

Importance of Blockchain Use in Cross-Border Payments and Evaluation of the Progress in this Area

Sınır-Ötesi Ödemelerde Blockchain Kullanımının Önemi ve Bu Alandaki Mevcut İlerlemenin Değerlendirilmesi

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ABSTRACT: In the banking industry, blockchains are currently being investigated as an alternate interbank money transfer platform. However, the blockchain network structure has not matured yet, and there could be many issues and opportunities on fully operating such a system. The research about the use of blockchain for cross-border payment systems is speedily progressing, which is why there is need to frequently emphasize the progress and make assessments. In this paper we analyze and discuss the significance and progress towards using blockchain technology for cross-border payments through recent literature consisting of research articles and cases.

Key Words: Blockchain, cross-border payments, interbank transfers, international trade

JEL Classifications: F13, F33, F65

Öz: Bankacılık sektöründe blok zincir sistemleri alternatif bir bankalar arası para transferi platformu olarak araştırılmaktadır. Bununla birlikte, blockchain ağ yapısı henüz olgunlaşmamış ve potansiyeli de henüz tam olarak analiz edilmemiştir. Böyle bir sistemi tamamen işletmek için çözülmesi gereken birçok husus ve barındırdığı fırsatlar olabilir. Sınır ötesi ödeme sistemleri için blockchain kullanımı ile ilgili araştırmalar hızla ilerlemektedir; bu nedenle, bu alandaki ilerlemeyi sıklıkla değerlendirmek gerekmektedir. Bu ihtiyaca cevap vermek için, bu makalede, araştırma makaleleri ve vakalardan oluşan güncel literatür analiz edilerek sınır ötesi ödemeler için blockchain teknolojisinin kullanımının önemi tartışılmış ve bu alandaki ilerleme analiz edilmiştir.

Anahtar Kelimeler: Blok zincir ağ yapısı, sınır-ötesi ödemeler, uluslararası banka transferleri, uluslararası ticaret

1. Introduction

There are many factors contributing to the customer satisfaction regardless of the service sector under consideration; speed, accuracy, and trust being a few of these. When financial services are considered, these factors take an even more important role (Johnston, 1997: 114-115). Since international trade is a prominent field within the financial sector, speed, accuracy, and trust are vital points for cross-border trade. One of the main activities for international trade is cross-border payments, and the determinant of speed, accuracy, and trust for these payments is the payment method.

The standard service for cross-border payments is the SWIFT network, and while this system is being used for a long time, there are criticisms about the speed and the source

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of trust for this system. This network operates on the principle of third-party assurance and due to the trust being certified by a central authority (Dunphy and Petitcolas, 2018: 12), there are criticisms about the speed of the system. SWIFT, Society for Worldwide Interbank Financial Telecommunications, is a cooperation and networking initiative between banks, other financial players such as brokers, and investment institutions. SWIFT provides, first and foremost, security for telecommunications between global financial players. Moreover, this network also provides its members with user interface to complete the transactions. Thus, the financial institutions first communicate about the transactions about to take place, and through the SWIFT network's user interface they complete the financial transactions (Park, 2007: 27). Not only in terms of speed, but SWIFT network is also challenged due to the recent attacks it endured. These attacks are believed to be connected with known hacker groups and these groups are believed to be successful in stealing funds via imitating the credential information belonging to the banks within the SWIFT network (Masters, 2017; 2).

The criticisms for the SWIFT network caused alternative methods to be considered for cross-border payments. Blockchain technology is one of these methods and although being developed very recently and still under development and evolution, there are some applications under use via blockchain technology for cross-border payments (Morabito, 2017: 156; Parker, 2015). However, the developments about blockchain are usually expressed in a technical way, related with computing methodology and algorithms constructing the underlying structure.

It could be challenging to comprehend the blockchain technology well enough to follow the current innovations related with specific topics such as cross-border payments, and this article aims to fill this gap by discussing the significance and assessment of blockchain technology specifically for cross-border payments. Moreover, the innovations related with blockchain develop very fast, and this makes it harder for practitioners and researchers to follow the developments related with their particular field. One way to track this type of developments is the frequent publications that are focused on the field of interest. Another objective of this research is to satisfy this need by discussing the current progress on the use of blockchain for cross-border payments.

This research involves review of publications in academic journals with high impact factors as well as white papers and internet resources, along with books and other related materials. Due to blockchain technology being very new and evolving, the information search requires a wider investigation with as many types of resources as possible. These findings are confirmed, compiled, and analyzed to provide the potential of blockchain technology specifically for cross-border payments.

In the subsequent sections we will first discuss the standard cross-border payment systems and discuss their performance. Afterwards, we will provide a non-technical description of blockchain along with the recent developments. Then, we will assess the usability of blockchain for cross-border payments under these developments and discuss the accomplishments required to fully operate cross-border payments via blockchain. Finally, we will end the paper with conclusions and discussion of future research.

2. Standard Cross-Border Payment Systems

Through decades, SWIFT network has become one of the greatest ecosystems in international trade, and today it is the world's largest central authority on financial assets trade, serving in more than 200 countries and for thousands of financial institutions as members (Scott and Zachariadis, 2012; 462). This network has more than 10,000 institutional members, consisting of not only bank, but other types of financial asset traders, with nearly 24 million messages sent through the network (Seth, 2017).

SWIFT is the network providing secure message exchanges between the institutions regarding electronic fund transfers (Ivannikov, Cvetkovic and Lalic, 2014: 47). This allows the institutions to trust the instructions regarding the fund transfer as long as the messages are received through the SWIFT network. Membership to the SWIFT network is currently required as a cross-border payment standard, and additionally the member institutions should perform due diligence on their customers and hence maintain trust on their accounting ledgers. The accounts of the member institutions are not managed by the SWIFT network though; the network is responsible for providing trustable instructions to its members regarding electronic fund transfers for cross-border payments. Finally, the financial institutions should maintain clearinghouses to execute the fund transfer instructions coming from the SWIFT network (Jovicic and Tan, 2018: 377).

The international trade and hence banking industry worldwide were originally using much less sophisticated systems to exchange information on interbank payment transfers. The banks initially used telegraph and telephone lines-coordinated Telex system for cross-border payments. The first international payment structure via Telex involved more than ten messages, and this procedure was making the whole trade process very slow and prone to errors. Sending the same messages several times through central authorities also involved labor costs. Another complication in this system was the format of the Telex messages being text only, and this had caused complete lack of standardization, opening the whole international money transfer system to misinterpretation and misunderstandings (Scott and Zachariadis, 2012; 465). The Telex system was already showing signs of not being able to stably control the increasing volume of international trade, and towards the end of 1960s, the banks were searching for initiatives to form a group of globally distributed banking corporations to sponsor projects for assessing an establishment that will provide standards and the necessary technical platform to exchange messages on financial transactions in a secure and reliable way.

The Telex system first used to complete the cross-border payments became unable to handle the massively increasing volume of global trade, and by 1971, more than 60 banks worldwide were willing to participate in a project to form a standard network of international payment processing. Different consulting agencies were hired for creating the required technology, financial and organizational structure, along with regulatory changes needed. All these efforts finally resulted in the formation of SWIFT on May 3, 1973 (Scott and Zachariadis, 2012; 466). After the society was formed, it introduced the ISO standards for international electronic fund transfers, and the technical infrastructure was established and began to operate a few years later (Jovicic and Tan, 2018: 376).

SWIFT operates on principles of providing telecommunication of transaction data to all network members without unnecessary paperwork and in real time. To achieve this goal; the SWIFT network uses their own private IP network. Via this infrastructure, SWIFT standardized the communications and the user interface for cross-border payments. Perhaps this, the standardization of communication procedures and the interfaces for international money transfers was the most needed requirement for international trade relations; and this has caused the SWIFT network to dominate the banking industry for these types of services through decades.

While the SWIFT system has been in operation for such a long time, as new inventions start to emerge, the regular means of doing business are challenged. If the traditional methods are especially starting to fail to satisfy the more demanding contemporary requests coming from the companies they are serving, then these challenges start to become threats for the traditional systems. As mentioned in the previous section, the SWIFT network has recently been criticized for being slow and lacking security compared to the newly emerging network protocols such as blockchain technology.

The scalability and well-established history of SWIFT is an attractive feature of this global telecommunications network, but blockchain technology, with its smart contracts and distributed ledgers, has created an autonomously secure and fast communications network that can transfer numerous types of information from marriage contracts to financial securities. Therefore, it is believed that blockchain technology could revolutionize the financial industry, among the many others (Skinner, 2016; 3). This belief and increasing movement towards blockchain technology requires the evaluation of significance and assessment of progress in utilization of blockchain for cross-border payments, and it is the aim of this research to provide such an evaluation.

3. Assessment of Progress in Blockchain Technology

3.1. What is blockchain and how does blockchain work?

Blockchain is a data storage infrastructure that cannot be tampered with and is distributed through a network of members via cryptography (Narayanan, Bonneau, Felten, Miller, and Goldfeder, 2016; 21). This platform provides transparency, trust, and secure storage of valuable information (Dujak and Sajter, 2019; 26). Blockchain technology first started as a network protocol to circulate Bitcoin, the very first cryptocurrency. The users of Bitcoin and the technology experts later noticed the network protocol used as a settlement environment for Bitcoin could have many other uses than only circulating cryptocurrencies. At the current situation, blockchain technology has still many opportunities and potential for improvement and it is constantly being investigated to discover more.

The main characteristic of the blockchain technology is the lack of need for a central authority to establish trust. Blockchain is essentially a digitally distributed ledger transparent to all nodes included in its network. The ledger is kept to allow all nodes to see all history of the transactions occurring within the network. The coding structure of the network provides the verification of records to be computationally executed; thus,

there is no need for a central authority to assure trust between different nodes (Underwood, 2016: 15). Moreover, it needs great computing power and hence energy reserves to break the already settled history of the transactions within the chain and hence damage the security of the system. This type of information protection is arranged via having all members of the chain receiving the same encrypted data regarding the history of the chain. The coding structure of the blockchain also allows the transactions to be executed with no need for paperwork and bureaucracy (Iansiti and Lakhani, 2017: 4). The nodes within the network do not have to know each other, and they also do not have to reveal any personal information. They could participate in the network through their 30-plus-character alphanumeric addresses. Internet connection, energy, and computing power are the necessities to maintain membership to the network. This type of arrangement is named as distributed ledger technology and the blockchain structures that are used for other purposes than exchanging cryptocurrencies are also referred to as distributed ledger technologies for diversification.

Execution of transactions without paperwork is accomplished via cryptographic procedures that are used to verify the authenticity of transactions before they are confirmed. This is done through the public-private key concepts where the transactions are disseminated to the blockchain network with a public key plus a private one, and while through the public key everyone in the network will be informed of the existence of the activity, only through the private key the details of the transaction can be verified. Hence, the security is enabled by the existence of the transaction being made publicly available but to be descrambled via the private key. The public keys act as account numbers whereas the private keys act similar to signatures (Morabito, 2017: 24).

The transactions need to be verified and then inserted into the track of transactions that were previously accepted by the blockchain network, and this is done by the network members themselves. The network members compile a bunch of recent transactions and they also solve a mathematical puzzle through intense computational power, then they publish the solution of this puzzle that can easily be verified by the other network members. There are the incentives provided to the members solving the puzzle, such as earning new bitcoins that will be newly released to circulation; thus, many network members will be competing to solve the puzzle and announce it to the network. Their solution is called the proof-of-work and it can be easily verified by other network members; hence, the solution of the puzzle is clear to understand, while the puzzle itself requires more and more computing power to solve as the blockchain network becomes wider. The other network members will implicitly vote on the members claiming to solve the puzzle when they work on the next block to follow the block of transactions announced by the member they accept as the winner of the puzzle (Morabito, 2017: 25).

Verifying the transactions and adding them to the blockchain via solving the proof-of-work is an insurance mechanism to control the circulation of transactions, as well as the verification of transaction history. Since the puzzle is related with the history of transactions, it also verifies the previous history and makes the network members agree on it. Moreover, the puzzle becomes mathematically more complex to solve as the network

accumulates members through time, and it requires more than 51% computing power of the whole network to overpower the transaction history and rewrite it. This provides a security that was not present in the previous systems related with a central authority to verify the transactions.

The transactions bundled by the “winner” member who solved the proof-of-work are added to the permanent previous blockchain and they become a part of it. Since they are bundled to a group and added in this format, they are called blocks, and since new blocks are added to the chain through this process, the network protocol is called the “blockchain” (Böhme, Christin, Edelman, and Moore, 2015; 217). The blockchain network has the incentive to dissuade the network members from fraud. At every computational cycle, where there is a certain puzzle to solve, one has to make an attempt to solve the puzzle to finally vote, and then they can also vote for only once, thus deterring the members from creating fake identities.

3.2. Why was the blockchain needed and when and by whom was the blockchain invented?

Blockchain network protocol originally emerged as an online communication algorithm to exchange a cryptocurrency called Bitcoin. The idea of cryptocurrency is not a new concept, since digital money has been a long-desired invention by the computer science discipline. The idea of earning “money” through executing difficult tasks online has been a practice applied on online gaming platforms such as World of Warcraft or Farmville on Facebook; but these digital “monetary values” were not intended to circulate outside of their own domain (Rice, 2013: 1). Having digital money, that has not been issued by any central bank could be considered as a game-changer in the economic world, since its circulation will be bound by different governance procedures and it will affect the global economy to a direction that will be hard to foresee. This type of monetary circulation also involves different risks that have not been encountered before by the existing systems, and hence after the initial ideas presented to their community by some researchers, it took more than a decade for a group of computer scientists to present a viable approach of networking protocol to circulate digital currency that would have value equivalent to or more than the physical goods and other national currencies. The idea of digital money, or cryptocurrencies was not new but it took a long time to establish the necessary grounds for it to be in use.

The birthing ground for the blockchain was the invention of Bitcoin, the first cryptocurrency by computer scientists; they announced the concept of a network protocol to exchange digital currency through a paper they had written under the nickname of “Satoshi Nakamoto”. The paper was self-published, and they had described the network protocol that would allow exchange of digital money with no central authority to control, the algorithm basically was mathematically arranging what had been done by central banks and other financial institutions, without the need for one, since the procedures were automating the release of new bitcoins and controlling the exchange of bitcoins between the users to avoid any malicious intent (Nakamoto, 2008: 1).

The first block chain structure accessible by the public to join was issued at <https://bitcoin.org/tr/> where the users, among other software related with Bitcoin, were also able to gain authorization to access the block chain data including all the past bitcoin activity. In this website, the Bitcoin source code was open and made publicly available. The original block chain structure was actually a data networking protocol, where, not the actual current monetary amount for digital currencies, but all history of transactions related with the notion of a cryptocurrency amount were stored as data. Thus, the blockchain structure was not a regular bookkeeping method, but rather an encrypted data keeping protocol for the whole transaction history of a digital currency that also controls for release of new bitcoins and secure public access to all data (Böhme et al., 2015; 215).

3.3. What is the level of current progress in the adaptation to blockchain?

The blockchain technology has been considered as an innovation on par with the invention of the Internet, and similarly it is seen as the locomotive of a paradigm change in global economies. However, for the economic ecosystem to fully adapt to this new technology, the shift in ways of doing business has to happen in more than one dimension. These dimensions involve but not limited to technological and regulatory aspects of the business world, and any progress assessment regarding blockchain technology should be considered for all of these dimensions simultaneously. Therefore, in this subsection we will consider the progress of the blockchain from technological, governance, organizational, and societal perspectives (Iansiti and Lakhani, 2017: 4).

Progress in the adaptation to blockchain from the technological perspective: The computational foundations of the blockchain are available as open-source distributed ledger framework and code base such as the Hyperledger Project (Cachin, 2016: 1) and the Bitcoin over the internet for developers to improve the existing structure. The current level of blockchain computational structure allows construction of public, consortium, and private types of blockchains. Anyone could join a public blockchain, but one needs to belong to the consortium or be accepted as a member by the central institution to join a consortium or private blockchain, respectively. The private blockchains are usually aimed at business use such as the Hyperledger Fabric (Cachin, 2016: 3), whereas the public blockchains are usually formed to underlie the circulation of cryptocurrencies and other public entities.

One potential area of interest to improve the blockchain technology is to make the transaction processing faster without sacrificing the security. The blockchain relies on the Nakamoto consensus protocol for maintaining the distributed ledger over the blockchain network via a Byzantine fault-tolerant transaction mechanism. The maximum rate of transaction processing depends on the block size (the number of transactions in a block) and the block interval (the time interval to add blocks to the blockchain). The computational experts are developing various protocols to reduce the rate of transactions within the blockchain in a secure way such as dividing the time into epochs and dedicating each time epoch to a single leader to process the transactions until a new leader is chosen (Eyal, Gencer, Sirer, Renesse, 2016: 45).

Another area of interest to blockchain technology developers is the self-enforcing or smart contracts that could be coded into the chain. This structure allows distrustful members to transact safely without a central authority of trust. However, the way this trust is certified allows the other members to see the contents of the transactions such as the amount and flow of money. Thus, the experts are developing systems that would store the desired level of privacy in the blockchain while still enjoying the lack of need for a central authority to assure trust between transaction members, for ex, there are decentralized smart contract systems that allows the privacy of financial transactions in the blockchain via private smart contracts (Kosba, Miller, Shi, Wen, Papamanthou, 2016: 839).

The blockchain experts are also searching to connect different blockchains with each other. As mentioned above, there are public and private blockchains, and connections between multiple blockchains would allow circulation of different types of assets such as cryptocurrencies between different blockchains to enhance their circulation more (Back et al., 2014, 1).

The cross-border payments via blockchain are currently experimented upon by constructing private blockchains between financial institutions within which the financial transactions will occur. Thus, groups of financial institutions are trying to form private online ledgers. Iansiti and Lakhani (2017: 7) define this step as localization of the blockchain technology adoption, where the degree of novelty is high but the amount of coordination to implement the innovation is low. In this regard these initiations remind of the beginnings of the foundation of the SWIFT system.

Progress in the adaptation to blockchain from the governance perspective: For the execution of blockchain protocols there are no globally established standards yet on topics such as security and privacy, identity, and smart contracts. Both researchers and standards developing organizations such as ISO are currently working on developing standards on these topics (Anjum, Sporny, Sill, 2017: 88). There is considerably more progress for private blockchains since the membership is with permission and there needs to be some set of rules for such a system; for instance, the Hyperledger collaboration has a governance model for community participation (Anjum et al., 2017: 88).

For the governance perspective, the blockchain experts also lack consensus on what needs to be done since this topic also involves ethical considerations. The Ethereum foundation annulled all the transactions on the Ethereum blockchain executed after a certain date due to stolen funds from a hack, and this has caused continuous debate on whether this action was against the principles of self-governance that the blockchain depended on as a core concept (Ishmaev, 2017: 668).

At this point, there is a clear understanding of the challenge for establishing rules and regulations of governance of the public and private blockchains (Deshpande, Stewart, Lepetit, and Gunashekar, 2017: 8), and this is due to the technology being a very recent and fast developing innovation. The focus of governance progress for blockchain is on assurance of the integrity of the data and answering the privacy concerns (Deshpande et al., 2017: 8).

While there are no widely-accepted solutions present at this point on how blockchain governance should be executed, there are suggestions made by researchers and other organizations, such as replicating corporate governance by issuing the decision-making power to multiple parties using multiple signature technology and coding governance rules into smart contracts (Wright and de Filippi, 2015: 16, 31).

For cross-border payment systems, like the case for all other blockchain applications, the issues of governance are still very immature. An advantage of these systems is that they are executed via private blockchains, and the level of consensus needed to implement the governance principles would require comparably less effort than a public blockchain.

Progress in the adaptation to blockchain from the organizational perspective: One of the highly discussed issues in blockchain innovation is the transformation of global supply chains and the interorganizational activities regarding them. Previously the companies and institutions involved in a global supply chain interacted by means of electronic links between their own information systems; however, through the use of blockchain these organizations could be much more integrated to provide more value to the final consumer. There are many emerging applications of establishing integrated supply chains even including central banks (Deniz, 2018) and trust in international trade activities (Schwabe, 2017: 117) via blockchain and this topic is also immature but fast and steadily developing.

Progress in the adaptation to blockchain from the societal perspective: Since the foundation of the Bitcoin blockchain, this technology became the focus of start-ups and innovation experts. There are blockchain start-ups present in every industry, and the finance sector oriented start-ups are mainly financed by venture capital, with US and UK dominating the innovations (Friedlmaier, Tumasjan, Welp, 2017: 1). Through the immense circulation of Bitcoin, the communities were introduced to the blockchain technology, and it seems that with the finance sector taking more funding for the development of blockchain applications, the electronic payment systems including the cross-border payment systems could demonstrate faster innovations, changing the payment and money circulations routines of the public.

4. Assessment of Progress in Cross-Border Payments via Blockchain

We will first elaborate on the major issues regarding the current cross-border payment systems in more detail; then, we will compile different solution efforts to overcome these problems via blockchain and emphasize how these issues are addressed. At the end of this subsection we will first overall evaluate the existing initiatives for cross-border payments via blockchain based on criteria such as price, speed, security, convenience, and similar; afterwards, we will present the most recent suggestions recommended by experts for taking the blockchain based cross-border payment systems to the next level.

The consumer to consumer type cross-border payments present a whole different set of challenges compared to a domestic payment. Domestic payments, since all banks in a country have accounts in the central bank of this country and the currency of the payer

and the payee are the same, are executed via debit-credit balancing of the payer's and the payee's banks at the ledger of the central bank and henceforth the banks balance the accounts of their respective customers to finish the transaction. Thus, such domestic payments are transacted via the use of central authority which is the central bank (Isaksen, 2018: 3).

For cross-border payments however, there is not necessarily a common fiat currency, moreover, even if the currency is common for both the payer and the payee, there is no global central bank that holds ledgers for all the banks in the world. In these circumstances, the transaction order has to travel from one fiat currency system governed by a central bank of the payer's country, to another currency system governed by another central bank as the final destination. To exceed the borders of the payer's country, the transaction has to go through the accounts of a bank holding its own account in the bank of another country (preferably, the country of the payee) in the currency of that country. These types of financial institutions are referred to as the correspondent banks, and they perform the role of intermediaries until the payment order arrives within the payee's country's fiat currency system (Qiu, Zhang & Gao, 2019: 430).

The current global ecosystem for cross-border payments requires the existence of intermediaries, in the form of correspondent banks (Neyer, 2017: 35). The connections set up by the intermediaries are formed to connect the ledgers of the payer's and the payee's bank by transmitting the debit-credit balancing and clearing operations through the correspondent banks' ledgers. This process is not only risky, but also inefficient (Rosner and Kang, 2015: 656). All ledgers belonging to the financial institutions involved have to be cleared and the transaction should be settled. For this to happen, the transfer process needs to have well-defined procedures and responsibilities for all parties included in the transaction. This is what the SWIFT system was able to achieve due to its standardized messaging structure. This structure ensures the security of the commands involved in the transaction and conveyed to all institutions included in the cross-border payment.

However, SWIFT system only provides the secure and correct information dissemination to all parties involved, the actual account clearing and settlement is left to the institutions themselves. Hence, although SWIFT may provide some tools in the form of interfaces for account settlement, the messaging and actual clearing operations are not synchronized for cross-border payments executed by the SWIFT system, even though the obligations of each party is well-defined and assured by regulations. Thus, albeit a cross-border payment instruction is conveyed to an institution, the actual update of the ledger may take days. This is usually the case since correspondent banks apply batch processing to such orders; in addition, time zone difference worsens the speed problem more. It is not unusual for a cross-border payment order done by SWIFT to take several days (Mills, Wang, Malone, Ravi, Marquardt, Chen, Badev, Brezinski, Fahy, Liao, Kargenian, Ellithorpe, Ng, Baird, Kargenian, 2016: 18).

The delays in the transaction via SWIFT may increase the foreign exchange spread and definitely bring uncertainty to the price of the whole transaction. The fee of a cross-border payment executed by the SWIFT system involves fees for SWIFT messaging,

correspondent bank fee, and the exchange rate fee (Qiu et al., 2019: 431). Hence, the biggest weaknesses of the existing SWIFT system are lack of speed, uncertain and high fees, and the fact that the payments are not synchronized with messaging, since the system has no control over the banks and any clearance operations conducted by them. The security issues may also arise if the message content is breached. Moreover, there is the possibility of the correspondent banks not recognizing the payer's bank and denying the transaction as a whole, which would disrupt the transaction completely (Zimakosov, 2018: 17).

In light of these issues experienced by the current cross-border payment systems managed through the SWIFT network, blockchain oriented solutions were proposed and we will now compile the status of these projects. The main aim of a blockchain network would be to create a distributed ledger that is common to all the network members around the world. However, this aim brings the question of eligibility for network members of a blockchain designed for cross-border payments, whether individuals or consumers could be the network members as in the example of Bitcoin or the banks and financial institutions should be the only types of members for a cross-border payment blockchain network. In many of the examples, the current trend is to involve only the banks as the network members rather than the consumers themselves, and even with the corporate level blockchain designs, there should still be an admission system to control and approve the admission criteria and processes to the network. Moreover, similar to the role of a domestic bank for a domestic payment, there should be a system to settle the accounts of all the related member institutions on the common ledger (Wu and Duan, 2019: 3).

The current blockchain initiatives for cross-border payments mostly involve only the banks and the financial institutions as their network members. The reason for this phenomenon is that there is an already established trust of a certain level between different banks and financial institutions; whereas due to the potential anonymity of individual accounts in a blockchain (especially in a public blockchain such as Bitcoin) it may not be possible to establish trust between consumer type of members of a blockchain network (Buitenhek, 2016: 116). The first cross-border payment executed via blockchain was ordered by Standard Chartered and it was executed by the Ripple blockchain network, which was completed in 10 seconds, and similarly another one of the early cross-border payment orders was given by the National Australia Bank to send funds from Australia to Canada, which was also completed in 10 seconds (Guo and Liang, 2016: 6).

The first initiative we will discuss for cross-border payments via blockchain is Ripple. Ripple is created by Ripple Labs, Inc. in 2012, and it is a software which involves a protocol that established the computer-to-computer interaction for the computers belonging to the institutions that are members of the Ripple blockchain. Although Ripple is created by Ripple Labs, Inc. the source code is open and it could be described as an Internet protocol since all blockchain network infrastructures are built upon the Internet (Rosner and Kang, 2015: 664; Marr, 2018). Ripple could be called as a decentralized and Internet-based payment protocol.

The main difference between Ripple and the SWIFT system is that both the communication and clearing and settlement operations are synchronized and happen at the same time for Ripple. Ripple system has several tools to realize this feat. First, Ripple has messenger tools to connect the payer's and the payee's banks. The main deficiency in the cross-border payments depending on the correspondent banks is the lack of a common ledger for the entire banks across all countries. To deal with this matter, Ripple has an underlying protocol called Inter-Ledger Protocol to automatically settle all the ledgers involved in the transaction once the transaction is approved. This type of cryptographic innovation could also connect different blockchains with each other (Zimakosov, 2018: 33; Levine, 2016). Ripple also possesses FX Ticket to monitor the validity of the exchange rate used as the reference for the transaction. Finally, the underlying Validator software determines the success or failure of the transaction cryptographically (Qiu et al., 2019: 433).

To make a cross-border payment via Ripple, a financial institution that is a network member posts a request on behalf of its customer, then the third-party intermediaries being the members of the network post quotes to make the transaction. At this point, the Ripple protocol calculates potential paths for the payment to be involved similar to the correspondent banks involved in the classical system, however, the Ripple protocol oversees the whole process, differently than the SWIFT network. Moreover, the protocol calculates the cheapest path for the payment under consideration and presents this result to the order owner. Hence, Ripple provides real-time settlement since these bid collection and calculations are completed fast and the ledgers are updated by the Ripple protocol due to Inter-Ledger Protocol. This provides both speed and less uncertainty due to foreign exchange spread. Once the complete payment path is approved by the payee's bank, the transaction is executed certainly. Ripple has its own cryptocurrency, XRP. In case the fiat currency of the payer's and the payee's bank is different, the payer's bank converts the payment amount to XRP and send it to the payee's bank directly. Inter-Ledger Protocol completes the ledger updates of the members, and the payee's bank converts the payment made in XRP to the local currency. If the payee's bank does not give approval, the transaction will not be executed at all; this is the all-or-nothing type of nature of the Ripple protocol (Rosner and Kang, 2015: 660). Ripple currently has more than 100 members in more than 75 countries (Qiu et al., 2019: 433).

For security purposes, Ripple prevents the users from double-spending, which is to send money to more than one user at the same time whereas there is enough in the account to make only one of these payments. Ripple prevents this by requiring each account to have a minimum balance of 20 XRP, and also for each transaction deducts 0.00001 XRP from an account, this is also a precaution to prevent a single member to open fake accounts to seize control of the network. These fees, which are negligible for individual members, amount to great lump sums in case of an attempt at fraud (Rosner and Kang, 2015: 660). In general, Ripple is claimed to have much lower fees per transaction compared to the SWIFT network. Ripple Labs, Inc. develops and promotes the Ripple protocol, however, it does not operate the payment system itself, and the changes to the protocol attempted by the Ripple Labs have to be adopted by the users to be realized.

As another example of a blockchain-based cross-border payment initiative JP Morgan had developed a blockchain network named Quorum, which uses the cryptocurrency Ethereum as the means of exchange between different fiat currencies involved in the payment. The initiative itself is named as Interbank Information Network and has around 75 members (JP Morgan, 2018). On the other hand, IBM blockchain used the Hyperledger Fabric technology from the Linux foundation to launch Blockchain World Wire payment system, and CLS consortium of banks (Barclays, Bank of America, Bank of China, Bank of Tokyo, and others) are developing alternative systems to SWIFT via Hyperledger Fabric technology. Stellar is also another project showing promise. Stellar is based on the same source code as Ripple, and initially it was an offshoot of this network, which gained independence eventually. Stellar could be described as a globally available currency exchange ledger distributed via blockchain. Stellar also has its own cryptocurrency, STR. Stellar uses the same precautions with Ripple to prevent fake accounts and double spending; however, differently than Ripple, consumers can trade on their own, the source code detects the best bid and STR is used as the medium to support the foreign currency exchange between the payer and the payee (Zimakosov, 2018: 44). There are also Money Transfer Operator initiatives processing in a similar nature to Western Union, PayPal, etc. that are built on the Stellar blockchain such as Velo in Thailand (Townsend, 2019: 56).

The cross-border payment systems reviewed so far are private and permissioned blockchains; meaning that their protocol is updated by a consortium or a company, and they use cryptocurrency as a medium of exchange between different fiat currencies in case the payer's and the payee's currencies are different. Similarly, Bitcoin could also be used for this purpose although it has a public and permissionless blockchain. There are companies overseeing such cross-border payment connections with Bitcoin used as a medium. For instance, Align Commerce converts the payment made by the buyer into bitcoins and sells the cryptocurrency to transform the payment into the currency of the seller to complete the transaction (Rizzo, 2015). Corda, on the other hand, is an open-source distributed ledger platform maintained by a consortium of many companies under the leadership of R3, a distributed database technology company. Similar to Ripple, Corda is also designed to serve the financial sector to execute complex transactions via smart contracts while protecting the privacy of the transaction content information (Demeyer, 2018: 22). Many companies and organizations such as IBM, JPMorgan Chase, ANZ Bank, Cisco and Accenture are also currently collaborating to enhance blockchain development and usage (Yurcan, 2016).

The successful examples above demonstrate how the blockchain and distributed ledger technologies are currently used to help companies with cross-border payments. A method used by the initiatives is to transfer the payment made by the buyer into a cryptocurrency and exchange the cryptocurrency with the fiat currency the seller needs to obtain as payment (Ripple and Align Commerce). Another method is to manage the execution of the payment via smart contracts, such as R3. The usage of smart contracts is currently researched to manage all international trade activities by companies like Skuchain (Collomb and Sok: 101). A common characteristic of all successful initiatives so far is that they are operated by private initiatives, suggesting that the blockchain or distributed

ledger technology applications at the moment need to be managed either by a consortium or a company, rather than having a fully public and decentralized structure as for Bitcoin.

The blockchain based cross-border payments present many advantages and opportunities. While some resources claim that the fees of Ripple and other initiatives are much smaller compared to the SWIFT system, there are other views as well. For instance, when cross-border payments using Bitcoin as a medium are concerned, it is possible that as the amount of money to be transferred increases so does the transaction fee. This is due to the fact that Bitcoin has a permissionless and public blockchain and it could get congested due to heavy traffic. In that regard, transaction fees are better controlled at private blockchains such as Ripple and in terms of pricing, blockchain presents an advantage over SWIFT. For speed related concerns, blockchain is definitely more advantageous since transaction time is on average one hour for the Bitcoin blockchain and it is measured in minutes or even seconds for the other blockchain-based cross-border payment systems; hence, blockchain clearly has advantage over SWIFT in this regard as well (Isaksen, 2018: 12).

While blockchain presents an advantage over costs and speed compared to the SWIFT network and other established systems, there are many issues regarding security and governance when it comes to cross-border payments via blockchain. While the current blockchain structures are of great help in execution and operation of the transactions, they present no standardization, and there are no established regulations on the rights and liabilities of the parties involved (Cheng and Geva, 2016: 4). Security also presents a major issue for blockchains since the privacy of the transactions belonging to different legal entities could reveal a major problem since the ledger is exposed to all members of the blockchain and the transactions can be tracked. Thus, if legal entities with different positions with respect to each other see the transactions of each other, their privacy could be breached within the principles of the protocol. One way to deal with this is the verification of each node's credentials, and this could at present be done in private blockchains such as Ripple. This poses another reason as to why the cross-border payments are currently executed in the private blockchain realm (Wu and Liang, 2017).

The blockchain-based cross-border payment systems and the cryptocurrencies used by these systems as a medium of exchange for fiat currencies involve no government interaction, and this creates possibilities for fraudulent activities. While the blockchain network has some mechanisms to prevent such activities occurring on a regular basis, the same cannot be said for supplementary tools to aid the blockchain, such as bitcoin wallets. Hackers may steal funds from the users' wallets and currently there is no established insurer for such lost funds (Isaksen, 2018: 13). These phenomena display the need for updates on the regulations, since the previous systems depended on central authorities and the legal system were designed with the assumption that there would be contracts signed within the representatives of the central authorities. However, this logic no longer applies when blockchain is concerned. For instance, Ripple is a protocol and Ripple Labs does not fully operate and control Ripple. Hence, a contract with Ripple Labs would not bestow rights and liabilities as a standard one. A recommendation in this case is to monitor the protocol's processes closely and have contingency plans in case of unexpected results (Rosner and Kang, 2015: 665). A recommendation by experts to ease the controls and

other regulatory checks (e. g. for anti-money laundering purposes) is to combine the blockchain technology with big data analytics with data repository serving as an external layer that is constantly fed, so real-time screening could be possible (Achanta, 2018: 7). In the distant future, if blockchains are managed by advanced artificial intelligence it would be possible to sign contracts with such intelligence though.

The initiatives for usage of blockchain and distributed ledger protocol show that the private or consortium networks obtained good results through the use of cryptocurrencies to catalyze the foreign exchange or smart contracts, and the technology is very promising. At the same time, these initiatives are led by private companies and therefore local to their networks. Hence, the adaptation of the financial ecosystem is far from complete, offering great potential.

5. Conclusion

Blockchain and distributed ledger technologies are very recent innovations with fast and steady development rate, and in this paper we aimed to analyze the potential of these computational technologies that rely on Internet specifically for cross-border payment systems. While the development of blockchain has gained some momentum from the technological perspective, there are no globally accepted standards or rules for governance for this technology. This presents a major challenge that has already been under the consideration of ISO and similar organizations; however, the financial sector is heavily working on using blockchain in any part of their business model. The current use of blockchain technology in the financial sector is for cost minimization and efficiency increase (Oh and Shong: 2017: 343), and the use of this technology in cross-border payment is to shorten the time the payments are taking under the execution via SWIFT network, as well as to reduce the charges imposed by the intermediary institutions. There are successful private initiatives already helping businesses on this topic; thus, the current level of advancement in the cross-border payments field for blockchain is that private blockchains are operating on a small scale but obtaining successful results. This is mainly because there are no established insurance and other precautionary or contingency regulations in the case of security breach or fraud. This requires the security to be assured by continuous monitoring and verification of the member nodes in the blockchain network, and currently this can only be done via the private blockchain structure. This provides the applications to stay as localized to the networks of the private initiatives, rather than changing the whole financial eco-system. From a technological perspective, the computational procedures are functioning well, and as the governance and standardization of blockchain protocols emerge, the usage of this technology for cross-border payments could become the industry standard for cross-border payments.

6. References

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