Safe Bank 3(100) 2025

DOI: 10.26354/bb.16.3.100.2025

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RippleNet as a Tool for Handling International Transfers

Abstract

Purpose: The article aims to evaluate RippleNet as a tool for processing cross-border payments, with particular emphasis on its ability to provide fast and predictable settlement, as well as its potential role in the modernization of global payment systems.

Problem and research method: Traditional models based on the SWIFT system, which serves only as a communication network and requires settlement within domestic payment infrastructures, are associated with high costs, low transparency, and long settlement times. In response to these limitations, blockchain technology has begun to be applied in cross-border payments. This study uses data from the public XRP Ledger (XRPL) to analyze settlement time, the structure and topology of the payment network, the concentration of activity, and transaction dynamics. The empirical findings are then combined with insights from the literature and presented in the form of a SWOT analysis.

Results: RippleNet enables quasi-instant settlement. The average transaction finalization time is 3.87 seconds, with maximum delays not exceeding 9 seconds. At the same time, network activity is highly concentrated, with a small number of nodes and communities accounting for the majority of transaction volume, as confirmed by the calculated Gini coefficient (0.969). The analysis shows that RippleNet functions in practice as a scale-free network, in which institutional hubs play a dominant role. The main benefits of the system include speed, cost reduction, and transparency, while key limitations involve regulatory risks and heavy reliance on a small group of dominant participants.

Conclusions: RippleNet demonstrates characteristics that make it an innovative solution for cross-border payments and a potential technological bridge in the context of CBDC integration. However, its broader adoption will depend on regulatory adaptation, addressing the problem of activity concentration, and the readiness of financial institutions to implement distributed settlement systems.

Keywords: Ripple, Blockchain, Cryptocurrency, Cross-border payments, XRP

JEL Codes: G21, E42, M15

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Introduction

Global economic interconnections result in the intensification of cross-border exchange, including financial flows, and in particular international money transfers, which for decades have been handled primarily through the SWIFT system. Although this system is considered a standard in banking, it has been criticized for its complexity, high cost, and low efficiency in terms of settlement time and transparency (Cipriani et al. 2023).

An alternative to SWIFT is blockchain-based solutions such as Ripple. It should be emphasized, however, that SWIFT is a communication system supporting cross-border payments but does not itself transfer value, whereas RippleNet simultaneously serves as both the communication and settlement layer through the use of the XRP Ledger. The RippleNet platform, utilizing the digital currency XRP, reorganizes the existing paradigm of international payments by providing near-instant transaction finality, cost reduction, and the elimination of intermediaries (Ahmadova and Erek 2022; Kaygin et al. 2021). Although Ripple is not the only project bridging the world of finance and blockchain technology, its implementation by more than 100 financial institutions and numerous partnerships with central banks make it an interesting research case (Islam et al. 2022; Hashemi Joo et al. 2020).

The technological foundation of Ripple is a decentralized ledger (XRP Ledger), which records all transactions and is updated by a network of validators using a consensus mechanism that is neither the classical "Proof of Work" nor "Proof of Stake," but a specifically designed Ripple consensus algorithm (Ripple doc, n.d.). As a result, Ripple can achieve high scalability and energy efficiency while maintaining data integrity (Hashemi Joo et al. 2020). Transactions on the network are verified and secured through the RPCA (Ripple Protocol Consensus Algorithm) consensus mechanism. Transaction confirmation is carried out by validating nodes. Any user may set up their own node within the network, however, it is the institution using the XRPL that determines which nodes will participate in the consensus process within its system. A transaction is confirmed when all nodes on the UNL (Unique Node List) that is, only those directly selected by the institution approve and broadcast the same set of transactions to the main ledger. At that point, the transaction is confirmed and recorded on the blockchain. This design of blockchain validation processes has significantly improved performance. According to developers, RippleNet's architecture allows for processing up to 50,000 transactions per second (Ripple doc, n.d.). However, the actual network activity remains significantly lower than its declared throughput (up to 50,000 TPS). This indicates that XRPL operates with a substantial performance reserve rather than at the limits of its technical capacity. Nevertheless, this speed is sufficient for global application in the financial services sector. The Ripple system also utilizes its native cryptocurrency, XRP, which serves as a bridge asset in transactions between two different currencies. XRP eliminates the need to maintain an account in the target currency and removes the necessity of involving correspondent banks (Ahmadova and Erek 2022).

Importantly, Ripple does not aim to exclude traditional financial institutions. It assumes cooperation with banks and integration with existing systems (Rosner and Kang 2015). Ripple is used, among others, in retail payments, remittances, and as a tool for optimizing liquidity in interbank settlements. This solution has attracted the interest of numerous financial institutions worldwide, and its partner network includes commercial banks, fintech companies, and payment system operators (Ripple, n.d.-b).

The purpose of this article is to evaluate RippleNet as a tool for handling international money transfers. The study includes the measurement of transaction finalization speed, the analysis of the dynamics of volumes and the number of operations, the assessment of the topology of the payment network (including the identification of hubs and communities), and the degree of concentration of value flows between participants. The obtained results are compared with the findings from the literature review, and the entire analysis is presented in the form of a SWOT framework, which allows for a comprehensive assessment of both the strengths and weaknesses of RippleNet, as well as the external opportunities and threats to its further implementation

Research Methodology

The conducted empirical study is based on the analysis of transactional data derived from the public XRP Ledger (XRPL), which constitutes the technological foundation of RippleNet's operation. Unlike traditional payment databases, the XRPL is a distributed ledger, meaning that each block (so-called ledger) contains complete information about account balances and the set of approved transactions.

The source data were obtained directly from the XRPL using proprietary C++ code developed on the basis of the open-source GetLedger project but significantly modified to enable the automatic retrieval of a larger volume of data. While the original solution allowed for downloading only a single specified ledger, the implemented modifications made it possible to iteratively retrieve entire ledgers (based on the *complete_ledgers* value) and to save only those records that contained actual transactions. The data were stored in JSON files including ledger headers and detailed transaction information.

In the next step, the collected sample comprising 1,000 ledgers retrieved on August 29, 2025, was processed using a fully proprietary analytical script written in Python. This script enabled transaction parsing, data structure construction, and the calculation of key quantitative indicators in three main areas: payment network topology, transaction value distribution, and flow dynamics.

The first stage of the analysis involved loading raw data containing information on *Payment*-type transactions that is, actual value transfers between addresses within the network. From these data, an event table was constructed, including sender and receiver identifiers, transaction value in XRP, transaction fees, and timestamps.

The second stage of the study involved network analysis. In line with the approach of network economics, XRPL participants were treated as nodes in a directed graph, while transactions were represented as edges connecting the sender and the receiver. For each node, basic degree measures were calculated (in-degree, out-degree, and total degree). To capture the social structure of the network, the Louvain algorithm was applied, allowing for the identification of communities of nodes with stronger internal connections. The next area of analysis concerned transaction value characteristics. Particular attention was given to the concentration of activity, i.e., assessing what portion of the total payment volume was attributed to the largest participants. For this purpose, volume shares were calculated for the top-N group of nodes (N = 1, 5, 10). Additionally, the concentration distribution was visualized using the Lorenz curve and the Gini coefficient, which made it possible to assess the degree of inequality in the distribution of activity among participants. The third area of the study focused on temporal analysis. For each ledger, the number of transactions and their total volume in XRP were calculated, which enabled the construction of time series describing network activity and the identification of periods of increased load.

The results were presented in the form of a SWOT analysis, which integrated both the author's own research findings and information obtained from the literature review on RippleNet. This combination made it possible not only to provide a synthetic overview of the strengths and weaknesses of the Ripple network but also to identify the opportunities and threats arising from its development and implementation potential in the financial sector.

The analytical methods employed were selected to enable an assessment of the Ripple network from the perspective of its suitability as an infrastructure for handling international money transfers. Topological analysis allows for the identification of nodes of central importance that play a dominant role in the structure of the transactional network. The analysis of transaction values and concentration makes it possible to evaluate whether the network fosters distributed competition or exhibits monopolistic tendencies. Meanwhile, temporal analysis provides insight into the system's dynamics and its capacity to handle flows under varying load conditions.

Literature Review

In response to the limitations of the traditional cross-border payment model, blockchain-based solutions have begun to emerge. One of the most recognizable projects in this area is Ripple – a system designed to improve global financial transfers while maintaining compliance with regulatory requirements (Kaygin et al. 2021). Ripple uses its own communication protocol (Ripple Protocol, also known as RTXP – Ripple Transaction Protocol), which enables the instant transfer of value in various currencies, both fiat and digital. The RippleNet network allows transactions to be settled within a few seconds, which represents a significant advantage over systems based on SWIFT (Qiu et al. 2019; Islam et al. 2022).

One of the most frequently cited cases of RippleNet implementation is the Spanish bank Santander, which deployed the One Pay FX application enabling fast international transfers for retail customers in selected European and South American countries (Ahmadova and Erek 2022) and benefits from its advantages. In Asia, a significant role is played by the Japanese financial group SBI Holdings, which not only uses RippleNet to execute transfers but also co-founded with Ripple a joint venture SBI Ripple Asia. Within this collaboration, an interbank payment system is being implemented in Japan and South Korea (Ahmadova and Erek 2022). Another example is IndusInd Bank from India, which adopted Ripple technology to improve cross-border services for corporate and institutional clients (Kaygin et al. 2021).

The implementation of RippleNet most often takes place in a pilot form or within a limited geographical scope. Financial institutions test RippleNet in selected currency corridors, such as between Asia and Latin America, in order to assess its efficiency and compatibility with existing back-office systems (Xia and Wang 2022). In many cases, this is not a complete replacement of existing solutions but rather a complement to them, particularly in the area of high-frequency or low-value settlements. Available information suggests that the greatest benefits from implementing RippleNet are achieved by institutions operating in regions with underdeveloped payment infrastructure, as well as by companies providing remittance services, where speed and cost are key factors for competitiveness.

The literature also highlights the potential of RippleNet as a solution that could support the future integration of central bank digital currencies (CBDCs). Owing to the transparency of the XRPL and the public recording of all transactions, the system can facilitate regulatory oversight and auditing, which constitutes a significant advantage in designing financial infrastructure that complies with legal requirements. Authors also point out that the use of RippleNet is not limited solely to the banking sector. It is increasingly attracting the interest of non-bank institutions, such as money transfer companies, for which low costs and transaction speed are key factors. At the same time, the lack of a clear legal status for XRP in many jurisdictions indicates the need for close cooperation with regulators as a prerequisite for the further expansion of RippleNet (Adrian et al. 2023). Meanwhile, a World Bank report indicates that the development of cross-border applications of CBDCs may significantly reduce costs and shorten settlement times; however, its success will depend on international coordination and regulatory harmonization (World Bank 2021).

Research Results

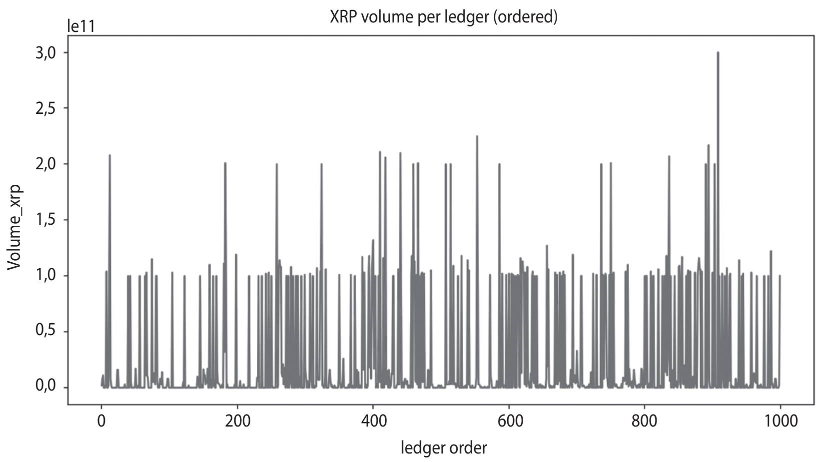
The conducted empirical analysis of the XRPL made it possible to assess the structure and dynamics of the Ripple network from three perspectives: transaction volume, payment network topology, and the distribution of value and concentration of activity. The results indicate clear centralization tendencies, an uneven distribution of activity among participants, and the occurrence of periods with significant intensity of flows.

Transaction Finalization Time

In the Ripple network, the process of closing a block (ledger close) is equivalent to transaction finalization—upon its completion, all operations recorded within it acquire a final status and cannot be reversed. Data on the rhythm of consecutive ledger closures in the XRPL show that the RippleNet network is characterized by a highly stable and predictable block finalization mechanism. In a sample of 999 observations, the average time between consecutive ledgers was 3.87 seconds, with a median of 1 second. The percentile values confirm this regularity: the 90th, 95th, and 99th percentiles all reach the same level of 9 seconds, which means that even during peak network load, the finalization time did not exceed this limit. The minimum recorded interval was 1 second, and the maximum was also 9 seconds. Such a narrow distribution of ledger closure intervals indicates high predictability and a deterministic nature of the XRPL consensus process. In the context of payment applications, this means that RippleNet provides quasi-instant transaction settlements that remain resistant to fluctuations in network load. This result represents a significant advantage compared to traditional cross-border systems, where settlement times are measured in hours or even days.

Transaction Volume Dynamics

Figure 1. XRP transaction volume recorded in the ledgers within the analyzed sample

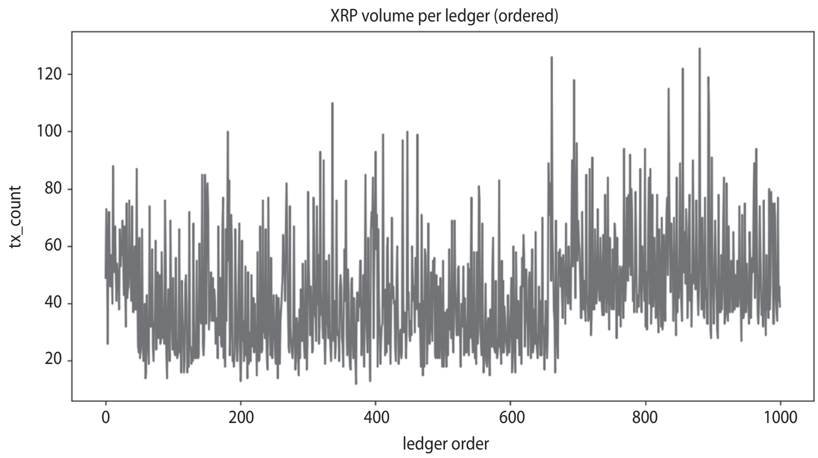


Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

Figure 1 presents the total transaction volume in XRP corresponding to each ledger in the analyzed sample. A significant variability in values is visible alongside periods of relative stability, there are numerous peaks reaching even above 2×10^11 XRP.

Such dispersion suggests that the network experiences irregular, very large transfers, likely associated with the activities of individual major institutional entities.

Figure 2. Number of transactions recorded in the ledgers within the analyzed sample



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

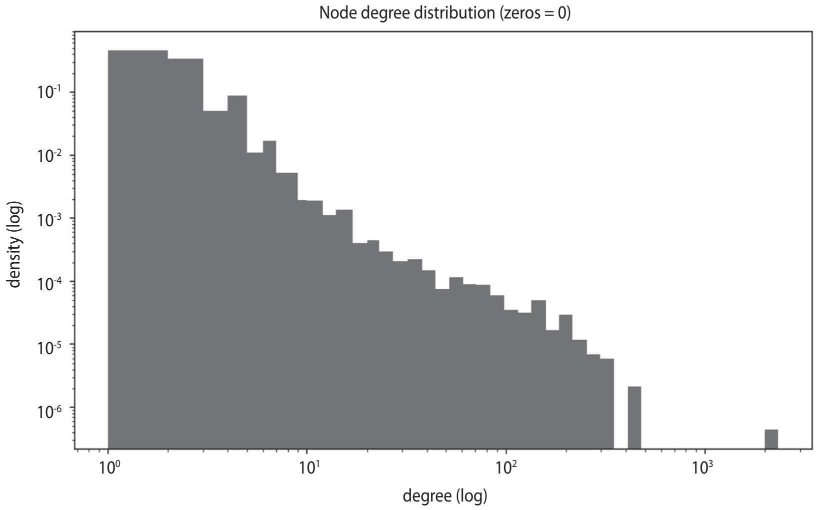
The variability in the number of transactions is presented in Figure 2. Although the average number of transactions per ledger fluctuates around 50–60, periods of increased intensity are also observed, during which the number of transactions exceeds 100. This indicates the existence of certain cycles of user activity within the network, which may be relevant for assessing RippleNet's capacity to handle increased load.

Payment Network Structure

To assess the structure of connections within RippleNet, the node degree distribution was analyzed on a log–log scale. A node represents a network participant identified by an XRPL address that took part in *Payment* transactions.

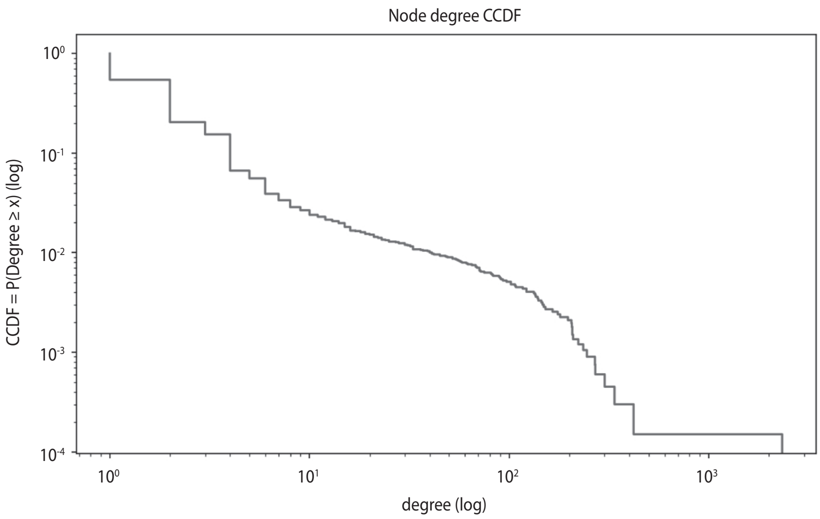
Figure 3 presents a histogram of node degrees (excluding zero-degree nodes with no transactions), which allows for a clearer illustration of the actual diversity of active participants. A characteristic asymmetry typical of financial networks is visible. Most nodes have a small number of connections, while a small group functions as hubs with very high degree values. The use of a logarithmic scale on both the X and Y axes allows for the compression of the "long tail" and the highlighting of the network's core structure.

Figure 3. Node degree distribution on a log–log scale



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

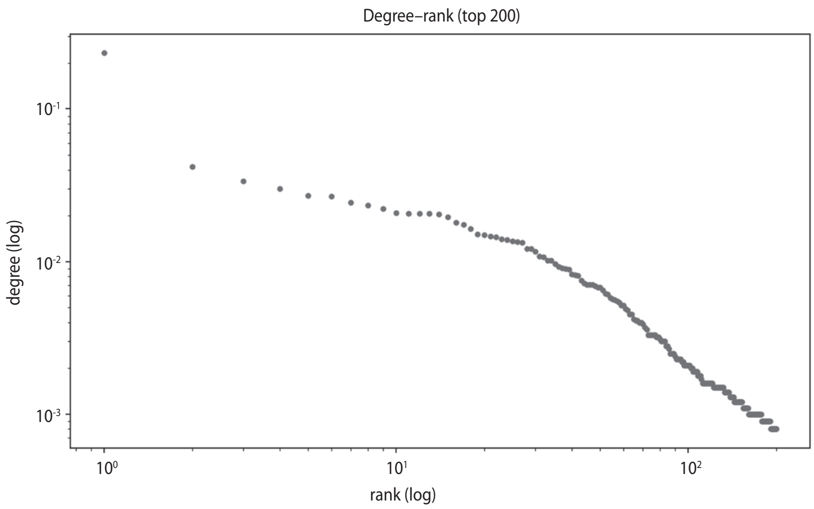
Figure 4. Complementary cumulative distribution function (CCDF) of node degrees



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

An even clearer representation is provided by the complementary cumulative degree distribution (CCDF) shown in Figure 4. It illustrates the proportion of nodes with a degree greater than or equal to a given value. It is clearly visible that the probability of having a high degree decreases slowly, which suggests the presence of a few, but highly connected nodes. Such distributions are typical of scale-free systems, where most participants play a marginal role, and dominance is concentrated among a small transactional elite (Albert and Barabási 2002).

Figure 5. Node degree ranks on a log–log scale



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

Figure 5 presents the degree–rank plot, also on a log–log scale. The nearly linear decline in this scale indicates an approximate fit to a power-law distribution. This means that RippleNet, similar to other economically oriented networks, exhibits strong hierarchical properties. It has a small number of addresses with exceptionally high connectivity that serve as central transactional hubs. In the context of payment applications, this suggests that value flows may be largely dependent on the stability and activity of these few dominant nodes.

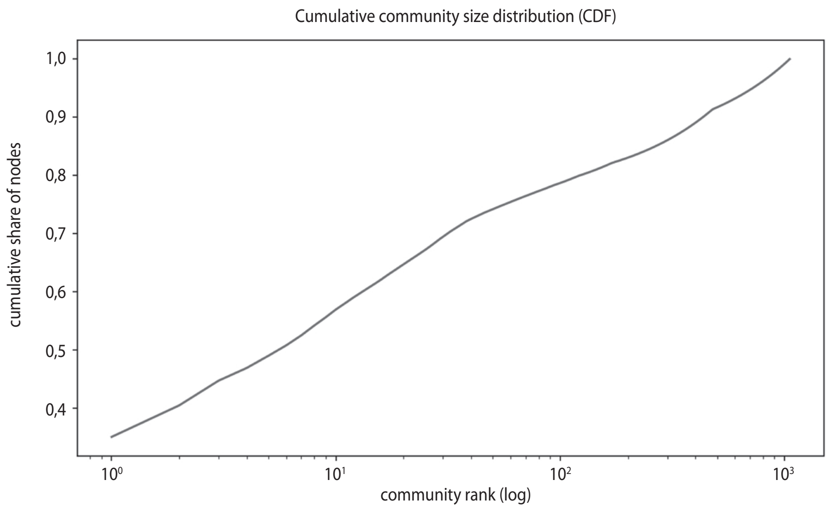
Node Degree Statistics

For the sample of 6,667 active addresses, the average total degree was 3.78 (median: 2), with p90 = 4, p95 = 6, and p99 ≈ 40; the maximum reached 2,329. The in-degree and out-degree distributions are highly skewed: median in-degree = 1 (p99 ≈ 13; max = 135), while median out-degree = 0 (p99 ≈ 16; max = 2,327), confirming the presence of a small group of hubs with exceptionally high numbers of outgoing connections. These findings are consistent with the earlier charts (histogram, CCDF, degree–rank), indicating a near scale-free structure and considerable heterogeneity of roles within the network.

Communities in the Ripple Network

The identification of communities using the Louvain algorithm made it possible to distinguish groups of nodes characterized by stronger internal connections. Instead of a traditional bar chart for all communities, two forms of representation were presented: cumulative distributions and a ranking of the largest groups.

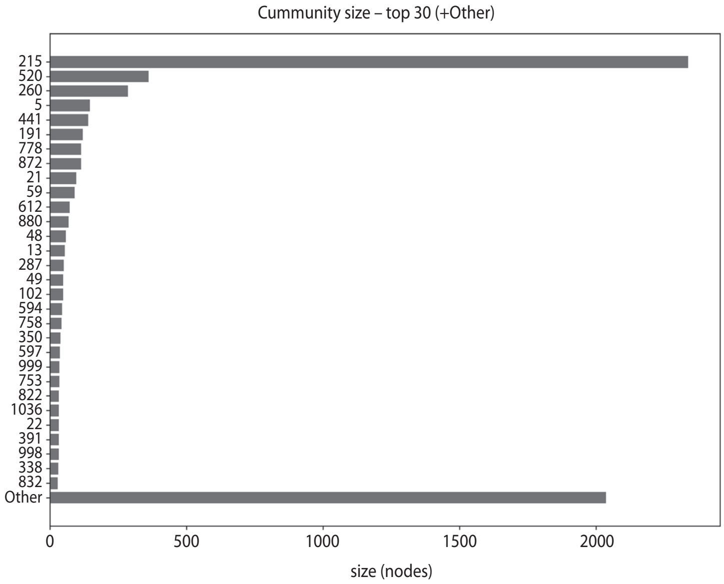
Figure 6. Cumulative distribution of community sizes



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

Figure 6 presents the cumulative distribution of community sizes (CDF) plotted against logarithmic rank. It is clearly visible that a relatively small number of the largest groups encompass a significant portion of all nodes, with 50% of the population reached within just a dozen or so of the largest communities. The curve also quickly "closes" around the 80–90% range, indicating a clear hierarchy: most participants belong to a few dominant communities, while thousands of smaller groups have only a marginal share in the network structure.

Figure 7. The 30 largest communities by the number of addresses



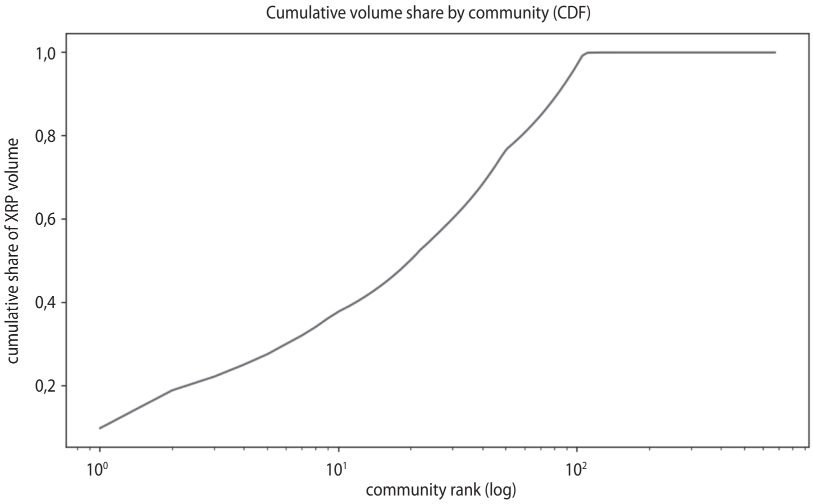
Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

Figure 7 presents the ranking of the thirty largest communities by size, with all remaining ones grouped under the category Other. The use of this approach eliminates the "long tail" problem and allows for an easy comparison of the dominant role of the largest groups. The largest community comprises more than 2,000 addresses, suggesting that it functions as a nodal core around which value flows are concentrated.

Similar conclusions arise from the analysis of transaction volumes attributed to communities. Figure 8 presents the cumulative distribution of shares in the total XRP volume. A very strong concentration is visible – just a few of the largest communities account for more than half of the total transaction value, while approximately 90% of the overall volume is concentrated within fewer than one hundred groups.

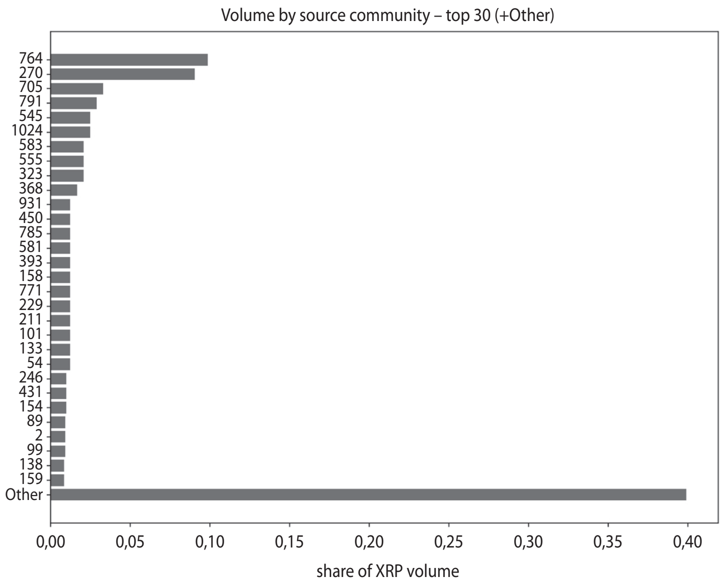
Figure 9 shows the ranking of the largest communities by their share in transaction volume (Top-30 + Other). The largest group accounts for over 15% of all flows, while the next three largest each contribute several additional percentage points. In contrast, the thousands of smaller communities grouped under Other collectively generate less than 40% of the total volume. The use of a percentage scale instead of absolute values allows for a clear assessment of the extent of this concentration and facilitates comparison.

Figure 8. Transaction volume attributed to communities



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

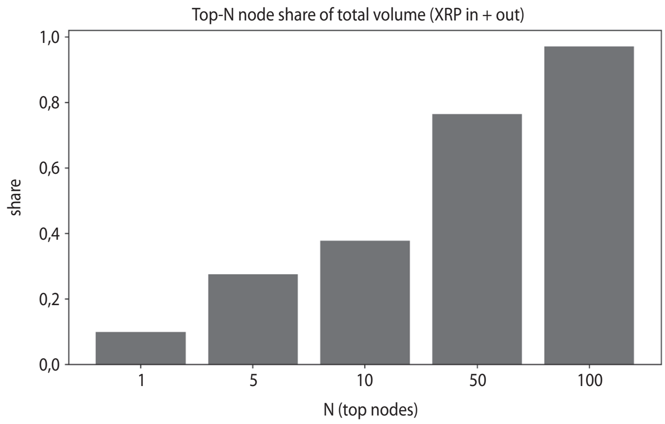
Figure 9. Ranking of the largest communities by share in transaction volume



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

Value Concentration and Inequality in Distribution

Figure 10. Distribution of shares in total transaction volume among the largest network participants

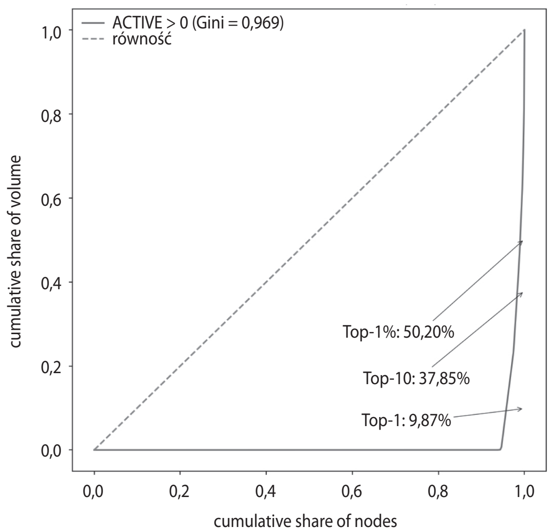


Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

The distribution of shares in total transaction volume among the largest participants is presented in Figure 10. The data show that the single largest node accounts for approximately 10% of all flows. The share of the five largest nodes amounts to about 27%, while the top one hundred account for nearly 97%. This indicates that network activity is extremely concentrated and remains under the control of a small number of addresses.

These results are consistent with the Lorenz curve presented in Figure 11, which exhibits a strongly convex shape relative to the line of equality (dashed line). The calculated Gini coefficient equals 0.969, indicating an extreme level of inequality in the distribution of XRP flows among participants. Additionally, the chart highlights the shares of the largest nodes: the single largest address accounts for 9.87% of the total volume, the ten largest collectively control 37.85%, and just 1% of all active nodes concentrate over 50% of the total volume. Such a high degree of concentration demonstrates that activity within the RippleNet network is dominated by a narrow elite of addresses, while the vast majority of participants account for only a marginal fraction of the flows.

Figure 11. Lorenz curve for node transaction volumes



Source: author's visualization based on Ripple ledger data (August 29, 2025); created in Python using the matplotlib library.

Ripple SWOT Analysis

Strengths

Ripple offers instant settlement of cross-border transactions, which significantly outperforms traditional banking systems, including SWIFT (Qiu, Zhang, and Gao 2019). This is also confirmed by the results of the conducted study – the average ledger closing time in the XRPL was 3.87 seconds, with a median of one second, and the maximum observed finalization time did not exceed 9 seconds. Such a stable and predictable consensus mechanism ensures quasi-instant settlements regardless of network load. Additionally, low operational costs and the ability to operate 24/7, independent of local time constraints, make RippleNet an attractive solution for financial institutions (Islam et al. 2022). Another important advantage is transparency. Transactions in the XRP Ledger network are available for real-time tracking, which increases trust and enables continuous monitoring of fund flows (Kaygin et al. 2021). The results also indicate that the network is capable of handling periods of increased activity, in which the number of transactions exceeded 100 per single ledger, without any loss of settlement stability.

Weaknesses

Ripple remains relatively centralized, although it is based on blockchain technology, a significant portion of the XRP supply is controlled by Ripple Labs, which raises concerns regarding the actual decentralization and independence of the network (Martin 2020). Additionally, despite its dynamic growth, the adoption of RippleNet is still limited compared to the global reach of SWIFT, and the implementation of this technology requires integration with existing banking systems, which can be time-consuming and costly (Qiu et al. 2019). The results of the author's own research indicate a very high level of activity concentration: the largest single node accounted for nearly 10% of the total volume, while 1% of participants controlled more than half of all flows, resulting in a Gini coefficient of 0.969. This means that activity within the RippleNet network is dominated by a small group of addresses, which may reduce its perceived decentralization and increase its vulnerability to disruptions in the activity of these key entities.

Opportunities

The growing demand for efficient, fast, and low-cost international transfers in the B2B and remittance segments creates room for the expansion of RippleNet, particularly in regions with underdeveloped banking infrastructure (Ahmadova and Erek 2022). Global trends in the digitalization of finance, including the development of CBDCs and the increasing openness of institutions to collaboration with fintech companies, may facilitate Ripple's further integration with regulated markets. Cooperation between Ripple and central banks is also possible – for example, in the area of facilitating the issuance or transfer of digital currencies (Ahmadova and Erek 2022).

Threats

Ripple operates in a high regulatory risk environment. The legal status of XRP as a financial asset remains ambiguous in many jurisdictions, which may affect the pace of implementation and discourage potential institutional partners (Spindler 2024). Ripple also faces competition from other blockchain-based initiatives, such as Stellar and stablecoin systems, which offer similar functionalities but with alternative governance structures. There is also a risk that the development of new, more advanced payment systems (e.g., ISO 20022) could reduce RippleNet's competitiveness (Constantino et al. 2024). It should be noted that ISO 20022 is a communication standard rather than a settlement system; however, its implementation may enhance SWIFT's competitiveness, thereby limiting RippleNet's advantages. Additionally, the strong concentration of flows identified in the author's own research, where only a small number of nodes account for the majority of activity, may be perceived by regulators and financial institutions as an additional threat to the system's stability and credibility.

Synthesis of the Author's Own Research Findings

The obtained results allow for the formulation of several key conclusions. First, the Ripple network is characterized by high variability in both the number of transactions and transaction volumes, indicating the presence of large, irregular transfers. Second, the topological structure and centrality metrics confirm the existence of a small number of key nodes dominating the rest of the participants. Third, community identification revealed the presence of core groups that generate the majority of network activity. Fourth, the distribution of transaction values and the concentration among top-N nodes clearly indicate an extreme inequality in the distribution of flows. As a result, although RippleNet is technologically decentralized, in practice it operates in a highly centralized manner, which has significant implications for its potential role as infrastructure for cross-border payments.

The literature review shows that RippleNet implementations are carried out primarily in pilot form, while full-scale global deployment faces regulatory, technological, and institutional barriers. Attention is drawn to the opportunities associated with integration with CBDC projects, as well as to the threats arising from competition and regulatory uncertainty.

Table 1. Summary of the SWOT analysis

Strengths	Weaknesses	Opportunities	Threats
Instant settlements (average 3.87 s, median 1 s, max 9 s) Low transaction costs Transaction transparency 24/7 operation Ability to handle increased activity (over 100 transactions per ledger without loss of stability)	Partial centralization (a significant portion of XRP supply controlled by Ripple Labs) Limited market adoption Integration challenges with legacy systems Ambiguous legal status of XRP Extreme activity concentration (1% of participants control >50% of volume; Gini coefficient = 0.969)	Growing importance of fintechs and CBDCs Expansion into emerging markets Potential cooperation with central banks RippleNet as a bridge for CBDCs	Regulatory risk Competition from other technologies (e.g., Stellar) Modernization of SWIFT or the development of alternatives (e.g., gpi, ISO 20022, CIPS in China, SPFS in Russia) Uncertainty regarding crypto assets Excessive dependence on a small number of key nodes and communities

Source: author's own elaboration based on the conducted research and the literature review presented in the article.

In the interpretation of results, regulatory issues must be taken into account. Due to the ambiguous legal status of XRP in many jurisdictions, and in particular the ongoing proceedings before the U.S. SEC, the implementation of RippleNet is subject to legal risk (Goforth 2024). The lack of a unified legal classification of XRP, whether as a digital currency, a commodity, or a security, creates uncertainty among financial institutions and may limit their willingness to adopt this technology. On the other hand, empirical studies indicate that while the implementation of RippleNet does not bring banks immediate improvements in efficiency and liquidity, in the longer term, some operational indicators show enhancement (Marisetty et al. 2024). The conducted analyses indicate the need for further examination of systemic risks associated with activity concentration and node centralization, as well as for careful monitoring of legislative developments. In the context of potential cooperation with central banks and integration with CBDC projects, RippleNet may serve as a technological bridge; however, its structural and regulatory limitations should constitute an integral part of assessing the network's credibility and resilience.

Bibliography

Adrian T., Garratt R., He D., Mancini-Griffoli T. (2023), *Trust bridges and money flows*. BIS Working Papers, No. 1112, Monetary and Economic Department, July. Bank for International Settlements. https://www.bis.org/publ/work1112.pdf (accessed 5.09.2025).

Ahmadova, S., & Erek, M. (2022). A review on Ripple, a financial intermediary Coin. *Akademik İzdüşüm Dergisi*, 7(2), 117–130.

Albert, R., & Barabási, A.L. (2002). Statistical mechanics of complex networks. *Reviews of Modern Physics*, 74(1), 47–49.

Armknecht, F., Karame, G.O., Mandal, A., Youssef, F., & Zenner, E. (2015). Ripple: Overview and outlook. In *Trust and Trustworthy Computing: 8th International Conference*, TRUST 2015, Heraklion, Greece, August 24–26, 2015, Proceedings 8 (pp. 163–180). Springer International Publishing.

Chen, S., Wang, N., & Zhong, Y. (2021). Ripple's market competitiveness in the long-term. *Advances in Economics, Business and Management Research*, 190, 218–223. Atlantis Press.

Cipriani, M., Goldberg, L.S., & La Spada, G. (2023). Financial sanctions, SWIFT, and the architecture of the international payment system. *Journal of Economic Perspectives*, 37(1), 31–52.

Constantino, J., Mamede, H.S., & da Silva, M.M. (2024). Adopting ISO 20022: Opportunities, challenges, and success factors for corporations in payment processing. *Emerging Science Journal*, 8(4), 1402–1419. https://doi.org/10.28991/ESJ-2024-08-04-010

Dörry, S., Robinson, G., & Derudder, B. (2018). There is no Alternative: SWIFT as Infrastructure Intermediary in Global Financial Markets (Financial Geography Working Paper Series No. 22). The Global Network on Financial Geography (FinGeo).

Goforth, C.R. (2024). SEC v. Ripple Labs: A Ripple or a Wave?. *Drake L. Rev.*, 71, 501–540.

Hashemi Joo, M., Nishikawa, Y., & Dandapani, K. (2020). Cryptocurrency, a successful application of blockchain technology. *Managerial Finance*, 46(6), 715–733.

Islam, M.R., Rashid, M.M., Rahman, M.A., Mohamad, M.H.S.B., & Embang, A.H.B. (2022). Analysis of blockchain-based Ripple and SWIFT. *Asian Journal of Electrical and Electronic Engineering*, 2(1), 1–8.

Kaygin, E., Zengin, Y., Topcuoglu, E., & Ozkes, S. (2021). The evaluation of block chain technology within the scope of ripple and banking activities. *Journal of Central Banking Theory and Practice*, 10(3), 153–167.

Marisetty, V.B., Mamidi, V., & Breda, L. (2024). Blockchain, cross border payments markets and banking efficiency. SSRN Working Paper. No. 5017790. https://ssrn.com/abstract=5017790 (accessed 7.07.2025).

Martin, L. (2020). Ripple Effects: How In Re Ripple Labs Inc. Litigation Could Signal The Beginning of the End of the Payment Platform. *Duke L. & Tech. Rev.*, 19, 1–20.

Nilsson, T., Bouther, R., Van Acoleyen, M., & Cohen, L. (2022). SWIFT gpi data indicate drivers of fast cross-border payments. *Journal of Payments Strategy & Systems*, 16(3), 256–270.

Qiu, T., Zhang, R., & Gao, Y. (2019). Ripple vs. SWIFT: Transforming cross border remittance using blockchain technology. *Procedia Computer Science*, 147, 428–434.

Ripple (n.d.) Ripple Documentation, https://docs.ripple.com/ (accessed 7.07.2025).

Rosner, M.T., & Kang, A. (2015). Understanding and regulating twenty-first century payment systems: The ripple case study. *Mich. L. Rev.*, 114, 649–688.

Spindler, J.C. (2024). Shaq, Ripple, and the Future of Crypto Regulation. Wm. & Mary L. Rev., 66, 1531–1590.

SWIFT (n.d.) Who we are, https://www.swift.com/about-us/who-we-are (accessed 7.09.2025).

Xia, H., & Wang, L. (2022, December). Reanalysis of Cross-Border Payment Based on Blockchain Technology. In 2022 International Conference on Bigdata Blockchain and Economy Management (ICBBEM 2022) (pp. 206–214). Atlantis Press.

World Bank, Central Bank Digital Currencies for Cross-border Payments: A Review of Current Experiments and Ideas. World Bank, Washington 2021. Dostępne pod adresem: https://worldbank.org/curated/en/369001638871862939/pdf/Central-Bank-Digital-Currencies-for-Cross-border-Payments-A-Review-of-Current-Experiments-and-Ideas.pdf (accessed 5.09.2025).