Journal of *Risk and Financial Management*

MDPI

Review

Towards a Truly Decentralized Blockchain Framework for Remittance

Kevin Coutinho [1], NeerajKumari Khairwal [1,*] and Pornpit Wongthongtham [2]

[1] L1X Foundation, Perth, WA 6005, Australia
[2] School of Physics, Maths and Computing, Computer Science and Software Engineering, The University of Western Australia, 35 Stirling Highway, Perth, WA 6009, Australia
* Correspondence: neeraj@blocksone.tech

Abstract: Blockchain is a revolutionary technology that is constructively transforming many traditional industries, including financial services. Blockchain demonstrates immense potential in bringing substantial benefits to the remittance industry. Although the remittance industry has crossed the mark of USD 600 billion in 2021, remittance cost is still substantially high, around 6% on average, indirectly limiting financial inclusion and promoting de-risking. The involvement of multiple intermediaries in global remittances makes cross-border payments more expensive. Many projects, including Ripple and Stellar, employ blockchain technology to provide alternative infrastructure for cross-border payments. However, the decentralization of blockchain networks in both solutions is debatable. This paper examines the market characteristics impacting remittance cost, a prominent factor driving the evolution of the remittance industry. A truly decentralized blockchain framework viz. LayerOneX, which provides remittance services at a reduced cost, is proposed in this paper. Devices with low computation and memory capacity can act as transaction validators in this solution. A universal wallet across homogeneous and heterogeneous blockchains is proposed to facilitate fast and inexpensive remittance services. Thus, a novel framework for true decentralization of blockchain-based remittance services, resulting in reduced cost and, therefore, better financial inclusion, is proposed in this paper.

Keywords: blockchain interoperability; cross-border payments; cross-chain communications; decentralization; remittance

Citation: Coutinho, Kevin, NeerajKumari Khairwal, and Pornpit Wongthongtham. 2023. Towards a Truly Decentralized Blockchain Framework for Remittance. *Journal of Risk and Financial Management* 16: 240. https://doi.org/10.3390/jrfm16040240

Academic Editor: Sisira Colombage

Received: 27 February 2023
Revised: 22 March 2023
Accepted: 6 April 2023
Published: 12 April 2023

1. Introduction

Blockchain is a Distributed Ledger Technology (DLT) devised to decentralize control and authority. Blockchain-based financial infrastructures have immense potential to transform financial markets. The financial crisis in 2008 propelled the creation of blockchain technology. Through decentralized cryptocurrency viz. Bitcoin, an attempt to limit the political power in the financial market was made (Lu 2022). The sustainability of this innovative digital asset has been a matter of debate for political and financial authorities. Several analyses have been conducted to explore whether these digital assets can stay or even replace traditional financial systems in the long run. Despite high volatility, Bitcoin has revolutionized the digital ecosystem with significant global economic impact. The advent of cryptocurrencies has opened new horizons for global financial markets. The adoption of cryptocurrencies in developing nations has led to positive growth.

Blockchain-enabled cryptocurrencies facilitate comparatively inexpensive financial transactions with enhanced operational efficiency in trading. This has led to the gigantic growth of cryptocurrencies, as depicted in Figure 1, with over 9000 active cryptocurrencies in global circulation by November 2022 as compared to a mere 7 in April 2013 (Howarth 2022). It is little wonder that the total market capitalization of all the

cryptocurrencies crosses the USD 800 billion figure with more than 300 million users worldwide and about 18,000 businesses accepting crypto payments.

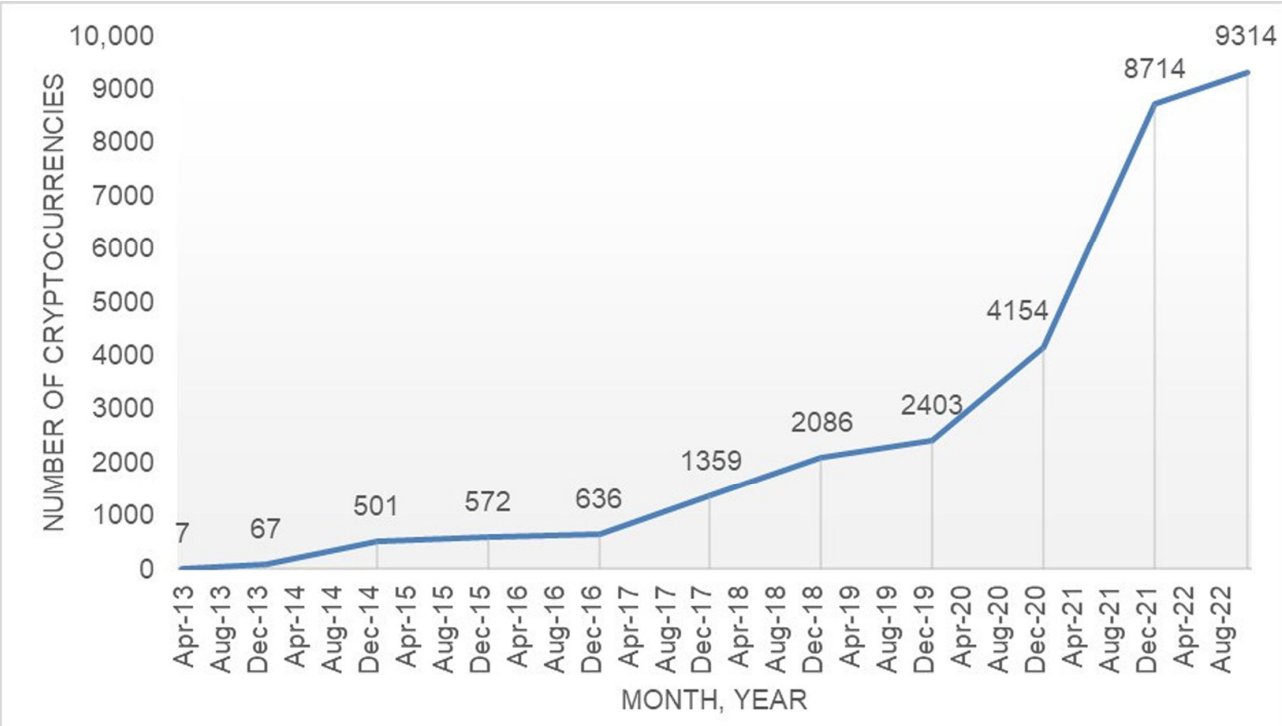


Figure 1. Cryptocurrency expansion in the last decade.

Apart from finance, blockchain has found applications in several domains. In healthcare, blockchain is widely used for electronic healthcare records, data sharing, and access control, whereas it can further be used for drug prescription management as well as for clinical trial (Hölbl et al. 2018; McGhin et al. 2019; Hasselgren et al. 2020). Heterogeneity of the agricultural stakeholders opens the door for the application of blockchain technology in the agri-food supply chain, agricultural insurance, improving food safety, and increasing customer confidence (Demestichas et al. 2020; Bermeo-Almeida et al. 2018; Sajja et al. 2021). Security, privacy, and the single point of failure are the common IoT issues that can be efficiently addressed using blockchain technology (Dorri et al. 2017; Panarello et al. 2018; Uddin et al. 2021). Blockchain technology has wide adoption in supply chain management to identify counterfeit goods, verify and track ownership, restrict fraud and data tampering, protect valuable assets from trafficking and thefts, etc. (Azzi et al. 2019; Queiroz et al. 2019). Access control, availability, confidentiality, and integrity of smart data for Industry 4.0 cybersecure applications can be ensured by employing the immutability of blockchain technology (Fernández-Caramés and Fraga-Lamas 2019; Bodkhe et al. 2020). Transparency and tamper-proof blockchain empowers sharing economy and energy democratization by enabling small renewable energy generators to monetize their assets (Andoni et al. 2019; Brilliantova and Thurner 2019; Wang and Su 2020).

Another field that is in dire need of inexpensive financial transactions is the remittance market. Around one billion people are involved in remittances valued at more than USD 600 billion, with currency exchange rates of over 6% on average (Ratha et al. 2022). Sub-Saharan Africa is the most expensive corridor for international money transfer, wherein from the region of Tanzania to Kenya, the total remittance cost on average was 35.21% in the second quarter of 2022 (Sending Money from Tanzania to Kenya—Remittance Prices Worldwide 2021). The average international transfer takes approximately two business days (up to five days in some cases), unlike domestic fund transfers which can be instantaneous. The remittance economy is expected to surpass trillions of dollars in the

near future. Cross-border payments expose security risks and lack transparency. Retail payments and remittances, in particular, are expensive, opaque, and slow. A substantial transaction fee has been incurred on transfers and can result in cumulative sums that can be substantial over a period of years. Multiple mediators and verification processes in conventional remittance channels can cause not only high fees but also slow processing time for transactions. Given that remittance transfers remain one of the most inconvenient to transact to date, customer experience in payment services needs significant improvements. The Department of Economic and Social Affairs at the United Nations (Remittances Matter: 8 Facts You Don't Know about the Money Migrants Send Back Home 2019) opines that blockchain innovations can fundamentally transform the remittance market. However, blockchain is balkanized in siloes and is incapable of handling large transaction volumes. Both serve as major hindrances to blockchain adoption in the Financial Services Industry (FSI).

This paper aims to supplement an understanding of the remittance industry and its impact on the global economy. An in-depth analysis of factors driving remittances and market characteristics affecting remittance cost is carried out to provide readers with a glimpse of significant yet outstanding issues for future investigation. The conventional FinTech and current state-of-art blockchain-based remittance solutions are examined in detail with merits and demerits. This paper proposes a LayerOneX (L1X) blockchain network that will tackle scalability and interoperability issues while keeping decentralization and security uncompromised. L1X blockchain-powered remittance will remove middlemen, i.e., payment systems, foreign exchange, or banks. The transactions will directly take place between sender and receiver, enabling peer-to-peer (P2P) transfers. L1X blockchain-powered remittance uses the key principles of cryptography for verification and security, thereby ensuring that transactions are verifiable and secure. L1X blockchain will be adopted and tested for production-ready P2P transfer services. A cross-border payment platform will be developed on the L1X blockchain to verify its use case. L1X blockchain will transform remittances and challenge traditional FinTech business models, resulting in efficiency gains, cost reduction, shortened processing times, better user experience, and enhanced transparency. The strength of the L1X blockchain can be expanded across many sectors of the economy and can open new horizons for global trade. Thus, innovations in this research are proposed to develop a new remittance and payment platform that enables real-time, 24/7 payments to be made across the global economy.

The remainder of the paper is organized as follows. Section 2 provides a detailed overview background of remittance as a flywheel of the global economy. The section explains the remittance mechanism, lists remittance drivers, and analyzes market characteristics impacting remittance cost. In Section 3, the traditional and FinTech remittance models are overviewed. Transformations in the remittance world due to blockchain-based solutions are discussed in Section 4 along with a detailed study on Ripple and Stellar. Section 5 presents the novel conceptual framework L1X blockchain network. Finally, Section 6 concludes the paper.

2. Remittance: A Global Economic Flywheel

Remittances are relatively low-value, recurrent, international payments between two individuals. For example, migrants may send support payments to their relatives inhabiting their homeland. Remittance flows are critical to aid household necessities such as food, medical care, and education. During a crisis, it serves as an important source to access cash. Thus, migrants and their families typically use remittance as the first financial service. This acts as a dot connecting migrants and their families with the financial sector and other financial services (Ardic et al. 2022). General remittance flow is from High-Income Countries (HIC) to Low- and Middle-Income Countries (LMIC). The economic development and welfare implications of Emerging Markets and Developing Economies (EMDEs) are also influenced by remittance flows as remittances are a major source of external finance to LMICs. Foreign Direct Investment (FDI), Overseas Development Assistance (ODA), and portfolio

investments are other external sources of finance for LMICs. Remittances are anticipated to exceed the total of FDI and ODA in LMICs, excluding China (Remittance Flows Register Robust 7.3 Percent Growth in 2021 2021). A robust 8.6% rise in remittances to LMIC has been observed, reaching USD 605 billion in 2021 (Ratha et al. 2022). Figure 2 depicts the rise in remittance growth rate in 2021 and forecasts it for 2022. Thus, an overall increase in remittance flows is expected in the next several years should this trend continue.

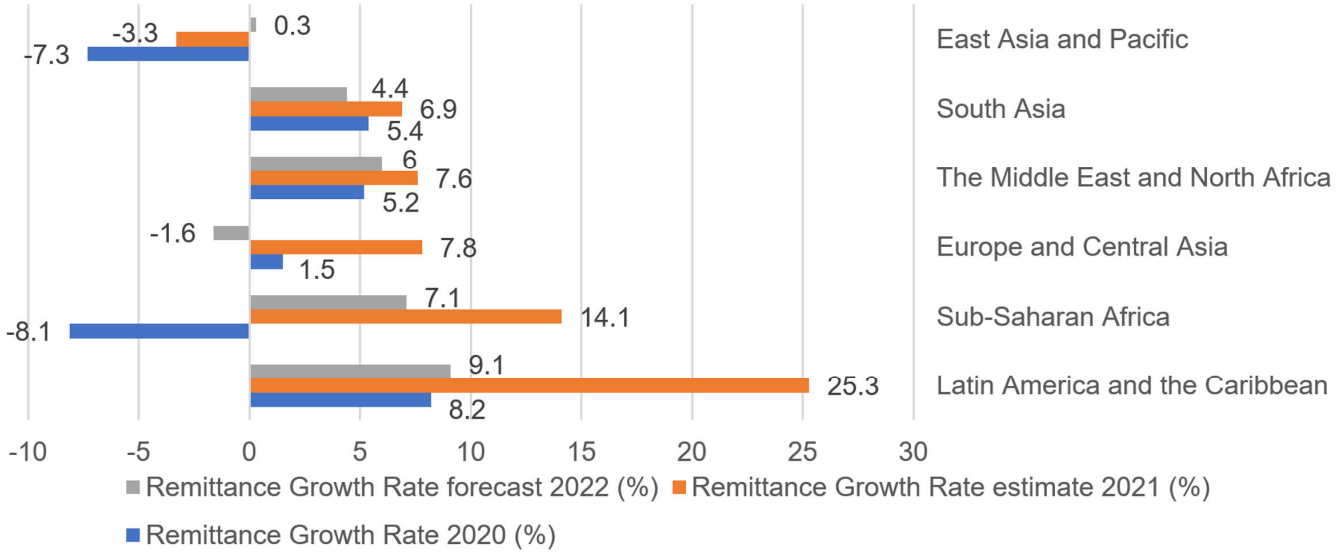
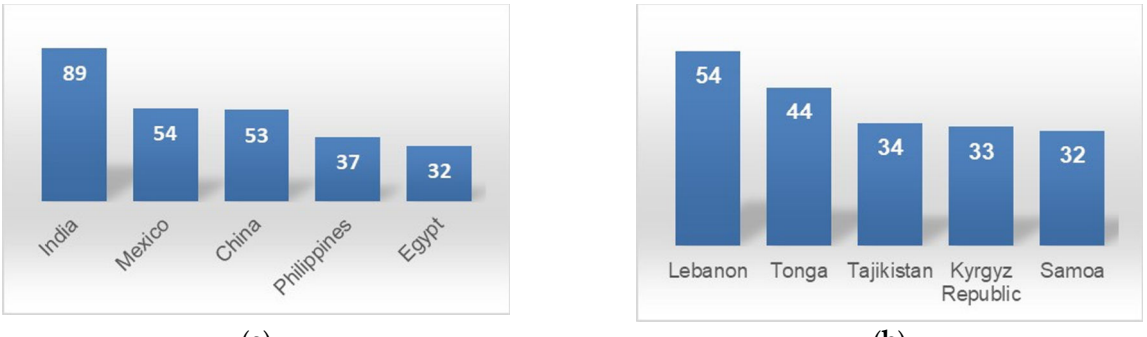


Figure 2. Remittance growth rate 2020–2022.

India ranks highest amongst the remittance recipients with an inflow of USD 89.4 billion in 2021, as shown in Figure 3a. Remittances constitute a large share of Gross Domestic Product (GDP) in a few economies, as illustrated in Figure 3b. In Lebanon, more than half the GDP share comes from remittances (Ratha et al. 2022). Thus, remittances hold great significance in the global economy, especially for EMDEs.



(**a**) (**b**)

Figure 3. Top remittance inflows, 2021 (**a**) in current USD (**b**) as a share of GDP.

2.1. Remittance Mechanism

Remittance typically involves a sender, receiver, intermediary in the host country, intermediary in the home country, and a payment transfer interface, as detailed in Figure 4. The channels for remittance flows are formal as well as informal. Due to varying regulations across different countries, a particular channel may be formal in one nation but informal in another (Jain et al. 2018). Traversing through these channels and bounded by the regulations, traditional remittance transactions take around five working days to

complete with no transparency. Therefore, the conventional money transfer model is deemed to be overcharged and underserved.

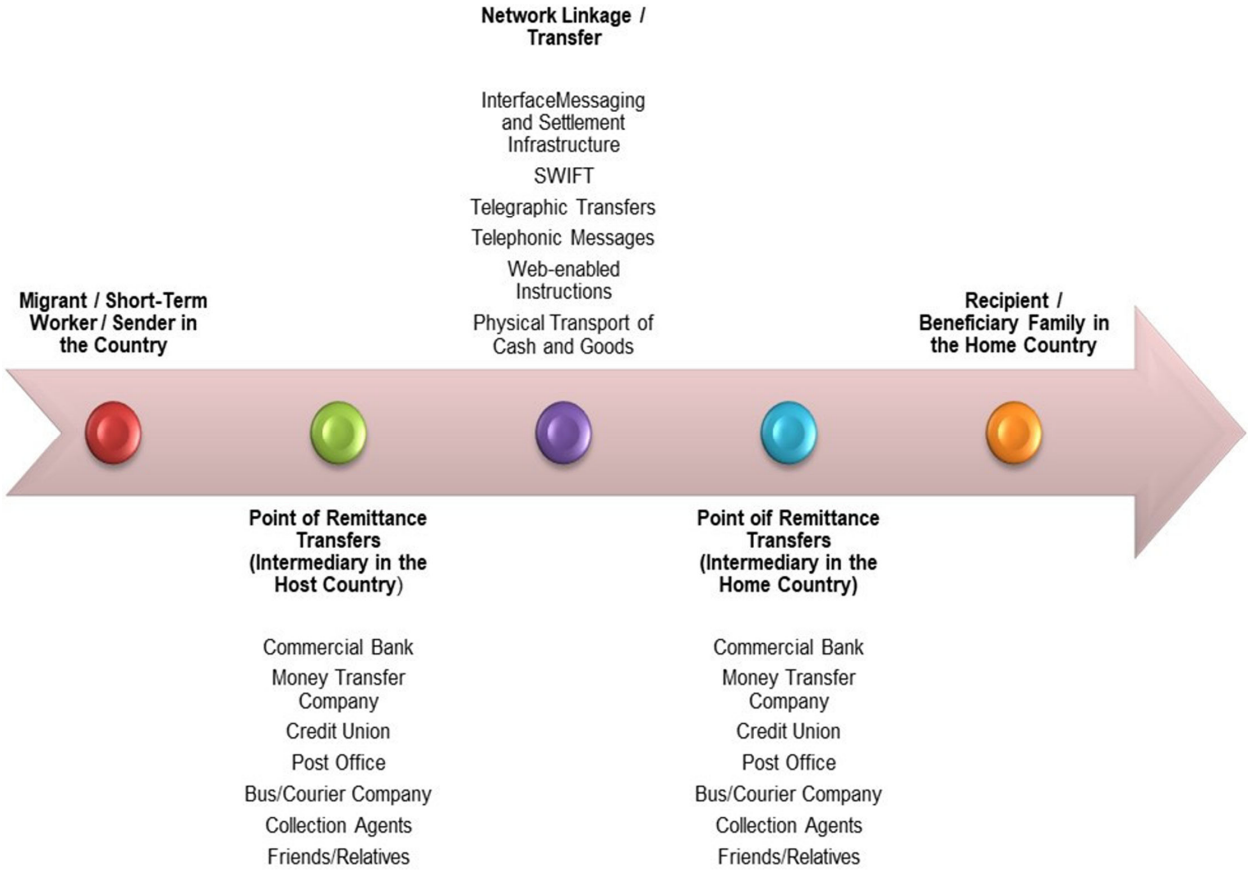


Figure 4. Remittance channels.

Wire transfer refers to the mode of electronic money transfer where no physical exchange of cash is involved; rather, transfers are settled electronically. These transfers are carried over a network of banks and non-banking services such as Money Transfer Operators (MTOs). Sufficient measures are taken to ensure that the money is not wired for money laundering or financing terrorism (Kagan 2022).

Clearance and settlement for countrywide payments are facilitated by retail payment systems such as Automated Clearing Houses and Deferred Net Settlement of the central bank. On the contrary, there is no such global clearing house for cross-border payments. Hence, international remittances pass through Correspondent Banking Relationships (CBRs), a network of financial institutions delivering financial services worldwide. Correspondent banks provide services for cross-border wire transfers, clearance, payment settlement, and foreign exchange services (Anti-Money Laundering Principles for Correspondent Banking 2014). On the other hand, MTOs such as Western Union manage their own proprietary network for faster cross-border payments through pre-funded agents at the receiving end and periodic settlements (Distributed Ledger Technology and Blockchain 2017). The Society for Worldwide Interbank Financial Telecommunication (SWIFT) facilitates interbank message transactions for international wire transfers. SWIFT is a reliable and secure organization spread over 200 countries and territories with 99.999% SWIFTNet availability (Swift—About Us 2023). These financial messages are utilized for clearances by correspondent banks and settled through Foreign Exchange markets. Since multiple intermediaries are involved in cross-border remittances, clearance and settlement are comparatively time-consuming and expensive affairs.

2.2. Remittance Drivers

Mobile-based money transfer channels, lower transfer cost and time, and integration with banking and financial services have been identified as the three main drivers for the remittance industry by Allied Market Research (Remittance Market: Global Opportunity Analysis and Industry Forecast, 2019–2026 2020), as depicted in Figure 5. With more and more people adopting mobile phones in LMICs, a rise in the tendency of migrants to use their mobile phones to transmit money to their families has been observed. Increased competition among remittance players has led customers to demand a better yet cheaper service. Unbanked people in EMDEs hinder the complete integration of remittance with banking and financial services. Subsequently, this paper discusses in more detail the second driving factor viz. remittance cost.

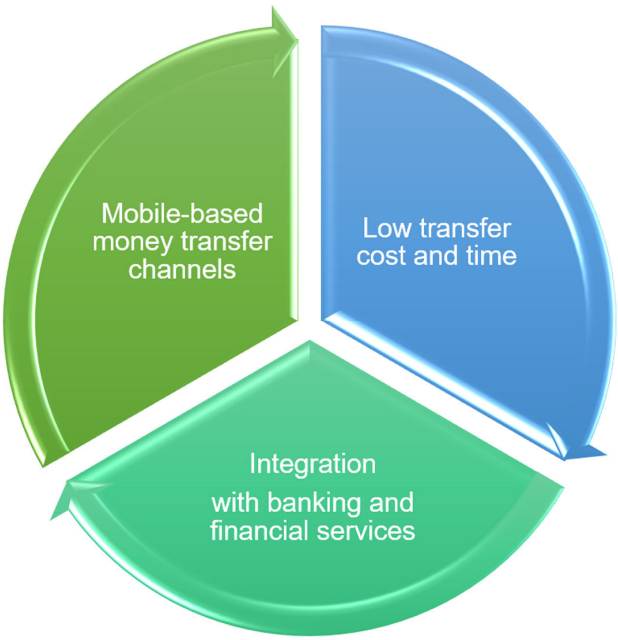


Figure 5. Remittance drivers.

The size of remittances is affected by several elements of the host country, such as fiscal stance, work migration-related domestic policy, and macroeconomic conditions. Another major factor that influences remittance inflows is the cost incurred for remitting funds (Jain et al. 2018). A remittance cost through correspondent banking channels can be split into three fees: (i) fees charged by the sender bank, (ii) fees charged by the receiver bank, and (iii) fees charged for cross-border transfers by each intermediary (Distributed Ledger Technology and Blockchain 2017).

Figure 6 represents the comparison of remittance costs in 2021 with the previous year 2020. The most expensive remittance cost of 31.5% has been recorded for flow from Tanzania to Kenya in the Sub-Saharan Africa region in Q4 2021. On average, remittance cost is 6% globally, which is double the target rate set to be achieved by Sustainable Development Goals (SDGs), i.e., 3% (Ratha et al. 2022). SDGs are established under Agenda 2030 by the United Nations General Assembly, which identifies 'reducing remittances cost for migrants' as one of the targets to achieve, as laid out in Goal 10: Reduced Inequality. Apart from costs, other issues concerning remittances are discussed in the subsequent section.

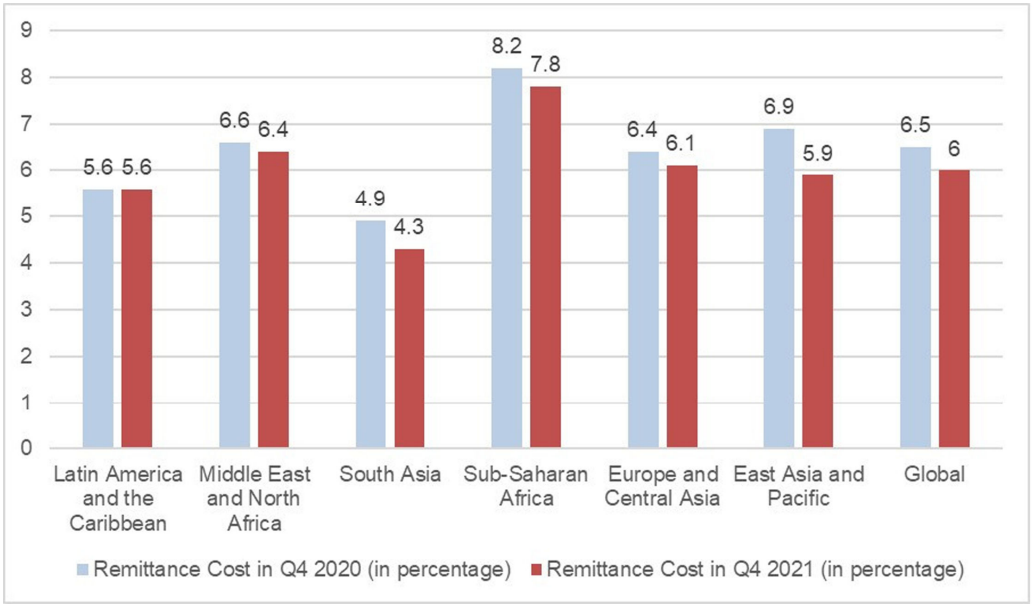


Figure 6. Remittance costs Q4 2020–21.

2.3. Remittance Market Characteristics

This section examines a few market characteristics that may cause inefficiencies in the way remittance services are offered. Due to such market inefficiencies, remittance services may be more expensive than they otherwise would be or may deliver lower-quality services (General Principles for International Remittance Services 2007; Rühmann et al. 2020; Beck and Pería 2011).

2.3.1. Monetary Exchanges

Remittances are largely used for household necessities rather than investments or savings. This drives cash-to-cash services where physical cash is involved either at the first mile or at the last mile (Suki 2007). To facilitate this, Money Transfer Operators (MTOs) open cash distribution access points that operate on commissions, salary, or rent. This operation cost is transferred to remitters in the form of remittance costs.

2.3.2. Intermediaries for International Payments

Weak economies lack the financial infrastructure, which leads to the involvement of multiple intermediaries for remittance. As the number of intermediaries increases, so does the process's complexity, time, and cost. This greater expense is incurred by the sender. To improve the effectiveness of remittances, the World Bank, Bank for International Settlements has emphasized the need of improving global payment infrastructure.

2.3.3. Price of Regulation and Compliance

Regulations such as Know Your Customer (KYC) and Customer Due Diligence have been introduced to eliminate money laundering and terror financing. To meet KYC obligations, financial institutions must bear an average cost of USD 60 million (Know Your Customer Surveys Reveal Escalating Costs and Complexity 2016). This has resulted in de-risking where many banks have terminated their relationships with MTOs.

2.3.4. Lack of Competitive Market Structure

Large MTOs like Western Union and Money Gram make privileged deals with huge distribution networks for high-volume corridors (Reducing Remittance Fees 2005). This restricts the entry of small rivals, thereby levying high prices for remittance services.

2.3.5. Transparency and Consumer Protection

The existing remittance system lacks transparency and uniform legal procedures worldwide to protect the interest of the sender and receiver. Regulations for data protection and privacy, business conduct, and dispute resolution that legally bind the Remittance Service Providers are required (Ardic et al. 2022).

2.3.6. Payment System Infrastructure

Currently, remittance payment infrastructure is not easily accessible in rural areas. This increases the cost as well as the time for last-mile delivery.

2.3.7. Slow Services

Due to the lack of modern infrastructure and multiple intermediaries, a standard remittance transaction takes approximately five days. In the digital age, such a long wait to receive money overseas is unendurable (Future of Cross-Border Payments: Blockchain Remittance Explained 2022).

2.3.8. Low Security

The present remittance system is centralized, with customer details, transaction data, and authentication details being shared among multiple intermediaries such as banks, correspondent banks, overseas merchants, MTOs, etc. Since the details of numerous remitters and consumers are stored with mediators, there is a risk of information leakage, as remittance data is an easy target for hackers (Deng 2020).

As evident from the above discussion and Figure 7, most market characteristics viz. intermediaries, lack of payment infrastructure, lack of competitive market, regulation compliance, and monetary exchanges all contribute to a high remittance cost and slow service.

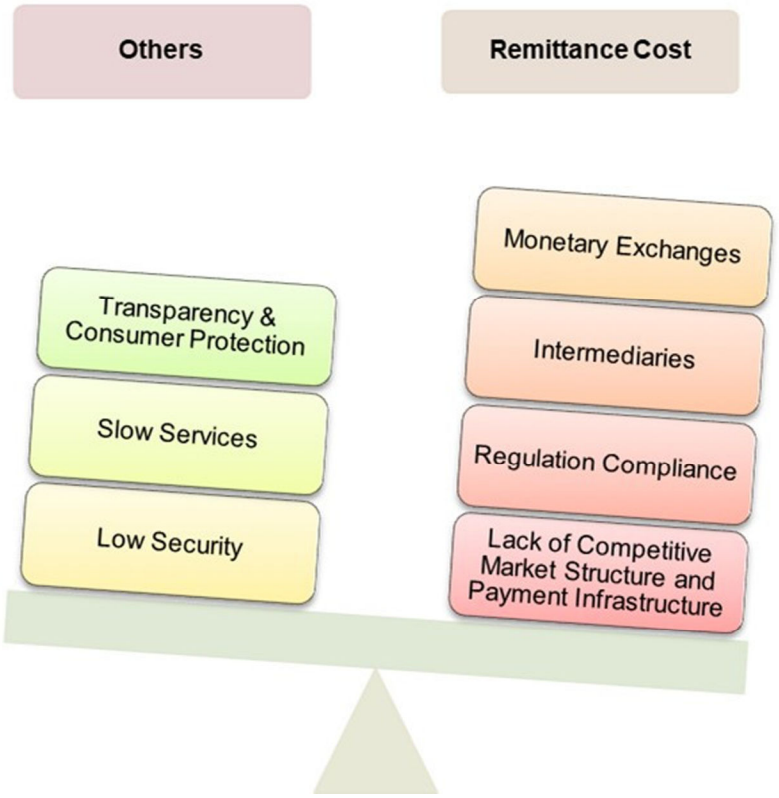


Figure 7. Remittance market characteristics increasing remittance cost.

3. Remittance Models: Conventions and FinTechs

Before blockchain, traditional MTOs and FinTech start-ups dominated the remittance industry. Western Union and MoneyGram have been the major MTOs. They provide the service for money movement and transfer. Western Union operates in over 200 countries and territories; it completes 31 transactions per second on average (International Money Transfers, Western Union India 2022). Being a pioneer in cash-to-cash and cash-to-account remittances, Western Union claims to achieve a global market share of 17% (Become a Western Union Agent 2022). MoneyGram, another global leader in cross-border P2P remittances, serves over 150 million people (About MoneyGram International, Inc. 2022) with over 400,000 locations (Products and Services 2022) around the world.

Various FinTechs have risen quickly to become significant challengers to established players. The global expansion strategy of Wise (formerly TransferWise) has reached 13 million customers across 44 countries remitting money over GBP 76 billion in the financial year 2022. Wise claims to provide services to move and manage money at an average of 0.61% fees with around 49% transfers in less than 20 s in Q4 FY2022 (Kaarmann 2021; Money without Borders. Annual Report and Accounts 2022 2022). WorldRemit claims to send money to over 130 countries and supports the transfer of 70 currencies within 10 min over mobile and within a day or two through the bank (WorldRemit About Us 2022). It has a base of over 5 million customers with a considerable share of African migrants. WorldRemit claims to be providing remittance services at a rate of 46% less than most banks (International Money Transfer—Send Money Online | WorldRemit 2022). Ria facilitates the transfer of money across 500,000+ locations in 165 countries while targeting migrants from Latin American countries (Ria Money Transfer—Send Money Online to Over 165 Countries Instantly 2022).

4. Remittances in the Era of Blockchain Technology

The World Bank recognizes applications of DLT to solve cross-border payments and remittances for greater financial inclusion and better financial access for impoverished populations. Particularly, DLT can be used to replace the CBR network with a distributed network for cross-currency fund settlement. This can plausibly result in lowering settlement costs, decreasing remittance costs, addressing the de-risking issue, and improving the overall efficiency of cross-border payments (Distributed Ledger Technology and Blockchain 2017). The International Monetary Fund further outlines risk management and real-time settlements as other potential use cases for DLT (Recent Trends in Correspondent Banking Relationships: Further Considerations 2017). Unused cash, locked as a form of liquidity in Nostro and Vostro accounts in CBRs, can be mobilized using this technology (Rella 2019). According to the World Bank, blockchain can redefine the current correspondent banking infrastructure by leveraging cryptocurrencies as bridge assets (The Decline in Access to Correspondent Banking Services in Emerging Markets: Trends, Impacts, and Solutions 2018).

Blockchain is a DLT with immutable data records stored in a cryptographically secured linked list as blocks. Bitcoin, the first application of blockchain technology, is a decentralized payment network handling accounting, clearance, and settlements independently (Nakamoto 2019). Bitcoin has the potential to form an alternative remittance channel by serving as an intermediary currency between other fiat currencies that are useful in remittances (Scott 2016). An example of Bitcoin (BTC) used as an intermediary currency for remittance is BitPesa. While frontier markets connect with the globe largely via USD, BitPesa replaces the requirement for USD to be used as an intermediary currency by using a network of digital brokers to build a global rapid settlement network (Yen 2017). By providing wholesale cryptocurrency BTC liquidity and being a market maker of over eight currencies, BitPesa has traded over USD 500 million in Africa without using SWIFT. It claims to complete remittance transactions in less than two hours (BitPesa | Africa's Crypto and BTC Exchange—Access the Deepest BTC Liquidity in Africa 2022). Another

enterprise using Bitcoin for remittances, specifically BTC-to-PHP, i.e., Philippines pesos, is Rebit.ph (Rebit—Crunchbase Company Profile & Funding n.d.). Rebit.ph aims to provide remittance services within 15 min at around 1% fees (Rebit.Ph 2023). With more than 16 million users in the Philippines, Coins.ph makes international remittances frictionless by use of mobile devices, blockchain technology, and teaming up with Western Union (Coins.Ph 2023; Rühmann et al. 2020; Soufaih 2020). At present, more than 20 cryptocurrencies including BTC, Ether (ETH), XRP, USD Coin (USDC), Tether (USDT), etc., are supported by Coins.ph to provide instant money transfer services, specifically targeting the unbanked Filipinos (What Cryptocurrencies Are Available on Coins.Ph? 2023). BitSpark and Abra both focus on trading services more than cross-border payments (Rella 2019). Abra is a global investment application that empowers users worldwide to invest and trade in hundreds of cryptocurrencies. Funds are denominated in USD; however, during transactions, they are rapidly settled in the local currency on the other end. Bitcoin is employed as back-end infrastructure in Abra (Flore 2018). BitSpark is a bankless ecosystem built on BitShares blockchain for cross-border money transfers focusing on Hong Kong, Malaysia, the Philippines, Indonesia, Vietnam, Ghana, and Nigeria. It also allows payment providers to trade their assets, i.e., fiat currencies or cryptocurrencies, against reward token Zephyr on their own decentralized exchange (Bitspark's Bankless Ecosystem 2023). BitSpark was closed on 4 March 2020 due to internal restructuring (De 2020).

Further to the discussion, Ripple and Stellar are the dominant blockchains in the remittance space which are currently being adopted and tested. Particularly, Stellar is renowned for its fast transactions and continues to excel in payment-based applications. However, their technology trades off decentralization and security for scalability. Both Ripple and Stellar forgo decentralization to add scaling capabilities. Decentralized tamper resistance is a key feature of blockchain and has a broad application prospect. However, blockchain scalability bottlenecks affect mainstream adoption due to the blockchain trilemma of decentralization, security, and scalability. Several solutions have been proposed; however, the existing solutions offer alternate approaches that do not directly solve the problem. One approach of blockchain scalability solutions is to provide a way to offload transactions to other blockchains, but these blockchains need to be interoperable. The problem is that current blockchains are not intrinsically designed to be interoperable. Rather, each blockchain is focused on solving particular challenges within industries in a siloed manner. There are attempts to develop approaches and protocols tackling blockchain interoperability limitations; however, assumptions and compromises are required for security and decentralization.

Table 1 compares the two most prominent blockchain solutions facilitating remittance services. Here is a detailed overview of both platforms: their approach, network, strength, and issues. Ripple is a blockchain-enabled remittance network that synchronizes real-time payment settlements with transaction message passing. It targets collaboration with financial institutions that are working with regulators and central banks for providing distributed ledger remittance solutions. Interledger protocol synchronizes the ledgers of all financial institutions for credits, debits, and liquidity in RippleNet (Qiu et al. 2019). Ripple's native cryptocurrency viz. XRP has also been used as a bridge asset for cross-border payments. XRP Ledger provides transparency in the funds' transfer process that streamlines KYC-AML compliance (Rella 2019). To verify transactions and maintain the integrity of the blockchain, a probabilistic voting model of trusted subnetworks with predetermined tolerance thresholds is employed (Chase and MacBrough 2018). The XRP Ledger has more than 750 active nodes in the network with around 138 validators as of September 2022, out of which 35 serve as Unique Node Lists (UNLs) for transaction validation (XRPL Explorer|Network 2022). Whenever a volunteer spins a node, Ripple recommends a list of default trusted validators, i.e., UNLs. Consequently, Ripple transaction finalization is driven by these 35 nodes in practice. Moreover, 6 out of 35 are directly controlled by Ripple, whereas 4 more are through grants (Moos 2020; FAQ Your Questions About XRPL, Answered 2022). Hence, the true decentralization of the Ripple network is

debatable. However, this model results in completing money transfer transactions in 3–5 s on the XRP ledger while handling 1500 transactions per second. On average, transaction fees cost USD 0.0002 (XRP Overview Your Questions About XRP, Answered 2022). The total XRP supply is 100 billion coins, with more than XRP 50 billion in the circulating supply until December 2022 (XRP Price Today, XRP to USD Live, Marketcap and Chart 2022). In this fixed supply model, XRP is burnt to pay fees for each transaction; thus, XRP is a deflationary cryptocurrency. Greater security risks due to trusted validators and the probability of dilution of XRP value, due to the sudden release of large quantities of XRP, have been a matter of concern. Moreover, the U.S. Securities and Exchange Commission (SEC) has sued Ripple for not registering XRP with the agency and illegally selling XRP as security (SEC Charges Ripple and Two Executives with Conducting $1.3 Billion Unregistered Securities Offering 2020).

Table 1. Comparison between Ripple and Stellar.

	Ripple	**Stellar**
Cryptocurrency	XRP	XLM
Model	Deflationary	Inflationary
Governance	Centralized	Decentralized
Network	Permissioned	Permissionless
Consensus Protocol	Ripple Consensus Protocol	Stellar Consensus Protocol
Consensus Mechanism	Probabilistic Voting	A decentralized version of Practical Byzantine Fault Tolerance
Target Group	Bank and financial institutions	Individuals
Target Market	International Bank Transfer	Micro Payments, Remittances
Focused on	Improving international transactions among financial institutions	Inexpensive financial services for people in the developing nation
Organization	Profit-driven	Non-profit driven

Stellar, a non-profit organization, provides economic remittance services to individuals on a publicly owned, decentralized, open-source network. Anyone can become a participant in this network. The decentralized governance model of Stellar makes it free from censorship. Stellar Consensus Protocol is a federated voting mechanism where each core node has a quorum set with a predefined threshold for consensus. Money transfer in this network is facilitated via its own cryptocurrency named Lumen (XLM). Currency exchange is facilitated either by the exchange rates on Stellar Decentralized Exchange or through a market maker. Transactions on Stellar are completed in 3–5 s (Run a Core Node Overview 2022). At the time of release in 2014, XLM 100 billion were created and an inflationary mechanism to increase the supply of XLM by 1% annually was adopted. In 2019, the XLM supply was reduced by burning XLM and limiting the existence of XLM to 50 billion, out of which around 30 billion is administered by Stellar Development Foundation (SDF) (Lumens-Stellar 2022). SDF, thus, arguably controls the entire network. Furthermore, Stellar has merely 53 validator nodes and around 42 full nodes as of September 2022 (Stellar Network Visibility 2022). Furthermore, Kim et al. inferred that the failure of two nodes controlled by SDF could result in a cascading failure of the entire network (Kim et al. 2019). Coincidentally, on 15 May 2019, a mass outage of the nodes belonging to the SDF resulted in the halting of the Stellar network for 67 min, as it could not reach a consensus (Stellar Development Foundation 2019).

Based on the above discussion, it can be inferred that blockchain-based remittance provides a better solution than traditional remittances in many ways, including cheaper fees, faster processing time, and better customer experience. As per the report from PYMNTS and the Stellar Development Foundation (The Digital Currency Shift—September 2021 2023), cryptocurrencies are used by almost 25% of US cross-border remittances, as instant real-time payment is completed without any intermediaries at low cost.

However, blockchain-based remittances lack true decentralization. Thus, there arises a need for a remittance solution that is truly decentralized and secure while ensuring scalability, providing economical service, and being compliant with regulatory policies.

5. Conceptual Framework

To explore the true potential of blockchain for remittances, this paper identifies a set of requirements for blockchain-based remittance solutions.

1. True Decentralization: Since the dependence on foundation-driven nodes for validation and consensus reduces the security and availability of the network, a truly decentralized network is the next big challenge.
2. Scalability: Given the demand for massive remittance transactions worldwide, a scalable protocol to reduce transaction processing time and fees is required
3. Interoperability: Amalgamating across borders through cross-blockchain communications to facilitate seamless remittances.
4. Digital Fingerprint: A unified digital identity recognized globally across blockchain networks, banks, and financial institutions.
5. Wide Alternatives: Use of cryptocurrencies, stablecoins, or central bank digital currencies as an intermediary currency.

This research proposes a conceptually novel approach of sending and receiving remittances that include digital assets, novel payment infrastructure, and new types of remittance services. The development of blockchain-based cross-border payments offers opportunities for reducing the cost and efficient gains in remittances. A blockchain-based remittance system where the transaction records are secured, transparent, traceable, and immutable through the use of L1X blockchain technology is the focus of this paper. The two main research areas are (i) the adoption of L1X blockchain scalability and interoperability technology for remittances and (ii) the development of fund transfer solutions on the L1X blockchain. Design science research methodology will be used in this research, focusing on the development and validation of artifacts in the blockchain-based cross-border payment platform. The research paradigm intends to improve the functional performance of the artifacts including the protocols, smart contracts, models, and platform.

L1X blockchain will be able to map and store information onto the computational model for the mobile-enabled devices allowing for cache threading and execution on a real-time basis, whilst the decentralized application provides synchronous finality. L1X scaling solution will have the following features: (i) mobile computational dependency, (ii) computational pool sharing, using the ability to use computationally based random delivery networks, and (iii) roll-ups using computational groups and full node threading. L1X's interoperable solution includes innovativeness by implementing flash contracts, nucleus scripting, data synchronization, and locker technologies. Flash contracts are the process of automating the decentralized pool allocation through the identification of participants and execution of the transaction. Nucleus scripting comprises the scripts that run through sharding and can transmit the updated state to the network. Synchronization of data and keeping a history of changes are critical for maintaining a secure and decentralized record of transactions. Locking assets allows the global state of the blockchain to be maintained.

Four main focuses of L1X blockchain technology for remittances will be created and a cross-border payment platform on L1X blockchain will be developed (i) enabling direct cross-border transactions in cryptocurrencies or stable coins, (ii) enabling fiat currency transfer by utilizing cryptocurrencies or stablecoins as a bridge asset, (iii) utilizing L1X blockchain for onboarding process requirements, and (iv) utilizing L1X blockchain technology for real-time settlement.

Figure 8 depicts the conceptual framework for L1X blockchain-powered remittances. Cross-border payment solutions will be developed to incorporate various needs of the remittance economy. L1X blockchain is utilized as an underlying technology to enable

direct cross-border transactions. A channel will be developed for customer acquisition and servicing for remittances. A user initiates transactions via the channel using a crypto/bank card or Near Field Communication mobile on a Point-of-Sale terminal or mobile app/website. The transactions can flow in two ways: (i) from the sender's fiat currency to cryptocurrency and from the cryptocurrency to the recipient's fiat currency or (ii) from cryptocurrency to cryptocurrency. For the former way, a bridge protocol will be developed to allow the use of intermediary currency to facilitate remittances.

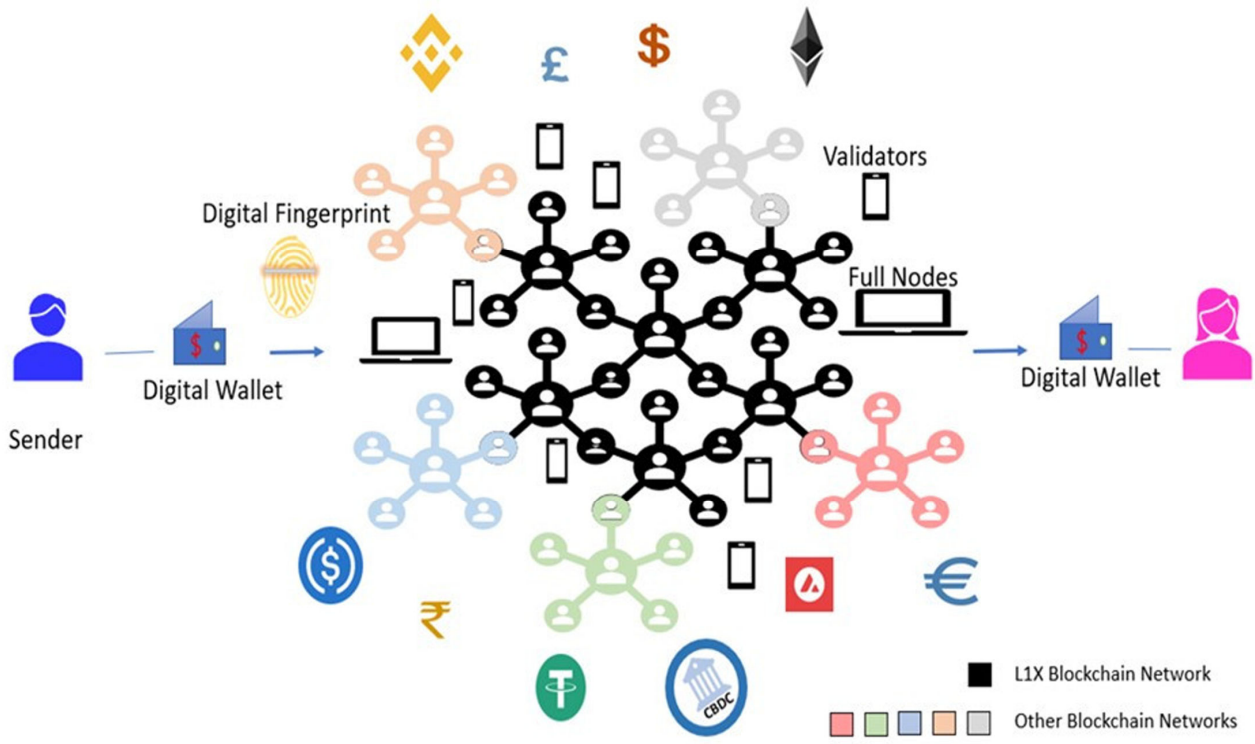


Figure 8. L1X conceptual framework.

L1X scalability protocol will be implemented aiming to improve transaction processing time and reduce transaction fees while keeping decentralization and security uncompromised. L1X blockchain performance is aimed to scale at least to 50,000 transactions per second, create a block within 500 milliseconds, and set a finality transaction cost at USD 0.00001 with more than 10,000 validating mobile nodes. Given the target performance, L1X scalability technology will be able to expedite settlement to real time or nearly real time for cross-border payments. The payments do not require any intermediary or third-party financial services, thus reducing remittance costs significantly.

L1X framework has been developed to farm mobile devices for its decentralized computation pool. This enables L1X to deliver dramatic improvements in transactional finality. L1X will implement a two-stage transaction validation process. Stage 1 consists of full nodes that can participate in consensus by staking L1X coins. Nodes can delegate the voting power to another full node for transaction validation. Stage 2 consists of validator nodes that can participate in the consensus as a random member of the dynamic group. L1X will allow every node to participate in transaction validation and the consensus mechanism. Any device with two CPUs' processing power and 2GB RAM storage capacity can participate in the L1X blockchain network consensus as a validator. The participation of a large number of mobile nodes as validators would restrict malicious users to approve fake transactions or reject valid transactions. Furthermore, validators will be rewarded for each transaction validation. Thus, enormous participation through mobile devices will make the L1X blockchain network truly decentralized while facilitating scalability and ensuring security.

L1X interoperability protocol will be implemented to manage a cross-blockchain applicable wallet system that will integrate and exchange values between different wallets without deploying the smart contract against every action that the user makes. This will allow users to authenticate transactions without transferring and changing the native global state. L1X will provide a single multi-blockchain wallet mechanism for users to access the cryptocurrency landscape. Customers set up a wallet to hold digital assets enabling payment, allowing customers to send and receive cryptocurrencies or stablecoins, store and manage account keys, and connect to decentralized network platforms. Different digital assets will be standardized to facilitate the identification of the digital assets. Hence, L1X universal wallets would reduce the transaction fee during the payment process and be able to accept, pay, and interoperate multiple digital assets. However, the interoperability to support the exchange of various fiat currencies will serve as a challenge to be countered during implementation. The industry partners will be interested in the implementation of this proposal as a surge is observed in the alternatives to traditional methods of remittances in order to avoid high processing fees and longer processing times.

Digital fingerprint technology will be developed and used as smart identity proof which can support onboarding and KYC verification processes. L1X blockchain manages digital identities using cryptography as the key principle for data security and privacy. Given that the digital fingerprint is securely stored in the L1X blockchain, the core KYC verification process is conducted only once, to correspond with anti-money laundering and terror financing compliance checks. By shortening and streamlining the process by utilizing L1X blockchain technology, the remittance market would have efficiency improvements, cost reduction, superior customer experience, and greater transparency throughout the onboarding process.

Outcomes from the previous developments will be integrated into a blockchain-based remittance platform. The smart contract protocol is leveraged to fingerprint all the transaction points and standardize transactions into a single object that can be recognized across multiple blockchain networks. The blockchain-based remittance platform consists of three elements including customer identification, digital asset identification, and its transfer to and from wallets and ledgers.

The blockchain-based remittance platform and its ecosystem will be assessed in an iterative validating process. The outcomes from every step will be assessed. Assessment criteria and hypotheses will be developed for example on the acceptance, transaction fingerprints, customer journey fingerprints, payment experience, and platform elements. Platform evaluation will be conducted to strengthen the knowledge base, effectiveness, and evolution that is driven toward commercialization development. This proposal represents a novel approach to enable blockchain-based remittance using L1X technology that provides enormous opportunities for the financial services industry and global trade.

5.1. Prominent Features of Proposed Framework

While keeping the most important features of blockchain—decentralization and security—uncompromised, L1X blockchain will provide a scalable and interoperable solution. L1X blockchain will be adopted and tested for production-ready P2P transfer services. Prominent features of the proposed framework are as follows:

1. Blockchain-based cross-border payment architecture and framework, incorporating various needs of the remittance economy on L1X blockchain;
2. L1X blockchain-powered payment solution (utilizing L1X scalable and interoperable solutions) that will improve transaction processing time and reduce transaction fees while keeping decentralization and security uncompromised;
3. A digital wallet mechanism and cross-border payment channel that accepts, pays, and interoperates with multiple digital assets;

4. Blockchain-based remittances that allow transfers using cryptocurrencies or stablecoins;
5. An interoperable protocol that allows the use of intermediary currency in the background to facilitate remittances;
6. Utilizing L1X technology to store digital fingerprints, enabling identification applicable to KYC for onboarding requirements.

5.2. Novel Features of Proposed Framework

The proposed solution institutes several novel features to achieve true decentralization and scalability for blockchain-based remittances. Any device with configuration as low as 2 CPU power and 2GB RAM can participate as a validator in the L1X blockchain network. This helps achieve true decentralization as dynamic selection of the mobile-enabled devices in random groups restricts malicious activities of the ill-intended users. The large availability of mobile-devices for computational dependency allows the network to scale rapidly. Nucleus scripting and flash contracts are other novel features used in L1X to realize interoperability. The L1X interoperability allows for a universal cross-blockchain wallet mechanism. Thus, L1X-based remittances has many novel features as summarized in this section.

5.3. Contribution of Proposed Framework

The proposed framework makes a significant contribution towards the true decentralization of the blockchain network. Mobile-enabled validation opens the door for larger user participation as validators, enabling synchronous finality and scalability. The standardization of digital assets and transparent customer onboarding process enable an L1X universal cross-blockchain wallet user to make real-time settlements for remittances at high speed and low cost.

6. Conclusions

The major distributed ledger technology blockchain holds a lot of promise for the remittance industry. To ensure the viability of blockchain-based global remittances, the economic, legal, and regulatory aspects need to be investigated. This paper investigates and examines the economic aspects of the remittance industry. Cross-border payments heavily rely on numerous intermediaries making payments and settlements slower and remittances expensive. Blockchain-based remittance solutions remove intermediaries while reducing costs, but they lack consensus security due to the high dependency on foundation-operated nodes for transaction validation. In this paper, a proposal is presented that aims to offer true decentralization for blockchain-powered remittance solutions by enabling mobile node validation. The proposed framework will support remittances over multi-currencies and multi-cryptocurrencies in a secure, scalable, and interoperable L1X network. L1X's interoperable contract connecting cross-homogeneous chains and heterogeneous blockchains along with L1X universal wallets would result in cheaper remittance services. Since this is a continuing project, the work will be developed as proposed. We are in the process of developing the L1X blockchain network to facilitate remittances that are truly decentralized, fast, and economical.

Author Contributions: Conceptualization and Design, K.C., N.K., and P.W.; writing—original draft preparation and editing, N.K.; writing—review, P.W.; writing—revision, N.K. and P.W.; supervision, PW. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: This research has no data.

Conflicts of Interest: The authors declare no conflict of interest.

References

(About MoneyGram International, Inc. 2022) About MoneyGram International, Inc. 2022. MoneyGram. Available online: https://corporate.moneygram.com/about-moneygram (accessed on 20 September 2022).

(Andoni et al. 2019) Andoni, Merlinda, Valentin Robu, David Flynn, Simone Abram, Dale Geach, David Jenkins, Peter McCallum, and Andrew Peacock. 2019. Blockchain Technology in the Energy Sector: A Systematic Review of Challenges and Opportunities. *Renewable and Sustainable Energy Reviews* 100: 143–74. https://doi.org/10.1016/j.rser.2018.10.014.

(Anti-Money Laundering Principles for Correspondent Banking 2014) Anti-Money Laundering Principles for Correspondent Banking. 2014. The Wolfsberg Group. Available online: https://www.wolfsberg-principles.com/sites/default/files/wb/Wolfsberg-Correspondent-Banking-Principles-2014.pdf (accessed on 20 September 2022).

(Ardic et al. 2022) Ardic, Oya, Hemant Baijal, Patrizia Baudino, Nana Yaa Boakye-Adjei, Jonathan Fishman, and Richard Audu Maikai. 2022. The Journey So Far: Making Cross Border Remittances Work for Financial Inclusion. Bank for International Settlements 2022, World Bank Group. June. Available online: https://www.bis.org/fsi/publ/insights43.pdf (accessed on 20 September 2022).

(Azzi et al. 2019) Azzi, Rita, Rima Kilany Chamoun, and Maria Sokhn. 2019. The Power of a Blockchain-Based Supply Chain. *Computers & Industrial Engineering* 135: 582–92. https://doi.org/10.1016/j.cie.2019.06.042.

(Beck and Pería 2011) Beck, Thorsten, and María Soledad Martínez Pería. 2011. What Explains the Price of Remittances? An Examination Across 119 Country Corridors. *The World Bank Economic Review* 25: 105–31. https://doi.org/10.1093/wber/lhr017.

(Become a Western Union Agent 2022) Become a Western Union Agent. 2022. Western Union Money Transfer. Available online: https://www.westernunion.com/li/en/become-agent.html (accessed on 20 September 2022).

(Bermeo-Almeida et al. 2018) Bermeo-Almeida, Oscar, Mario Cardenas-Rodriguez, Teresa Samaniego-Cobo, Enrique Ferruzola-Gómez, Roberto Cabezas-Cabezas, and William Bazán-Vera. 2018. Blockchain in Agriculture: A Systematic Literature Review. In *Technologies and Innovation.* Edited by Rafael Valencia-García, Gema Alcaraz-Mármol, Javier Del Cioppo-Morstadt, Néstor Vera-Lucio and Martha Bucaram-Leverone. Communications in Computer and Information Science. Cham: Springer International Publishing, pp. 44–56. https://doi.org/10.1007/978-3-030-00940-3_4.

(BitPesa|Africa's Crypto and BTC Exchange—Access the Deepest BTC Liquidity in Africa 2022) BitPesa|Africa's Crypto and BTC Exchange—Access the Deepest BTC Liquidity in Africa. 2022. Available online: https://www.bitpesa.co/ (accessed on 20 September 2022).

(Bitspark's Bankless Ecosystem 2023) Bitspark's Bankless Ecosystem. 2023. Bitspark ZEPH. Available online: https://whitepaper.io/document/486/bitspark-whitepaper (accessed on 20 September 2022).

(Bodkhe et al. 2020) Bodkhe, Umesh, Sudeep Tanwar, Karan Parekh, Pimal Khanpara, Sudhanshu Tyagi, Neeraj Kumar, and Mamoun Alazab. 2020. Blockchain for Industry 4.0: A Comprehensive Review. *IEEE Access* 8: 79764–800. https://doi.org/10.1109/ACCESS.2020.2988579.

(Brilliantova and Thurner 2019) Brilliantova, Vlada, and Thomas Wolfgang Thurner. 2019. Blockchain and the Future of Energy. *Technology in Society* 57: 38–45. https://doi.org/10.1016/j.techsoc.2018.11.001.

(Chase and MacBrough 2018) Chase, Brad, and Ethan MacBrough. 2018. Analysis of the XRP Ledger Consensus Protocol. Ripple Research. *arXiv*. Available online: https://arxiv.org/pdf/1802.07242.pdf (accessed on 20 September 2022).

(Coins.Ph 2023) Coins.Ph. 2023. Available online: https://coins.ph/ (accessed on 20 March 2023).

(De 2020) De, Nikhilesh. 2020. Bitspark Fades Out Following COO Maxine Ryan's Departure. Available online: https://www.coindesk.com/markets/2020/02/04/bitspark-fades-out-following-coo-maxine-ryans-departure/ (accessed on 20 September 2022).

(Demestichas et al. 2020) Demestichas, Konstantinos, Nikolaos Peppes, Theodoros Alexakis, and Evgenia Adamopoulou. 2020. Blockchain in Agriculture Traceability Systems: A Review. *Applied Sciences* 10: 4113. https://doi.org/10.3390/app10124113.

(Deng 2020) Deng, Qing. 2020. Application Analysis on Blockchain Technology in Cross-Border Payment. In *Advances in Economics, Business and Management Research*. Amsterdam: Atlantis Press SARL, vol. 126, pp. 287–95. https://doi.org/10.2991/aebmr.k.200306.050.

(Distributed Ledger Technology and Blockchain 2017) Distributed Ledger Technology and Blockchain. 2017. World Bank Group. Available online: https://documents1.worldbank.org/curated/en/177911513714062215/pdf/122140-WP-PUBLIC-Distributed-Ledger-Technology-and-Blockchain-Fintech-Notes.pdf (accessed on 20 September 2022).

(Dorri et al. 2017) Dorri, Ali, Salil S. Kanhere, and Raja Jurdak. 2017. Towards an Optimized BlockChain for IoT. In *Proceedings of the Second International Conference on Internet-of-Things Design and Implementation*. Pittsburgh: ACM, pp. 173–78. https://doi.org/10.1145/3054977.3055003.

(FAQ Your Questions About XRPL, Answered 2022) FAQ Your Questions About XRPL, Answered. 2022. XRP. Available online: https://xrpl.org/faq.html (accessed on 20 September 2022).

(Fernández-Caramés and Fraga-Lamas 2019) Fernández-Caramés, Tiago M., and Paula Fraga-Lamas. 2019. A Review on the Application of Blockchain to the Next Generation of Cybersecure Industry 4.0 Smart Factories. *IEEE Access* 7: 45201–18. https://doi.org/10.1109/ACCESS.2019.2908780.

(Flore 2018) Flore, Massimo. 2018. *How Blockchain-Based Technology Is Disrupting Migrants' Remittances: A Preliminary Assessment*. EUR 29492 EN vols. JRC Publications Repository JRC113484. Luxembourg: Publications Office of the European Union. Available online: https://publications.jrc.ec.europa.eu/repository/handle/JRC113484 (accessed on 20 September 2022).

(Future of Cross-Border Payments: Blockchain Remittance Explained 2022) Future of Cross-Border Payments: Blockchain Remittance Explained. 2022. Liquid-Technology, Industry (blog). Available online: https://blog.liquid.com/remittance-blockchain-crypto#TheProblemswiththeCurrentRemittanceChannels (accessed on 20 September 2022).

(General Principles for International Remittance Services 2007) General Principles for International Remittance Services. 2007. Committee on Payment and Settlement Systems, The World Bank. Available online: https://www.bis.org/cpmi/publ/d76.pdf (accessed on 20 September 2022).

(Hasselgren et al. 2020) Hasselgren, Anton, Katina Kralevska, Danilo Gligoroski, Sindre A. Pedersen, and Arild Faxvaag. 2020. Blockchain in Healthcare and Health Sciences—A Scoping Review. *International Journal of Medical Informatics* 134: 104040. https://doi.org/10.1016/j.ijmedinf.2019.104040.

(Hölbl et al. 2018) Hölbl, Marko, Marko Kompara, Aida Kamišalić, and Lili Nemec Zlatolas. 2018. A Systematic Review of the Use of Blockchain in Healthcare. *Symmetry* 10: 470. https://doi.org/10.3390/sym10100470.

(Howarth 2022) Howarth, Josh. 2022. How Many Cryptocurrencies Are There In 2023? *Exploding Topis* (blog). Available online: https://explodingtopics.com/blog/number-of-cryptocurrencies (accessed on 30 November 2022).

(International Money Transfer—Send Money Online|WorldRemit 2022) International Money Transfer—Send Money Online|WorldRemit. 2022. WorldRemit. Available online: https://www.worldremit.com/en (accessed on 20 September 2022).

(International Money Transfers, Western Union India 2022) International Money Transfers, Western Union India. 2022. Western Union Money Transfer. Available online: https://www.westernunion.com/in/en/home.html (accessed on 20 September 2022).

(Jain et al. 2018) Jain, Rajeev, Dhirendra Gajbhiye, and Soumasree Tewari. 2018. Globalising People: India's Inward Remittances in 2016–2017. Division of International Finance, Department of Economic and Policy Research (DEPR), Reserve Bank of India. Available online: https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/1AR_14112018071B9474B5D74DDC91FC8AA015C5A360.PDF (accessed on 20 September 2022).

(Kaarmann 2021) Kaarmann, Kristo. 2021. Modern Slavery and Human Trafficking Statement for Wise. WISE. Available online: https://wise.com/public-resources/assets/public-navigation/modern_slavery_statement.pdf (accessed on 20 September 2022).

(Kagan 2022) Kagan, Julia. 2022. What Is a Wire Transfer? How It Works, Safety, and Fees. *Investopedia*, August 17. Available online: https://www.investopedia.com/terms/w/wiretransfer.asp (accessed on 20 September 2022).

(Kim et al. 2019) Kim, Minjeong, Yujin Kwon, and Yongdae Kim. 2019. Is Stellar As Secure As You Think? In *2019 IEEE European Symposium on Security and Privacy Workshops (EuroS&PW)*. Stockholm: IEEE, pp. 377–85. https://doi.org/10.1109/EuroSPW.2019.00048.

(Know Your Customer Surveys Reveal Escalating Costs and Complexity 2016) Know Your Customer Surveys Reveal Escalating Costs and Complexity. 2016. Thomson Reuters. Available online: https://www.thomsonreuters.com/en/press-releases/2016/may/thomson-reuters-2016-know-your-customer-surveys.html (accessed on 20 September 2022).

(Lu 2022) Lu, Cindy. 2022. Cryptocurrency and Digital Assets: A Positive Tool for Economic Growth in Developing Countries. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4177415.

(Lumens-Stellar 2022) Lumens-Stellar. 2022. Stellar. Available online: https://stellar.org/lumens (accessed on 20 September 2022).

(McGhin et al. 2019) McGhin, Thomas, Kim-Kwang Raymond Choo, Charles Zhechao Liu, and Debiao He. 2019. Blockchain in Healthcare Applications: Research Challenges and Opportunities. *Journal of Network and Computer Applications* 135: 62–75. https://doi.org/10.1016/j.jnca.2019.02.027.

(Money without Borders. Annual Report and Accounts 2022 2022) Money without Borders. Annual Report and Accounts 2022. 2022. Annual Report. Wise. Available online: https://lienzo.s3.amazonaws.com/images/2aeb66e27009d06acbd6f46f746feae2-WIS001_Book.pdf (accessed on 20 September 2022).

(Moos 2020) Moos, Mitchell. 2020. Is XRP Decentralized? Ripple's Involvement in the Cryptocurrency. *Crypto Briefing* (blog). March 31. Available online: https://cryptobriefing.com/is-xrp-decentralized-ripples-involvement-cryptocurrency/ (accessed on 20 September 2022).

(Nakamoto 2019) Nakamoto, Satoshi. 2019. *The White Paper*. Edited by Ben Vickers. IGNOTA. Available online: https://ignota.org/products/the-white-paper (accessed on 20 September 2022).

(Panarello et al. 2018) Panarello, Alfonso, Nachiket Tapas, Giovanni Merlino, Francesco Longo, and Antonio Puliafito. 2018. Blockchain and IoT Integration: A Systematic Survey. *Sensors* 18: 2575. https://doi.org/10.3390/s18082575.

(Products and Services 2022) Products and Services. 2022. MoneyGram. Available online: https://corporate.moneygram.com/products-and-services (accessed on 20 September 2022).

(Qiu et al. 2019) Qiu, Tianyi, Ruidong Zhang, and Yuan Gao. 2019. Ripple vs. SWIFT: Transforming Cross Border Remittance Using Blockchain Technology. In *Procedia Computer Science, Science Direct*. Amsterdam: Elsevier, vol. 147, pp. 428–34. https://doi.org/10.1016/j.procs.2019.01.260.

(Queiroz et al. 2019) Queiroz, Maciel M., Renato Telles, and Silvia H. Bonilla. 2019. Blockchain and Supply Chain Management Integration: A Systematic Review of the Literature. *Supply Chain Management: An International Journal* 25: 241–54. https://doi.org/10.1108/SCM-03-2018-0143.

(Ratha et al. 2022) Ratha, Dilip, Eung Ju Kim, Sonia Plaza, Elliott Riordan, and Vandana Chandra. 2022. Migration and Development Brief 36: A War in a Pandemic: Implications of the Russian Invasion of Ukraine and the COVID-19 Crisis on Global Governance of Migration and Remittance Flows. KNOMAD-World Bank. Available online: https://www.knomad.org/publication/migration-and-development-brief-36 (accessed on 20 September 2022).

(Rebit—Crunchbase Company Profile & Funding n.d.) Rebit—Crunchbase Company Profile & Funding. n.d. Crunchbase. Available online: https://www.crunchbase.com/organization/rebit-2 (accessed on 20 March 2023).

(Rebit.Ph 2023) Rebit.Ph. 2023. Tracxn. Available online: https://tracxn.com/d/companies/rebit.ph/__n4cHrmD3KFLuyjrcjW3CSCTsTTVP4i1auTObd8sFnY0 (accessed on 20 March 2023).

(Recent Trends in Correspondent Banking Relationships: Further Considerations 2017) Recent Trends in Correspondent Banking Relationships: Further Considerations. 2017. IMF. Available online: https://www.imf.org/en/Publications/Policy-Papers/Issues/2017/04/21/recent-trends-in-correspondent-banking-relationships-further-considerations (accessed on 20 September 2022).

(Reducing Remittance Fees 2005) Reducing Remittance Fees. 2005. *Global Economic Prospects 2006*. World Bank. Available online: https://documents1.worldbank.org/curated/fr/507301468142196936/841401968_200510319014045/additional/Global-economic-prospects-2006-economic-implications-of-remittances-and-migration.pdf (accessed on 20 September 2022).

(Rella 2019) Rella, Ludovico. 2019. Blockchain Technologies and Remittances: From Financial Inclusion to Correspondent Banking. *Frontiers*, *Frontiers in Blockchain* 2: 14. https://doi.org/10.3389/fbloc.2019.00014.

(Remittance Flows Register Robust 7.3 Percent Growth in 2021 2021) Remittance Flows Register Robust 7.3 Percent Growth in 2021. 2021. Text/HTML. World Bank. Available online: https://www.worldbank.org/en/news/press-release/2021/11/17/remittance-flows-register-robust-7-3-percent-growth-in-2021 (accessed on 20 September 2022).

(Remittance Market: Global Opportunity Analysis and Industry Forecast, 2019–2026 2020) Remittance Market: Global Opportunity Analysis and Industry Forecast, 2019–2026. 2020. Allied Market Research. April. Available online: https://www.alliedmarketresearch.com/remittance-market (accessed on 20 September 2022).

(Remittances Matter: 8 Facts You Don't Know about the Money Migrants Send Back Home 2019) Remittances Matter: 8 Facts You Don't Know about the Money Migrants Send Back Home. 2019. Organization. United Nations Department of Economic and Social Affairs. Available online: https://www.un.org/development/desa/en/news/population/remittances-matter.html (accessed on 20 September 2022).

(Ria Money Transfer—Send Money Online to Over 165 Countries Instantly 2022) Ria Money Transfer—Send Money Online to Over 165 Countries Instantly. 2022. Ria. Available online: https://app.riamoneytransfer.com/en-us/ (accessed on 20 September 2022).

(Rühmann et al. 2020) Rühmann, Friederike, Sai Aashirvad Konda, Paul Horrocks, and Nina Taka. 2020. Can Blockchain Technology Reduce the Cost of Remittances? OECD Development Co-Operation. Available online: https://www.oecd-ilibrary.org/docserver/d4d6ac8f-en.pdf?expires=1676616987&id=id&accname=guest&checksum=BCF1F8BD7F580120355A7683265D99FB#:~:text=The%20characteristics%20of%20Bitcoin%20enabling,systems%20including%20speed%20and%20cost (accessed on 20 September 2022).

(Run a Core Node Overview 2022) Run a Core Node Overview. 2022. Stellar. Available online: https://developers.stellar.org/docs/run-core-node (accessed on 20 September 2022).

(Sajja et al. 2021) Sajja, Guna Sekhar, Kantilal Pitambar Rane, Khongdet Phasinam, Thanwamas Kassanuk, Ethelbert Okoronkwo, and P. Prabhu. 2021. Towards Applicability of Blockchain in Agriculture Sector. *Materials Today: Proceedings*, August. https://doi.org/10.1016/j.matpr.2021.07.366.

(Scott 2016) Scott, Brett. 2016. How Can Cryptocurrency and Blockchain Technology Play a Role in Building Social and Solidarity Finance? *UNRISD*, February 10. Available online: https://www.unrisd.org/en/library/publications/how-can-cryptocurrency-and-blockchain-technology-play-a-role-in-building-social-and-solidarity-finan (accessed on 20 September 2022).

(SEC Charges Ripple and Two Executives with Conducting $1.3 Billion Unregistered Securities Offering 2020) SEC Charges Ripple and Two Executives with Conducting $1.3 Billion Unregistered Securities Offering. 2020. U.S. Securities and Exchange Commission. 2020. Available online: https://www.sec.gov/news/press-release/2020-338 (accessed on 20 September 2022).

(Sending Money from Tanzania to Kenya—Remittance Prices Worldwide 2021) Sending Money from Tanzania to Kenya—Remittance Prices Worldwide. 2021. Remittance Prices Worldwide. December. Available online: https://remittanceprices.worldbank.org/corridor/Tanzania/Kenya (accessed on 20 September 2022).

(Soufaih 2020) Soufaih, Amine. 2020. Revolutionizing the International Remittance Payment Industry Using Cryptocurrency and Blockchain-Based Technology. *Social Impact Research Experience (SIRE)*, 75. Available online: https://repository.upenn.edu/sire/75 (accessed on 20 September 2022).

(Stellar Development Foundation 2019) Stellar Development Foundation. 2019. May 15th Network Halt. *Stellar Developers* (blog). Available online: https://medium.com/stellar-developers-blog/may-15th-network-halt-a7b933103984. (accessed on 20 September 2022).

(Stellar Network Visibility 2022) Stellar Network Visibility. 2022. Stellarbeat. September. Available online: https://stellarbeat.io/?network=public. (accessed on 20 September 2022).

(Suki 2007) Suki, Lenora. 2007. Competition and Remittances in Latin America: Lower Prices and More Efficient Markets. Organization for Economic Cooperation and Development and Inter American Development Bank. Available online: https://www.oecd.org/daf/competition/prosecutionandlawenforcement/38821426.pdf (accessed on 20 September 2022).

(Swift—About Us 2023) Swift—About Us. 2023. Swift. Available online: https://www.swift.com/about-us (accessed on 17 February 2023).

(The Decline in Access to Correspondent Banking Services in Emerging Markets: Trends, Impacts, and Solutions 2018) The Decline in Access to Correspondent Banking Services in Emerging Markets: Trends, Impacts, and Solutions. 2018. Working Paper. Washington, DC: World Bank Group. https://doi.org/10.1596/29778.

(The Digital Currency Shift—September 2021 2023) The Digital Currency Shift—September 2021. 2023. PYMNTS. Available online: https://www.pymnts.com/study/the-cross-border-remittances-report-cryptocurrency-digital-payments/ (accessed on 20 March 2023).

(Uddin et al. 2021) Uddin, Md Ashraf, Andrew Stranieri, Iqbal Gondal, and Venki Balasubramanian. 2021. A Survey on the Adoption of Blockchain in IoT: Challenges and Solutions. *Blockchain: Research and Applications* 2: 100006. https://doi.org/10.1016/j.bcra.2021.100006.

(Wang and Su 2020) Wang, Qiang, and Min Su. 2020. Integrating Blockchain Technology into the Energy Sector—From Theory of Blockchain to Research and Application of Energy Blockchain. *Computer Science Review* 37: 100275. https://doi.org/10.1016/j.cosrev.2020.100275.

(What Cryptocurrencies Are Available on Coins.Ph? 2023) What Cryptocurrencies Are Available on Coins.Ph? 2023. Coins.Ph Help Center. Available online: https://support.coins.ph/hc/en-us/articles/900006877303-What-cryptocurrencies-are-available-on-Coins-ph- (accessed on 20 March 2023).

(WorldRemit About Us 2022) WorldRemit About Us. 2022. WorldRemit. Available online: https://www.worldremit.com/en/about-us (accessed on 20 September 2022).

(XRP Overview Your Questions About XRP, Answered 2022) XRP Overview Your Questions About XRP, Answered. 2022. XRP. Available online: https://xrpl.org/xrp-overview.html (accessed on 20 September 2022).

(XRP Price Today, XRP to USD Live, Marketcap and Chart 2022) XRP Price Today, XRP to USD Live, Marketcap and Chart. 2022. CoinMarketCap. Available online: https://coinmarketcap.com/currencies/xrp/ (accessed on 20 September 2022).

(XRPL Explorer|Network 2022) XRPL Explorer|Network. 2022. XRP. Available online: https://livenet.xrpl.org/network/nodes (accessed on 20 September 2022).

(Yen 2017) Yen, David. 2017. Blockchain-Based FX/Treasury Solution in Africa. *BitPesa*, October. Available online: http://www.gtreview.com/wp-content/uploads/2017/03/Classroom-style-breakout_How-is-technology-enabling-African-trade.pdf (accessed on 20 September 2022).