreover, under step no. 5, once the L/C is issued, shared, and advised directly to the advising bank, the seller can be notified electronically, and the seller can track the L/C for upcoming steps from 5 to 11. The same applies to seller's bank and buyer's bank, as their ability to trace the L/C process using digital signatures depends on public and private encoding keys which are only known to authorized parties. Also, it is controlled by the level of authorities for the information to be shared by each party.

The current paper process involves manual authentication and enormous archiving. Blockchain can reduce work, and reliability and improve traceability in the supply chains (Kshetri 2018).

7.2 Blockchain and Bank Payment Obligation (BPO)- a comparison

Blockchain provides complete digital transformation of trade finance processes with significant attributes compared to BPO as alternative digital solution, which are explained as follows.

- **Process efficiency:** From the simulation results, more than 94% efficiency gained while shifting to digital process using blockchain-based platform and 74% while shifting to digital process using BPO**.**
- **Process capacity in terms of number of trade parties:** Within BPO only four parties can interact in this limited digital process. On the other hand, the blockchain process can include more than 20 trade parties.
- **Blockchain independency:** Blockchain technology enables parties of the process to interact within each other at any time without dependency, while in BPO, seller and buyer can only interact with their banks (i.e., The obligor and the recipient bank).
- **Real time examination and approval of electronic documents:** E-documents uploaded through blockchain can examined and approved by respective parties instantly, allowing the Seller to see and access all approvals and start the shipment process. While in BPO, the seller must wait for its bank (Recipient bank) notification of the purchase order and BPO acceptance to start the shipping process.

- **Decentralization in terms of contract implementation:** Real time change status features in blockchain eliminate the lengthy manual process to monitor the delivery of goods. While in BPO, the buyer will manually track the goods with the shipper.
- **Proof of ownership:** Because of blockchain unique attributes, electronic documents of title such as electronic bill of lading (E-bill) will be automatically assigned to the buyer once payment or undertaking of payment is executed in the blockchain platform. In contrast, within BPO, the buyer will require the seller to dispatch the original physical documents of title, such as bill of ladings, to have ownership over the good.

8. Conclusion

Many banks worldwide have considered that the novel coronavirus ("COVID-19") is a serious risk of interrupting its business and raised concerns on the long-term inability of physical document delivery and circulation between all parties in the trade. This study explored how blockchain technology can essentially impact trade finance processes. The blockchain can improve trade business processes, eliminate paper manipulation, increase process efficiency, and provide a real opportunity to all parties involved in the trade process to reduce costs and increase productivity. The impact of blockchain technology on the trade finance processes was examined by testing and simulating 1,200,000 L/C processes in both cases, the current paper-based process and blockchain process, and 600,000 BPOs as an additional alternative digital solution. We used Simulation Software, AnyLogic, to examine and test the effect of blockchain technology on trade finance processes using three simulation models, letter of credit paper-based process, blockchain-based process, and bank payment obligation (BPO). The research findings observed a significant increase in process efficiency up to 94% while conducting L/Cs under the blockchain platform and 74% while shifting to digital process using BPO. In addition, the study demonstrated how the efficiency gained by applying blockchain technology to the trade finance process increases productivity and reduces labor and courier costs. The automatic notification of status changes can be an added value function enabled by blockchain platforms creating end-to-end traceability features to trade finance processes.

This study is a supporting tool that enables experts make their important and strategic decision of the miraculous proven effect of blockchain technology to trade ecosystems and supply chains. It presents near-real proof of concept by Simulative illustration. As such, our study should assist banks, corporates, and government authorities in making decisions about implementation. Standardization of this technology as the first milestone will give full support for blockchain-enabled initiatives toward an umbrella use of this technology to cover all banks and trade parties worldwide.

Even though this study is unique, it also has limitations. The research is limited to the specific effect of blockchain technology on supply chain and trade finance in respect of processing time efficiency implementation and costs. Other costs involved in trade finance processes such as papers, administrative, emission, technology were not considered in this study. In the future, researchers may focus on the implementation of blockchain technology in trade finance processes considering other costs. More studies have to be conducted to explore and include more stakeholders in the process or cover broader forms to include more parties involved in the entire trade ecosystem.

Acknowledgements

The Authors would like to thank Dr. Mahaboob Sheriff Khader Muhammad, a Postdoctoral Researcher in the Engineering Management and Decision Sciences Division at the College of Science of Engineering (CSE), HBKU in Doha, Qatar for his support.

References

Chang SE, Luo HL, Chen Y., Blockchain-Enabled Trade Finance Innovation: A Potential Paradigm Shift on Using Letter of Credit. Sustainability. Vol. 12, no. 1, pp. 188, 2020

Susmus, Turker and S. Ozgur Baslangic, The New Payment Term BPO and its Effects on Turkish International Business, Procedia Economics and Finance Vol 33, pp. 321-330, 2015.

Gausdal AH, Czachorowski KV, Solesvik MZ. Applying Blockchain Technology: Evidence from Norwegian Companies. Sustainability, Vol 10, no 6, pp 1985. 2018

Al-Sabri R, Limitations of Digitizing Trade Finance Services in Yemeni Banking Sector, Digital Economy. Emerging Technologies and Business Innovation. ICDEc. Lecture Notes in Business Information Processing, vol 358, pp 66-84, 2019

Kshetri N, 1 Blockchain's Roles in Meeting Key Supply Chain Management Objectives, International Journal of Information Management, Vol 39, pp 80-89, 2018

World Trade Organization, Available: https://www.wto.org/english/thewto_e/coher_e/challenges_e.htm, Accessed on May 25, 2021.

Cowdell P, McGregor P, Ibrahim S, Chantry N, & Hennah D. Guide to international trade and finance, CAPDM Limited, Edinburgh, Scotland, 2014.

Basimanyane, K, The legal Implications of Electronic Letter of Credit as a Cross Border Trade Payment Mechanism: Botswana as a case study, University of Pretoria, 2016

Chopra, S., Meindl, P., Supply Chain Management Strategy, Planning, and Operation, 6th edition, Pearson, 2016

Ramachandran S, Porter J, Kort R, Hanspal R and Garg H., Digital Innovation in Trade Finance have we Reached a Tipping Point?, Available: https://www.swift.com/resource/digital-innovation-trade-finance, accessed on MAY 20, 2021.

Chanjaroen C and Boey D., Fraud in $4 Trillion Trade Finance has Banks Turning Digital, Available: https://www.bloomberg.com/news/articles/2016-05-22/fraud-in-4-trillion-trade-finance-turns-banks-to-digital-ledger, Accessed on May 20, 2021.

Society for Worldwide Interbank Financial Telecommunication (SWIFT), Available: https://www.swift.com/swift-resource/35051/download#:~:text=%E2%80%9EA%20Bank%20Payment%20Obligation%20(BPO,%E2%80%9C, Accessed on May 24, 2021.

Susmus, Turker and S. Ozgur Baslangic, The New Payment Term BPO and its Effects on Turkish International Business, Procedia Economics and Finance Vol 33, pp. 321-330, 2015.

Wright C, Bitcoin: A Peer-to-Peer Electronic Cash System, SSRN, 2019

Wang, Y., Han, J.H. and Beynon-Davies, P. , Understanding blockchain technology for future supply chains: a systematic literature review and research agenda, Supply Chain Management, Vol. 24 No. 1, pp. 62-84, 2019

Romain C., Smart contracts: The use of the blockchain technology in trade finance, Haute école de gestion de Genève (HEG-GE), 2018

Frankenfield J, Smart Contracts: What You Need to Know, Available: https://www.investopedia.com/terms/s/smart-contracts.asp, accessed on April 29, 2021,

International Chamber of Commerce, ICC, Available: https://iccwbo.org/publication/icc-trade-register-report/#1558629101831-8e73dbe9-5247, Accessed on May 01, 2021,

Civelek, M., Uca, N, and Çemberci, M., eUCP and Electronic Commerce Investments: e-Signature and Paperless Foreign Trade, Eurasian Academy of Sciences, Eurasian Business & Economics, Vol 3, 2015.

R3, Available: https://www.r3.com/wp-content/uploads/2020/06/Corda_Contour_CS_R3_June2020.pdf, Accessed on 24/05/2021

Biographies

Munaf A. Khalil Graduated from College of Science and Engineering, HBKU with Master of Science in Logistics and Supply Chain Management. He received BSc in Banking and Finance at American University of Science and Technology 2005. He has 21 years of banking and trade experience, He is responsible of managing the centralized processing of Trade Finance transactions for Qatar National Bank (QNB) and its Global Network.

Dr. Laoucine Kerbache is currently serving as a Professor and a Founding Faculty Member of the Logistics and Supply Chain Management Program within the Engineering Management and Decision Sciences Division at HBKU and affiliated with HEC Paris, Qatar. For over thirty-five years of academic, research, and consulting activities, he has been very active in his areas of expertise, focusing on modeling and optimization in Operations and Supply Chain Management. He has published over one hundred papers in international journals. He has a PhD, MSc, and BSc in Industrial Engineering and Operations Research from the Mechanical and Industrial Engineering Department, University of Massachusetts, Amherst, USA.

Dr. Adel Elomri holds a Ph.D. and an MSc in Operations Management (with Highest Honors) from Ecole Centrale Paris (France). He has more than fifteen years of international experience as a lecturer and researcher in Supply Chain and Operations Management. Dr. Elomri has published many papers in top academic international journals, such as Production and Operations Management, European Journal of Operational Research, Cleaner Production, and Waste Management, among many others. Currently, Dr. Elomri has projects underway in the areas of healthcare operations management, sustainable supply chain management, and smart logistics.