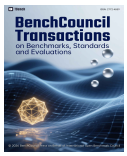

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Review Article

REVIEW ARTICLE

Mapping the Intellectual Landscape of Blockchain in the Banking Industry: A Hybrid Bibliometric and Systematic Review (2015–2025)

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Abstract

The advent of blockchain technology has introduced new alternatives to traditional banking systems, providing a decentralized, secure, and transparent framework. However, its adoption is still complex and uneven for many reasons. This study provides a comprehensive mapping of the intellectual trajectory, thematic structure, and development of blockchain technology research in the banking sector. Using a hybrid literature review methodology that combines bibliometric analysis and systematic content review, the study analyzes 389 peer-reviewed publications retrieved from Scopus (2015–May 2025). VOSviewer was employed to conduct performance analysis and science mapping, including co-authorship, co-citation, keyword co-occurrence, and bibliographic coupling analyses. In parallel, qualitative thematic analysis identified six clusters: (1) blockchain in banking and financial intermediation to enhance operational efficiency, (2) decentralized finance and cryptocurrencies, (3) integration of blockchain with other digital innovations, (4) trust-related dimensions, (5) institutional and regulatory aspects, and (6) strategies for modernizing banking business models. The findings reveal a steady rise in research output, regional disparities in collaboration, and thematic evolution from early conceptualization to recent signs of diversification of applied research. By integrating quantitative and qualitative insights, this study highlights key research gaps, offers directions for future work, and provides guidance for academics, practitioners, and policymakers on the transformative potential and challenges of blockchain in banking.

Key words: Blockchain Technology, Banking Sector, Bibliometric Analysis, Systematic Content Review, Financial Technology, Decentralized Finance

1. Introduction

In recent years, the banking sector has undergone a significant transformation, driven by the rapid advancement of emerging technologies, particularly blockchain. The widespread adoption of smartphones and high-speed data transmission has not only disrupted social interactions but also traditional business operations. However, legacy banking systems have faced challenges in adapting to these technological advancements due to factors such as structural rigidity, high operational costs, and inadequate transaction processing speeds. For instance, cross-border remittances frequently necessitate several days to complete, an inefficiency that starkly contrasts with the near-instantaneous nature of digital communication [1].

In this context, blockchain technology emerged in 2008 as the technology underpinning Bitcoin, a peer-to-peer digital currency eliminating the intermediary [2]. Its decentralized nature allows for secure, anonymous, and cost-effective transactions. This has led to the conclusion that it possesses considerable potential as an off-balance sheet replacement for conventional banking systems [3].

The theory behind blockchain, however, goes back to the early 1990s when Stuart Haber and W. Scott Stornetta developed a cryptographically secure method of time-stamping digital documents [4]. Their subsequent introduction of Merkle trees enabled data to be gathered into chained blocks, significantly enhancing security as well as efficiency [5]. The modern blockchain, conceptualized by Satoshi Nakamoto, is a form of Distributed Ledger Technology (DLT) that utilizes consensus algorithms on distributed nodes to record transactions [6, 7]. The design of the blockchain, which consists of a series of blocks that are cryptographically linked, ensures immutability and tamper-proofing. Consequently, it establishes a highly reliable digital record-keeping system [8]. The application of blockchain technology has expanded beyond its initial implementation in the domain of cryptocurrency. It has been adopted in various fields, including logistics, health, public administration, supply chain management, and, notably, financial services [9–14].

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In the banking sector, blockchain is increasingly seen as an innovative way to transform the trustworthiness and reliability of data management [15]. As digital technology continues to penetrate daily life and concern about data security grows, blockchain's significance will continue to rise. It may become as integral to daily life as the internet [6]. Furthermore, the emergence of newer technologies, such as blockchain, will transform the banking sector in the near future [16]. For example, banks are expected to save $10 billion in cross-border payment fees by 2030 by adopting blockchain technology [17]. According to World Economic Forum projections, blockchain technology will reach a significant milestone by 2027, becoming integrated into various sectors of the global economy. A considerable augmentation in the financial sector, including the banking industry, is projected to increase GDP by 10% [18].

Among the most prominent manifestations of this transformation is the rise of decentralized finance (DeFi), which uses blockchain technology to facilitate peer-to-peer financial services without the need for intermediaries such as conventional banks. This setup transcends geographical locations and provides basic financial services, such as savings, loans, and investment products to poor communities in emerging economies [19, 20].

As a revolutionary innovation, blockchain technology offers numerous benefits: enhanced security, privacy, operational transparency, and increased efficiency. This is all a result of its decentralized nature and the use of cryptographic algorithms, which significantly reduce the risk of cyberattacks and fraud while ensuring traceability and data integrity [21–24]. Consequently, banks are increasingly exploring blockchain technology for applications such as cross-border payments, streamlined Know Your Customer (KYC) processes, enhanced anti-money laundering (AML) measures, and automated contract enforcement through smart contracts. These innovations collectively contribute to lowering operational costs and improving overall efficiency [25, 26].

Despite the promise of blockchain technology, its adoption by banks faces limiting factors. These factors include regulatory uncertainty, technical complexity, and resistance to change at the organizational level. A meticulous examination of the opportunities and limitations presented by this technology is imperative, accompanied by a thorough assessment of awareness, readiness, and acceptance levels among banks and customers [27–29].

The timing, evolution trajectory, and possible impact of blockchain technology on banking have garnered considerable interest among academics and practitioners. In recent years, academic interest in the topic has increased markedly, resulting in a large and diverse body of literature. No study, to the best of my knowledge, has ever carried out a detailed systematic mapping of the intellectual structure, theme development, and future research trends of blockchain literature in the banking sector using a systematic integration of bibliometric analysis and systematic content review methods. Consequently, there is a need to identify and assess the current state of the art and prevailing research trends in this domain.

To fill this gap, this study utilizes a hybrid methodology of literature review, combining the bibliometric analysis and systematic content review to answer the following research questions:

RQ1: *What are the prevailing research trends and patterns of scholarly collaboration in the domain of blockchain technology in the banking sector between 2015 and 2025?*

RQ2: *What are the core thematic clusters and intellectual structures underpinning blockchain research in the banking sector?*

RQ3: *What key research gaps and future directions can be identified to advance the understanding and application of blockchain technology in the banking sector?*

Amidst the accelerating digitalization of banking and financial systems, blockchain technology is revolutionizing how banking services are produced and disseminated. The primary aim of this research is to synthesize the current academic literature on the impact of blockchain on banking by identifying the key concepts, emerging research trends, and prevailing themes. To this end, the study adopts a mixed-method research approach combining quantitative bibliometric analysis with a qualitative systematic content analysis to map the intellectual landscape of blockchain studies in banking. The combination strengthens the validity and credibility of the findings, offering an overarching perspective on how blockchain is reshaping the industry. Besides mapping the literature, the study provides critical reflections on academic and institutional responses to the emergence of blockchain and indicates avenues for further research in a bid to advance its revolutionary potential in the banking sector.

By doing so, this study contributes to a deeper understanding of the significant development of the field and guides future academic and practical engagement with blockchain innovation in the banking sector. The novelty of the study lies in its explicit framework of triangulation and cross-validation that combines bibliometric science mapping and qualitative thematic analysis, providing valuable and actionable insights for academics, practitioners, and policymakers. In addition, the study contributes to the development of transparent, safe, and effective banking and financial systems by identifying the advantages and obstacles related to the adoption of blockchain technology systematically and the proposal of an organized agenda for future research in this field.

The present article is structured as follows. Subsequent to this introduction, Section 2 delineates the hybrid review methodology, meticulously expounding the bibliometric and systematic content analysis approaches. In Section 3, the results of the performance analysis and science mapping of 389 publications on blockchain in banking are presented, and the six main thematic clusters identified are discussed. Section 4 identifies the managerial and practical implications of the findings. Finally, Section 5 offers the main conclusions, which include a summary of the key findings, a proposal of directions for future research, and an acknowledgement of the study's limitations.

2. Research Methodology

To achieve the purposes of this study, we use a hybrid review methodology that integrates bibliometric analysis and systematic content analysis. The mixed-method approach combines quantitative analysis with a substantial emphasis on qualitative analysis.

A hybrid review approach, as described by Paul and Criado [30], is a method that facilitates a comprehensive examination of the literature by combining quantitative and qualitative approaches, with the aim of organizing, analyzing, and interpreting data in a meaningful way. The objective is to provide a comprehensive summary of the scholarly literature on the adoption of blockchain technology (BCT) in the banking industry and to offer an integrative review of the main topics, major findings, and research agendas for the future in this domain.

Bibliometric analysis, which relies on the statistical evaluation of academic production [31], is complemented in this study by content analysis, a qualitative technique used for the systematic analysis of textual information and disclosure structure of existing knowledge within a given discipline [32]. The methodology stages and analytical tools adopted to fulfill the objectives of the study are outlined in Figure 1.

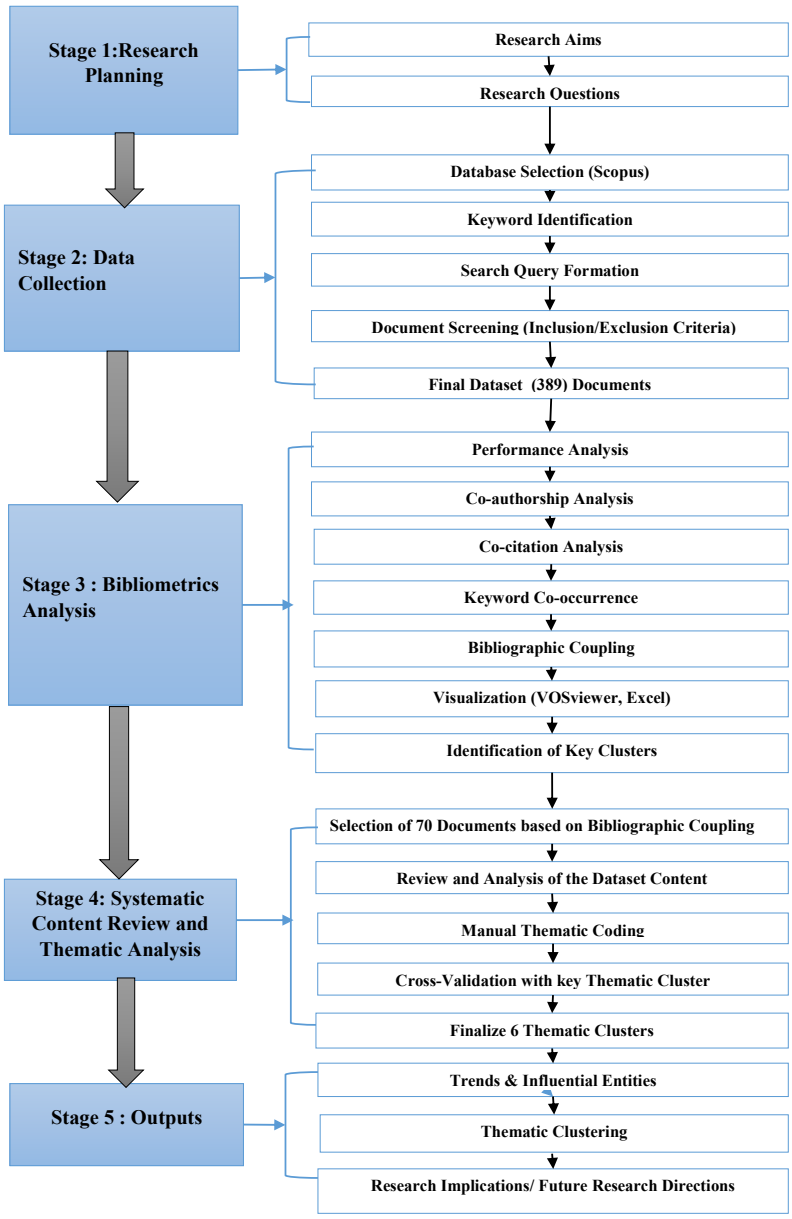

Figure 1. Research Design of the Hybrid Bibliometric–Systematic Literature Review (Developed by the Authors)

2.1. Data Collection

2.1.1. Database Selection

In this stage, data were collected from the Scopus database, a widely recognized and reputable source for bibliometric research [18, 33]. Although there are other databases, such as Web of Science, IEEE Xplore, and Google Scholar, Scopus was selected because it offers the largest curated abstract and citation database of peer-reviewed social science and business publications, indexing over 27,000 active titles from more than 7,000 international publishers, with particularly strong coverage in Finance, Management, Economics, and Information Systems disciplines[34, 35]. Prior bibliometric methodology research indicates that Scopus retrieves broader journal coverage and comparable citation structures to Web of Science for management and interdisciplinary technology studies, while offering superior metadata consistency for science mapping analyses. Its extensive coverage also makes it convenient for research in corporate finance, such as the adoption of blockchain in the banking sector. A defined inclusion criterion was applied for the selection of relevant keywords and the extraction of the dataset for bibliometric analysis and systematic literature review.

2.1.2. Keyword Identification

To identify the appropriate keywords for retrieving the dataset of our research, we have carried out a comprehensive review of the previous literature on blockchain in the banking sector. The focus was on determining the most frequent words used in the current literature [18, 36, 37]. For this purpose, Google Scholar was used in the search using the keyword phrase "Blockchain Technology in the Banking Sector," and related studies were referenced to determine common keywords. Besides, previous bibliometric and systematic literature reviews were also examined to confirm that the selected keywords were inclusive and specific.

Based on this literature review, we identified several frequently used search terms, such as "Blockchain in Bank," "Blockchain Technology in Bank," "Blockchain in Finance," and "Blockchain Technology in Finance." Additionally, Boolean search strings such as (blockchain AND banking) and (block-chain AND adoption AND banking) were identified. Furthermore, consultation with two academic experts in finance and block-chain confirmed that the keywords "Blockchain AND Banking" are frequently used to describe studies where both blockchain and banking are major foci, rather than merely contextually related.

Although this exploratory phase did identify a number of related terms, we purposely restricted the scope of the final retrieval query to just "Blockchain AND Banking" to make sure that both the blockchain and banking domains are the primary focus of our analysis and that the studies retrieved are focused products of those two areas of study. Moreover, the selection of these keywords is congruent with our research objectives, particularly in developing an intellectual structure and determining the main contributions towards the understanding of the impact of blockchain technology on banking.

2.1.3. Search Criteria and Data Extraction

The data collection process during the study was conducted systematically, following standard bibliometric study practices [38] and PRISMA guidelines for transparent reporting [39]. On 12 May 2025, a search was made using the Scopus database with the search term "Blockchain AND Banking" and yielded 1,641 documents published between 2015 and 12 May 2025. Although blockchain technology emerged in 2008, until 2015, academic interest in adopting blockchain technology in the banking sector was significantly nonexistent. Therefore, the selected time frame (2015–2025) indicates the evolution of scientific production in the field.

Because of the novelty and rapid progress of the research field, formal inclusion criteria were applied to ensure the analytical relevance and dataset quality. Only peer-reviewed articles, conference papers, and review articles were chosen, restricting analysis to the most relevant subject areas: Business, Management, and Accounting; Economics, Econometrics, and Finance; and Social Sciences. Publications that focused primarily on technical or computational aspects without a substantial connection to banking, economic, or financial applications were excluded to maintain thematic consistency with the study's objectives. Additionally, only English-language documents were included to ensure conceptual consistency and facilitate systematic review. The final search string was as follows:

TITLE-ABS-KEY (Blockchain AND Banking) AND PUBYEAR > 2015 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "BUSI") OR LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "re"))

This search strategy prioritizes thematic specificity over broad recall, which is a typical approach used in bibliometric mapping studies that strive for clearer concepts and greater analytical coherence. In addition, exploratory pilot studies utilizing broader terminology (fintech, financial services, distributed ledgers, etc.) resulted in the retrieval of an excessive number of records (more than double) that either only slightly or not substantially referenced Blockchain and/or Banking. As a result, continued usage of this focused search strategy was maintained to ensure precision and maintain the analytical quality of the results of bibliometric and thematic analyses of this research.

Following the removal of duplicates and non-relevant documents using filters, the final dataset of 389 documents was attained. The records were saved in CSV (Comma-Separated Values) format for subsequent bibliometric analysis. To ensure replicability and transparency, the dataset has been publicly released in a special repository and is in line with the banking and finance literature's standard practices.

2.2. Data Refinement and Analysis

The second stage of the systematic protocol involved refining retrieved data after the previous step to generate a dataset for bibliometric mapping and thematic synthesis of the literature. It is important to note that this stage did not change the content or makeup of the dataset retrieved from earlier stages; rather, it enhanced the reliability and interpretability of analyses of keyword-based data, specifically co-occurrence networks and clustering themes from keywords.

Data preparation involved the systematic elimination of false positives, the cleaning of metadata fields, and the normalization of author-provided keywords. Keyword optimization was accomplished by merging singular and plural forms, standardizing spelling differences, and consolidating synonymous terms into cohesive conceptual labels. For instance, terms like "cryptocurrency" and "cryptocurrencies," "smart contracts" and "smart contract," as well as "bank" and "banks," were standardized into singular keyword inputs. Additionally, terminology standardization was employed to harmonize overlapping definitions typically found in the diverse blockchain literature. This process included incorporating equivalent phrases such as "distributed ledger," "distributed ledger technology," "fintech," "decentralized finance," and "DeFi," along with "banking sector"

and "banking industry." Terms that were irrelevant or contextually unsuitable (such as "bibliometric analysis and COVID-19") were eliminated to uphold thematic consistency. After optimization and normalization, two complementary analytical methods were executed: - Descriptive bibliometric analysis, which evaluated publication trends, citation patterns, source productivity, and networks of key contributors across various fields; - Systematic content analysis, which pinpointed key research themes, core theme groups, and predominant scholarly discussions arising from the literature.

As a result, this refinement process ensured the statistical reliability of bibliometric network structures and the conceptual clarity of thematic interpretations while not impacting article inclusion or research coverage.

2.2.1. Bibliometric Analysis

Following the collection and preparation of the research dataset, a scientometric analysis was conducted for the purpose of examining the structure and dynamics of the research field. In this study, VOSviewer [40], a specialized computer software program for constructing and visualizing large-scale bibliometric networks [41], was employed. VOSviewer software was selected due to its proven capabilities in the management of large networks, as well as its inbuilt text-mining functionality, which enables the extraction and analysis of valuable terms and concepts from the literature [42]. Additionally, Microsoft Excel was used for statistical analysis and data visualization, including examining publication trends by year, conducting citation analysis, and determining keyword frequency.

Bibliometric analysis provides a comprehensive approach for tracing the development of a research theme with established and reproducible methods. These methods are largely recognized as objective, accurate, and reproducible [43]. Two main bibliometric approaches were applied in this study: performance analysis and science mapping.

Performance analysis is a fundamental component of bibliometric analysis, focused on the quantitative assessment of scientific productivity and impact. It provides a data-driven perspective of scholarly output and the growth of a scientific discipline over time. This technique encompasses the analysis of annual publication trends, identification of highly cited publications, evaluation of leading scientific journals, and assessment of the research contributions by institutions, countries, and individual authors [44]. By examining these indicators, performance analysis provides a comprehensive understanding of the intellectual evolution of the field and uncovers its most influential contributors.

Science mapping, on the other hand, provides a graphic and structural representation of the intellectual architecture of the field [45]. This technique involves advanced bibliometric techniques such as co-authorship analysis, citation and co-citation analysis, keyword co-occurrence, and bibliographic coupling. These analyses help to uncover primary research areas, common keywords, and the thematic clusters that form the landscape of the field [46]. In particular, bibliographic coupling was used to study thematic clusters and current fronts of research to identify emeging topics, research gaps, and directions for future research. Certain previous bibliometric research has utilized similar approaches to examine blockchain research within the banking sector [18], [36], [37], confirming the relevance and propriety of the methodology used herein.

2.2.2. Systematic Content Review

To comprehensively explore the emerging themes of block-chain technology in banking, this study adopted a two-phase methodological design. Specifically, it combined bibliometric analysis with systematic content review. The mixed-method approach was used to address the research questions RQ2 and RQ3. By integrating quantitative and qualitative techniques, the study aimed to synthesize dominant research themes, assess how blockchain would impact banking operations, and ascertain dominant scholarly trends. Systematic content analysis not only contributed to complementing bibliometric findings but also to enhancing the interpretative depth of the results.

In the first phase, bibliometric techniques were applied using VOSviewer in order to visualize the intellectual structure of the field. Following the procedure outlined by [38], two science mapping techniques were used. First, an analysis of keyword co-occurrence was performed to identify words that frequently co-occur together in the metadata of articles' titles, abstracts, and keywords [47]. Consequently, the main research areas, key themes, and emerging research topics were identified [45]. Second, bibliographic coupling was employed to cluster articles that share common cited references, thereby revealing thematically related research streams [48]. A minimum citation threshold of 30 citations per document was applied to exclude publications with limited scholarly impact. This resulted in the selection of 69 highly cited papers. Additionally, the 10 highly cited papers were manually added to ensure conceptual comprehensiveness. After duplicate removal and further manual filtering, the final dataset of 70 peer-reviewed papers was established as the foundation for the subsequent qualitative review.

In the second phase, a qualitative content analysis was performed using Braun and Clarke's framework [49] as follows. First, each article in the final dataset was examined and coded to extract relevant information regarding research objectives, methodological approaches, core themes, principal findings, and identified research gaps. Second, the coded content was grouped into preliminary thematic categories based on their conceptual similarities. Thereafter, these thematic categories were manually refined to ensure conceptual relevance and logical coherence within the categorization. For instance, thematic clusters that have similar central themes (e.g., blockchain and cryptocurrency, blockchain and DeFi) were consolidated into a common thematic cluster. Finally, the outcomes derived from the qualitative analysis were cross-validated against those generated through keyword co-occurrence analysis to enhance the results of the study.

Methodological Novelty and Contribution

The novelty of the methodological approach of this study resides in its explicit triangulation and cross-validation framework that combines bibliometric maps of science with qualitative thematic analysis. Previous studies in this field either used descriptive bibliometric mapping or a qualitative synthesis, but these studies were typically based on small samples and treated these methods separately. In contrast, this research is designed in three stages: (i) to identify macro-level thematic structure through quantitative bibliometric mapping; (ii) to use systematic qualitative content analysis to capture in-depth conceptual patterns and research gaps; and (iii) to cross-validate the results of quantitative and qualitative analysis to determine both the statistical relationship and conceptual alignment of those analyses.

The triangulation approach provides greater methodological strength because it provides a more extensive and functionally reliable representation of the research landscape, helping to better establish a framework for developing theories, as well as planning future investigations into the impact of blockchain on banking studies.

Methodological Challenges and Mitigation

The rapid growth of the literature on blockchain applications in banking presents several methodological challenges. These issues arise from four dimensions of interrelated challenges: disciplinary fragmentation, terminological inconsistency, publication volume/size/overview, and methodological heterogeneity. Blockchain research in banking spans broad disciplinary areas, including finance, computer science, information systems, law, and regulatory research, making it difficult to align themes and integrate theories. Additionally, many overlapping terms exist, including fintech, digital banking, cryptocurrencies, decentralized finance (DeFi), central bank digital currency (CBDC), etc. These multiple terms significantly increase the potential for conceptual confusion and misclassification.

In addition to these difficulties caused by the rapid growth in the number of publications, many difficult processes of literature screening and synthesis occur when hundreds of literature articles are reviewed while attempting to keep the reviews analytically sound. Moreover, the research literature reviewed exhibited considerable methodological differences, ranging from technical system architectures and research analysis to policy-oriented and conceptual frameworks, complicating the synthesis of cross-study data.

To alleviate these issues, the present research develops a triangulated methodological approach that employs bibliometric mapping of literature using computer analysis tools as well as systematic qualitative analysis and manual validation [50–52]. Triangulating the methodology allows for increased coverage of the literature reviewed while providing for increased assurance of analytical integrity and credibility in addition to conceptual consistency.

In summary, this study's integrated methodology enhances the validity and reliability of its findings by combining quantitative mapping, qualitative thematic interpretation, and cross-validation. This integrative approach strengthens the robustness of the findings and enables a holistic understanding of blockchain's role in banking. It also provided a solid foundation for identifying future research directions in this evolving field.

3. Results and Discussion

3.1. General information and performance analysis

The bibliometric analysis revealed 389 documents, published in 269 sources between 2015 and May 2025, authored or co-authored by 1,077 scholars. The principal purpose of collecting this bibliographic dataset is to provide an overall picture of the scientific literature that addresses the application of blockchain in banking during this period. This overview not only identifies key publication patterns but also brings an understanding of the evolution of the field. Such mapping is essential for understanding the development of the topic, as it helps to identify publication patterns, collaborative networks, and the most active research domains. Moreover, it underscores the academic relevance of the dataset and provides a foundation for further analysis.

Table 1 presents the descriptive statistics summarizing the dataset. In addition, the results illustrate key aspects of research productivity and collaboration, such as annual publication trends (Table 2; Figure 2), top productive scientific journals publishing in the field (Table 3), top contributing authors (Table 4), and most active institutions (Table 5),leading countries in publication output (Table 6), and the highly cited documents (Table 7). These analyses collectively provide a detailed account of the scientific landscape and support the evaluation of scholarly performance in the field.

Table 1. Main Information of the Dataset

Description	Results
Retrieval Date	12 May 2025
Time-Span	2015–May 2025
Total Publications	389.00
Subject Area:	
Business, Management, and Accounting	
Economics, Econometrics, and Finance	
Social Sciences	
Document Type:	
Article	274.00
Conference Paper	84.00
Review	31.00
Number of Cited Publications	313.00
Number of Non-Cited Publications	76.00
Total Citations	9354.00
Average Citations per Publication	24.05
Average Citations per Cited Publication	29.89
Average Years from Publication	3.10
Average Citations per Year per Document	4.63
Sources (Journals, Books, etc.)	269.00
Affiliations	786.00
Countries	88.00
References	18437.00
Keywords Plus (ID)	1818.00
Author's Keywords (DE)	1131.00
Authors	1077.00
Publications per Author	0.36
Authors per Publication	2.77

3.1.1. Publication Trends Over Time

Table 2 and Figure 2 illustrate the publication trends over a year from 2016 to May 2025. The analysis comprises metrics such as total publications (TP), cumulative publications (CTP), total citations (TC), and average citations per publication (TC/CTP and TC/TCP). The data reveal three distinct phases in the evolution of the research field: (1) Early emergence and foundational impact (2016–2018), (2) Expansion and thematic diversification (2019–2021), and (3) Peak production with initial signs of saturation (2022–2025).

The initial phase (2016–2018) reflects the inception of academic activity, with four articles published in 2016 being cited 1,249 times (312.25 per article), indicating foundational significance. The number of publications increased from eight in 2017 to 20 in 2018, reflecting growing interest in the potential of blockchain technology in the banking sector.

In the second phase, between 2019 and 2021, production increased sharply, from 30 in 2019 to 47 papers in 2020, though decreasing slightly to 41 papers in 2021. Despite the growth being notable, average citations declined (TC/CTP fell from 8.85 in 2019 to 5.99 in 2021), most likely due to higher participation and decline of the novelty. This is the stage that points towards the diversification of research themes and the decline in the productivity of 2021, possibly impacted by global disruptions such as the COVID-19 pandemic.

The third phase (2022–2025) represents the most productive period in terms of publication volume, with annual outputs increasing from 54 in 2022 to a peak of 78 in 2024. Publications during this phase constitute over half of the total output, highlighting the area's rapid expansion and highest level of publication activity. Although the TC/CTP ratio fell from 6.53 in 2022 to 1.17 in 2024, this decline

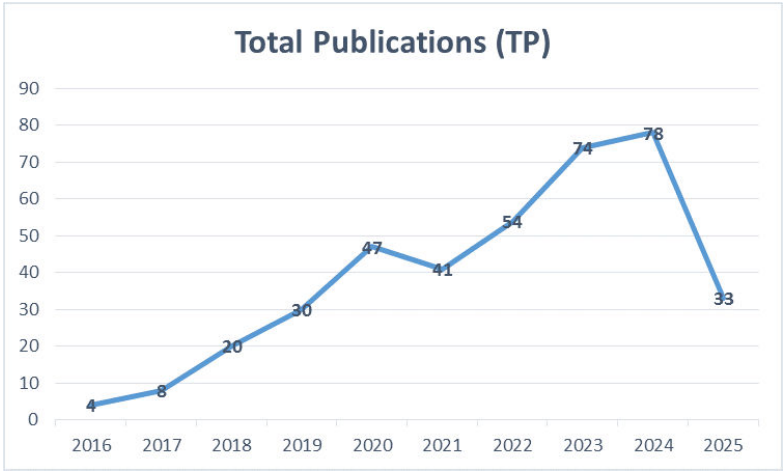

Figure 2. Total Publications (TP) over time (2016–2025). *Note: The data for 2025 (33 publications) is incomplete, reflecting the data cutoff date of May 12, 2025, and therefore does not accurately represent a decline in annual output.*

Table 2. Publication Trends Over Time

Year	TP	PTP	CTP	TCP	TC	TC/CTP	TC/TCP
2016	4.00	1.00%	4.00	4.00	1249.00	312.25	312.25
2017	8.00	2.00%	12.00	8.00	850.00	70.83	106.25
2018	20.00	5.00%	32.00	19.00	1033.00	32.28	54.37
2019	30.00	12.00%	62.00	28.00	549.00	8.85	19.61
2020	47.00	12.00%	109.00	44.00	2321.00	21.29	52.75
2021	41.00	11.00%	150.00	38.00	899.00	5.99	23.66
2022	54.00	14.00%	204.00	52.00	1333.00	6.53	25.63
2023	74.00	19.00%	278.00	56.00	656.00	2.36	11.71
2024	78.00	20.00%	356.00	53.00	418.00	1.17	7.89
2025	33.00	8.00%	389.00	11.00	46.00	0.12	4.18

TP = Total Publications, PTP = Percentage of Total Publications, CTP = Cumulative Total Publications, TCP = Total Cited Publications, TC = Total Citations.

is largely attributable to the recency effect, as newer articles have not yet accumulated significant citations.

The data for 2025 is partial and represents an artifact of the data cutoff. As of May 12, 2025, only 33 publications were indexed at this time. So, the apparent decline in output for 2025 constitutes a methodological artifact rather than a substantive downturn. While this figure is expected to increase significantly by the end of the year, annual publication counts, rather than citation-based indicators, reflect a consistent rise in research activity. Moreover, the increasing diversification of research themes, particularly applied studies integrating blockchain with AI, IoT, and FinTech, is likely to influence future citation patterns.

Overall, while publication volumes have risen exponentially, falling citation metrics indicate the need for yet more innovative and theory-driven studies. Future studies need to undertake interdisciplinary, problem-based approaches to advance the practical uptake of blockchain in banking contexts.

3.1.2. Leading Scientific Journals Publishing Blockchain and Banking Research

The most impactful journals that publish research on block-chain technology within the banking sector are detailed in Table 3, which presents both productivity measures (Total number of publications) and impact indicators (Total citations, Average citations per article, Average publication year, and normalized citation metrics). These combined measures enable the evaluation of not only the quantity of output but also the intellectual impact of each journal within the rapidly changing research environment.

An important observation in Table 3 is that, while Technological Forecasting and Social Change and Sustainability (Switzerland) are at the forefront journals in terms of volume, each journal's scholarly impact varies significantly. Technological Forecasting and Social Change exhibits a notably superior citation profile (648 total citations; 92.57 citations per article), which underscores the journal's strong focus on technology adoption, innovation dissemination, and socio-economic changes, subjects that closely relate to block-chain research in the financial sector. Its wide interdisciplinary readership and emphasis on theory-driven forecasting likely enhance its visibility and citation across various fields. In comparison, although Sustainability frequently covers block-chain topics, its more practical and policy-oriented focus, often aimed at specific sustainability audiences, leads to lower average citation rates (18.86 per article), indicating a more localized rather than broad academic influence.

In contrast, Financial Innovation, despite having published only five articles, boasts the highest overall citations (922) and greatest average impact per article (184.40). This remarkable achievement illustrates that thematic relevance of a journal, rather than just the volume of publications, drives academic influence. The journal's concentrated focus on financial technologies, digital currencies, and banking change positions it as a primary outlet for significant theoretical and empirical contributions, making its articles particularly prominent and often cited across finance, economics, and policy research communities.

Table 3. Leading Scientific Journals Publishing Blockchain in Banking Research

Rank	Source	Documents	Citations	Avg. Citations	Avg. Year	Avg. Norm. Citations
1	Technological Forecasting and Social Change	7.00	648.00	92.57	2022.29	4.04
2	Sustainability (Switzerland)	7.00	132.00	18.86	2021.57	0.98
3	International Journal of Scientific and Technology Research	6.00	57.00	9.50	2019.67	0.21
4	Financial Innovation	5.00	922.00	184.40	2020.40	1.99
5	Technology Analysis and Strategic Management	4.00	101.00	25.25	2022.75	3.55
6	Journal of Risk and Financial Management	4.00	72.00	18.00	2022.75	1.67
7	IEEE Transactions on Engineering Management	4.00	204.00	51.00	2022.00	6.44
8	Frontiers in Blockchain	4.00	93.00	23.25	2021.00	2.01
9	New Economic Windows	3.00	543.00	181.00	2016.00	0.58
10	Journal of Money Laundering Control	3.00	116.00	38.67	2020.00	2.00
11	Journal of Financial Stability	3.00	83.00	27.67	2020.33	0.99
12	Fintech	3.00	85.00	28.33	2023.00	1.15

A similar trend is evident in New Economic Windows, which attained 543 citations with just three publications. Its early exploration of blockchain topics (with an average publication year of 2016) enabled its articles to gather citations over an extended period, demonstrating the benefits of early involvement in emerging research areas. These foundational studies often serve as essential reference points for subsequent scholarship.

On the other hand, journals like the International Journal of Scientific and Technology Research, while comparatively productive (six publications), exhibit limited citation impact (averaging 9.5 citations per article). This variance likely stems from the journal's broader technical audience and its less focused engagement with financial or banking communities, leading to reduced citation engagement within social science and finance-oriented research networks.

Normalized citation metrics further enhance impact evaluation by considering publication age. Journals such as IEEE Transactions on Engineering Management (6.44) and Technology Analysis and Strategic Management (3.55) show strong relative citation performance given their more recent publication schedules. Their heightened normalized impact emphasizes the increasing importance of management- and gover-nance-related perspectives in blockchain research, particularly at the crossroads of engineering innovation, organizational strategy, and transformation in the financial sector.

Overall, these trends suggest that scholarly influence in the realm of blockchain-banking research is more influenced by journal thematic alignment, multidisciplinary engagement, early positioning in specific topics, and theoretical focus rather than merely by publication frequency. Journals that contextualize blockchain within wider discussions on financial governance, innovation management, regulatory adjustment, and socio-economic change achieve greater citation visibility than journals that are technically oriented or narrowly focused on sustainability. This uneven distribution of influence indicates that the intellectual essence of the field is anchored in publications that connect financial theory, policy analysis, and studies of innovation rather than solely in technically driven or sustainability-centric journals.

3.1.3. The 10 Most Influential Authors

Table 4 shows the most prolific authors who have made the largest academic contributions to blockchain research in the banking sector. This evaluation considers their productivity, citation impact, normalized influence, and the strength of their collaborative networks. These metrics not only identify the most visible researchers but also show how intellectual leadership and collaboration patterns shape the field.

It can be seen that Devi, N. Chitra and Kumari, Anitha are the most prolific with three papers each and the same citation count of 105 and 35 average citations per paper. While both have the same normalized citation score (2.14), only Devi has a sizable total link strength (19), suggesting more robust collaboration networks. This suggests that Devi's influence goes beyond citation metrics to include a bridging function between various research teams, encouraging cross-pollination of ideas related to adoption, operational efficiency, and governance in blockchain.

In contrast, although Mbaidin, Hisham O. has the same number of publications of Devi and Kumari, he has lower citations and average citation per document wit 43 and 14.33 respectively. Moreover, the author is strongly linked (link strength: 23), suggesting broad collaborative activity in the field. This pattern highlights authors whose main contributions are in interdisciplinary collaboration and empirical research across multiple countries. This fosters methodological diversity but may not yet result in highly cited conceptual breakthroughs.

A different type of intellectual leadership is seen in authors like Ramzi El-Haddadeh, Nitham Hindi, Vishanth Weerakkody, and especially Uthayasankar Sivarajah. They achieve notable citation efficiency despite fewer publications. Each of them had two high-impact papers with over than 100 citations, an average of 55 citations per article, and 2.54 normalized scores, indicating influence and visibility. However, Uthayasankar Sivarajah has the highest citation average (109.5) and a 5.03 normalized citation score, showing exceptional scholarly impact with fewer papers. He particularly focuses on governance, data management, and digital transformation strategies within financial institutions. These authors help consolidate theory by presenting models that link blockchain adoption with organizational readiness and regulatory issues.

Emerging researchers like Gan, Qingqiu, and Lau, Raymond Yiu Keung, show strong normalized citation rates of 4.78 despite their recent publication activity, with an average publication year of 2024.5. Their rapid accumulation of citations highlights a growing second wave of leadership focused on algorithmic finance, data analytics, and the convergence of emerging fintech. This trend indicates a shift in the field from foundational theoretical work to application-oriented and interdisciplinary growth.

In summary, the author network structure illustrates a layered knowledge ecosystem that balances established theorists, network connectors, and rapidly advancing innovators. Leadership in this field is defined not just by the number of publications but also by the ability to present impactful conceptual frameworks, provide scalable empirical evidence, and foster new research initiatives through collaborative networks. This evolving profile of authorship shows the maturation of blockchain and banking research into a more unified yet methodologically diverse academic domain.

3.1.4. The Top 10 Most Productive Institutions

Table 5 presents the leading institutions that have contributed most to blockchain research in banking in terms of productivity, impact,

Table 4. The Most Influential Authors

Rank	Author	TP	TC	APY	ACPP	ANC	TLS
1	Devi, N. Chitra	3.00	105.00	2022.33	35.00	2.14	19.00
2	Kumari, Anitha	3.00	105.00	2022.33	35.00	2.14	0.00
3	Mbaidin, Hisham O.	3.00	43.00	2023.67	14.33	1.91	23.00
4	Choo, Kim-Kwang Raymond	2.00	63.00	2022.00	31.50	2.14	3.00
5	El-Haddadeh, Ramzi	2.00	110.00	2022.00	55.00	2.54	27.00
6	Gan, Qingqiu	2.00	37.00	2024.50	18.50	4.78	8.00
7	Hindi, Nitham	2.00	110.00	2022.00	55.00	2.54	10.00
8	Lau, Raymond Yiu Keung	2.00	37.00	2024.50	18.50	4.78	3.00
9	Sivarajah, Uthayasankar	2.00	219.00	2022.00	109.50	5.03	13.00
10	Weerakkody, Vishanth	2.00	110.00	2022.00	55.00	2.54	10.00

TP = Total Publications; TC = Total Citations; APY = Average Publication Year; ACPP = Average Citations Per Publication; ANC = Average Normalized Citations; TLS = Total Link Strength.

and other important indicators such as, citations, average publication year, average citations per document, and average normalized citations.

Foremost among them is the Department of Management Studies at the Indian Institute of Technology Delhi, with 3 papers that garnered 110 citations, achieving an average of 36.67 citations per paper and an average normalized citation score of 1.32. This reflects a high academic impact and research quality in the feild. Conversely, the Adnan Kassar School of Business at the Lebanese American University, despite being equally prolific with 3 papers, has a lower average citation (3.67) and normalized citation score (0.49), revealing a less widespread scholarly impact.

In addition, certain institutions such as Al Qasimia University, Mutah University, Abu Dhabi University, and independent institutions such as the Financial and Taxation Consultant, Jordan, both of which have 2 papers of low citation frequency (average number of citations per paper of 6) but relatively high normalized citation scores (1.12), showing greater engagement and increasing popularity over the last few years (average year of publication: 2024), were also taken into account.

Most prominently, Spiru Haret University of Romania, with only 2 publications, received 56 citations and the highest normalized citation score (3.23), indicating the influence of its work in the discipline. Similarly, Symbiosis Institute of Digital and Telecom Management achieved a moderate impact with 21 citations from 2 publications.

In general, the results show geographically widespread and institutionally varied research efforts. Productivity is spread across institutions, but citation impact is concentrated in a few, indicating the distinction between quantity and quality of scholarly production.

3.1.5. The Most Productive and Influential Countries

Table 6 illustrates the significant geographical variation in research contributions, citation impact, and other major indicators, such as average publication year, average citations, average normalized citations, and total link strength of blockchain research in the banking sector.

As shown in Table 6, India is the most prolific and productive country with 94 documents, but it is lower ranked in citation impact (average citations per paper with 17.33) and normalized citation score (1.28). This indicates that while it leads in quantity, the overall impact remains moderate.

In contrast, the United States, with 51 papers, has the highest total citations (2,847) and a high average citation score (55.82), thus indicating a high academic impact. Likewise, the United Kingdom, with a lower productivity of 25 publications, achieves the top average citations (64.44) and normalized citation score (2.42), reflecting high-quality and highly recognized research output.

China also demonstrates a balanced profile with 24 papers and an average citation of 47.79, showing a good compromise between productivity and impact. The United Arab Emirates shows emerging activity with 21 papers and a good normalized score (1.41), yet still a moderate average citation per document (12.19).

Other countries, such as Germany, Italy, and Malaysia are moderately impactful and productive. Jordan and Switzerland, in contrast, while producing smaller volumes of output (12 and 10 papers, respectively), stand at competitive normalized citation averages (1.15 and 0.82, respectively), indicating quite high-impact research. Surprisingly, Spain and the Russian Federation have lower normalized and average citation indicators, reflecting limited impact despite modest research production.

Overall, India produces the most research in quantity, but other countries like the UK, the US, and China have a greater scientific impact. These patterns show that there is a global contribution, but the quality and visibility of research in the field of blockchain in banking are uneven.

3.1.6. The Top 10 Most Cited Documents

As we stated above, the dataset is retrieved from the Scopus database, and as we know, the topic has been investigated in various contexts by authors from Business, Management and Accounting, Economics, Econometrics and Finance, and Social Sciences. The analysis of the top 10 most cited documents in blockchain and banking research identifies the seminal works that have influenced academic investigation and applied applications in this multidisciplinary research area. These documents span various areas of study, ranging from financial innovation to accounting, regulatory studies, and information systems. Citation counts indicate academic and intellectual interest, while more complex metrics, such as average citations per year and normalized citation score, provide a better indication of the significant documents and their comparative influence over time and across research fields [53].

In view of this, Table 7 presents the ten most highly cited documents in our research field, according to the Scopus database. It is noted that, nine of the ten most highly cited papers received more than 200 citations, even though most of them were published less than four years ago.

Leading the list is Guo and Liang [26] pioneering document entitled "Blockchain application and outlook in the banking industry," published in the Financial Innovation journal, with a total of 706 citations as the most cited document in finance. Its average annual citation rate of 78.44 indicates a consistently high impact since its publication, although its normalized citation score of 2.26 suggests that, despite its high number of citations, its performance compared to other publications in its field is more moderate. Nonetheless,

Table 5. The Most Influential Institutions

Rank	Institution	TP	TC	APY	ACPP	ANC
1	Adnan Kassar School of Business, Lebanese American University, Beirut, Lebanon	3.00	11.00	2023.67	3.67	0.49
2	Dept. of Management Studies, Indian Institute of Technology Delhi, New Delhi, India	3.00	110.00	2023.00	36.67	1.32
3	Al Qasimia University, United Arab Emirates	2.00	12.00	2024.00	6.00	1.12
4	Business Intelligence and Data Analytics Dept., Business School, Mutah University, Jordan	2.00	12.00	2024.00	6.00	1.12
5	Dept. of Economics, College of Economics and Management, Al Qasimia University, Sharjah, UAE	2.00	12.00	2024.00	6.00	1.12
6	Faculty of Economics, Kharazmi University, Tehran, Iran	2.00	13.00	2022.50	6.50	0.37
7	Faculty of IT, Abu Dhabi University, UAE	2.00	12.00	2024.00	6.00	1.12
8	Financial and Taxation Consultant, Jordan	2.00	12.00	2024.00	6.00	1.12
9	Spiru Haret University, Romania	2.00	56.00	2023.50	28.00	3.23
10	Symbiosis Institute of Digital and Telecom Mgmt., Symbiosis Intl. (Deemed Univ.), Pune, India	2.00	21.00	2022.00	10.50	0.43

TP = Total Publications; TC = Total Citations; APY = Average Publication Year; ACPP = Average Citations Per Publication; ANC = Average Normalized Citations.

Table 6. The Most Productive Countries

Rank	Country	TP	TC	APY	ACPP	ANC	TLS
1	India	94.00	1629.00	2022.60	17.33	1.28	48.00
2	United States	51.00	2847.00	2021.35	55.82	1.62	31.00
3	United Kingdom	25.00	1611.00	2022.08	64.44	2.42	43.00
4	China	24.00	1147.00	2022.50	47.79	1.30	20.00
5	United Arab Emirates	21.00	256.00	2022.71	12.19	1.41	12.00
6	Italy	20.00	327.00	2021.70	16.35	0.90	16.00
7	Russian Federation	19.00	169.00	2019.58	8.89	0.29	0.00
8	Germany	18.00	740.00	2021.44	41.11	1.31	8.00
9	Malaysia	14.00	186.00	2022.36	13.29	0.97	19.00
10	Jordan	12.00	103.00	2023.75	8.58	1.15	18.00
11	Spain	11.00	145.00	2021.55	13.18	0.81	0.00
12	Indonesia	10.00	137.00	2022.30	13.70	0.33	2.00
13	Switzerland	10.00	280.00	2021.80	28.00	0.82	5.00

TP = Total Publications; TC = Total Citations; APY = Average Publication Year; ACPP = Average Citations Per Publication; ANC = Average Normalized Citations; TLS = Total Link Strength.

the work is still influential owing to its pioneering and general introduction of the revolutionary nature of blockchain for banking, specifically as it pertains to operational efficiency and transparency and transactional security.

On the contrary, Thakor's [54] article entitled "Fintech and banking: What do we know? ranks second in terms of total citations (601), but outperforms all other documents in terms of average annual citations (120.20) and the number of normalized citations (12.17). This suggests that the study has quickly become a leading reference in its field, although it has just 4 years since its publication. This suggests that the study is already a classic reference in the area. The Journal of Financial Intermediation presents a solid theoretical model on how fintech, including blockchain technology, is transforming long-established paradigms in banking. Its very high normalized citation score also indicates high influence and cross-disciplinary adoption, especially in finance, economics, and regulation studies in banking.

Its third most cited paper, authored by Dai and Vasarhelyi [55], entitled "Toward blockchain-based accounting and assurance," published in the Journal of Information Systems, has been cited 532 times. It has a high average of 66.5 yearly citations and a normalized score of 5.01, attesting to its contributory quality as a connecting publication between accounting theory and blockchain technology. It offers research that informs discussion about the use of blockchain to enable auditability and trust in financial reports, and is thus a reference work on the research of financial assurance with blockchain-based.

An equally significant contribution is made by Peters and Panayi [56], entitled "Understanding modern banking ledgers using blockchain technologies," cited 452 times. Its 50.22 times per year citation rate indicates ongoing interest by researchers, while its normalized citation of 1.45 indicates moderate impact in its broader research field. The significance of this work lies in its specific contribution to addressing distributed ledger technology and smart contracts, and offering insight into blockchain's technology foundation from a banking industry perspective.

Additionally, the International Journal of Information Management published research by Schuetz and Venkatesh [57] on using blockchain to drive financial inclusion in India. The article was cited 297 times with an average annual citation rate of 59.4 and a normalized citation rate of 6.01. This article is clearly very interdisciplinary in applicability. Its focus on social and developmental implications of blockchain makes it more relevant in policy development and financial inclusion policies, particularly in emerging economies.

With regard to infrastructure and security, although not banking-focused, Minoli and Occhiogrosso's [58] article entitled "Blockchain Mechanisms for IoT Security," has garnered 285 citations, an average annual citation of 40.71, and a normalized

Table 7. The Top 10 Most Cited Documents

Rank	Authors	Year	Title	Source	Document Type	TC	ACPY	NC
1	Ye Guo & Chen Liang	2016	Blockchain application and outlook in the banking industry	Financial Innovation, 2(1)	Original research article	706.00	78.44	2.26
2	Anjan V. Thakor	2020	Fintech and banking: What do we know?	Journal of Financial Intermediation, 41	Review article	601.00	120.20	12.17
3	Dai J.; Vasarhelyi M.A.	2017	Toward blockchain-based accounting and assurance	Journal of Information Systems, 31(3)	Conceptual research article	532.00	66.50	5.01
4	Gareth W. Peters & Efstathios Panayi	2016	Understanding Modern Banking Ledgers Through Blockchain Technologies: Future of Transaction Processing and Smart Contracts on the Internet of Money	New Economic Windows (NEW), pp. 239–278	Book chapter	452.00	50.22	1.45
5	Schuetz S.; Venkatesh V.	2020	Blockchain, adoption, and financial inclusion in India: Research opportunities	International Journal of Information Management, 52	Original research article	297.00	59.40	6.01
6	Daniel Minoli & Benedict Occhiogrosso	2018	Blockchain mechanisms for IoT security	Internet of Things (Netherlands), 1–2, 1–13	Original research article	285.00	40.71	5.52
7	Zetzsche D.A.; Arner D.W.; Buckley R.P.	2020	Decentralized Finance	Journal of Financial Regulation, 6(2), 172–203	Conceptual/policy article	264.00	52.80	5.35
8	Poonam Garg et al.	2021	Measuring the perceived benefits of implementing blockchain technology in the banking sector	Technological Forecasting and Social Change, 163	Empirical research article	218.00	54.50	9.94
9	Saurabh Ahluwalia et al.	2020	Blockchain technology and startup financing: A transaction cost economics perspective	Technological Forecasting and Social Change, 151	Empirical research article	212.00	42.40	4.29
10	Mohd Javaid et al.	2022	A review of Blockchain Technology applications for financial services	BenchCouncil Transactions on Benchmarks, Standards and Evaluations, 2(3)	Review article	207.00	69.00	8.39

TC = Total Citations; ACPY = Average Citations per Year; NC = Normalized Citations.

score of 5.52. Its interdisciplinary contribution comes in the form of providing data transmission protocols that are secure, something that would be essential to highly technologically advanced banking systems that are based on Internet-of-Things (IoT) incorporation.

Furthermore, regulatory aspects of blockchain are analyzed in the most highly-cited paper by Zetzsche, Arner, and Buckley [59], entitled "Decentralized Finance," which has been cited 264 times. The article has a yearly average of 52.8 citations and a normalized citation of 5.35, and it illustrates increasing academic interest in legal and compliance matters of decentralized financial systems. Published in the Journal of Financial Regulation, it offers a critical framework for the examination of blockchain's legal and systemic issues and thus is extremely useful to researchers as well as policymakers.

Empirical understanding of blockchain adoption is presented in their article "Measuring the perceived benefits of implementing blockchain in the banking sector," which has been cited 218 times, by Garg et al. [60]. Interestingly, it has a high average citation rate of 54.5 per year and a significant normalized citation score of 9.94, which indicates high use and strong cross-field influence. Using structural equation modeling, the authors assign a numeric value to the benefits of blockchain, such as trust, transparency, and efficiency, and make this study highly applicable to banking professionals.

Parallel to this is the work of Ahluwalia, Mahto, and Guerrero [61] enhances the knowledge of blockchain technology within the entrepreneurial finance context through their empirical article titled "Blockchain and Startup Finance." The paper has been cited 212 times at an average rate of 42.4 citations per annum, besides a normalized citation count of 4.29. The article extends the use of blockchain from traditional banking institutions to its impact on startup and venture capital environments through the adoption of transaction cost economics as a conceptual building block. Rounding out the list is the most recent contribution by Javaid et al. [62], titled "A Review of Blockchain Applications in Financial Services," which accumulated 207 citations within a brief period. With an annual average of 69.0 citations and a normalized citation score of 8.39, the article's direct impact and growing importance are evident. The article summarizes the various applications of blockchain technology in financial services, reflecting the growing demand from academics and industry experts for comprehensive reviews amid the rapid development of the Fintech sector.

Taken together, the citation patterns observed suggest that the influence within the blockchain-banking literature is more linked to the capacity to relate technological advancements to broader institutional, accounting, regulatory, and socio-economic issues than to purely technological innovation. Works that receive a high number of citations bring together conceptual theorization (like fintech transformation), incorporate insights from multiple disciplines (such as accounting, law, and information systems), and present empirical evidence that tackles real-world banking issues, including trust, financial inclusion, compliance, and efficiency. This highlights that the most impactful articles in academia frame blockchain not merely as a technical tool, but as a driver for significant changes in banking ecosystems. As a result, the structure of citations indicates a mature field that is progressively focusing on governance frameworks, adoption processes, regulatory legitimacy, and organizational transformation instead of isolated demonstrations of technology.

3.2. Science Mapping

Science mapping examines the relationships among contributors in a research field. Particularly, it focuses on patterns of intellectual interaction and structural connections between key scholarly constituents, such as how sources, countries, institutions, authors, references, keywords, and publications relate to each other [46, 63, 64].

The present study uses a range of science mapping techniques, including co-authorship analysis, co-citation analysis, co-occurrence analysis, and bibliographic coupling analysis. These methods facilitate gaining in-depth knowledge about the evolution of the field, the collaborative patterns that characterize it, and the thematic structure that underpins it [46]. When paired with network visualization software such as VOSviewer, these methods illustrate the bibliometric and intellectual structure of the research landscape [41, 45], as outlined below.

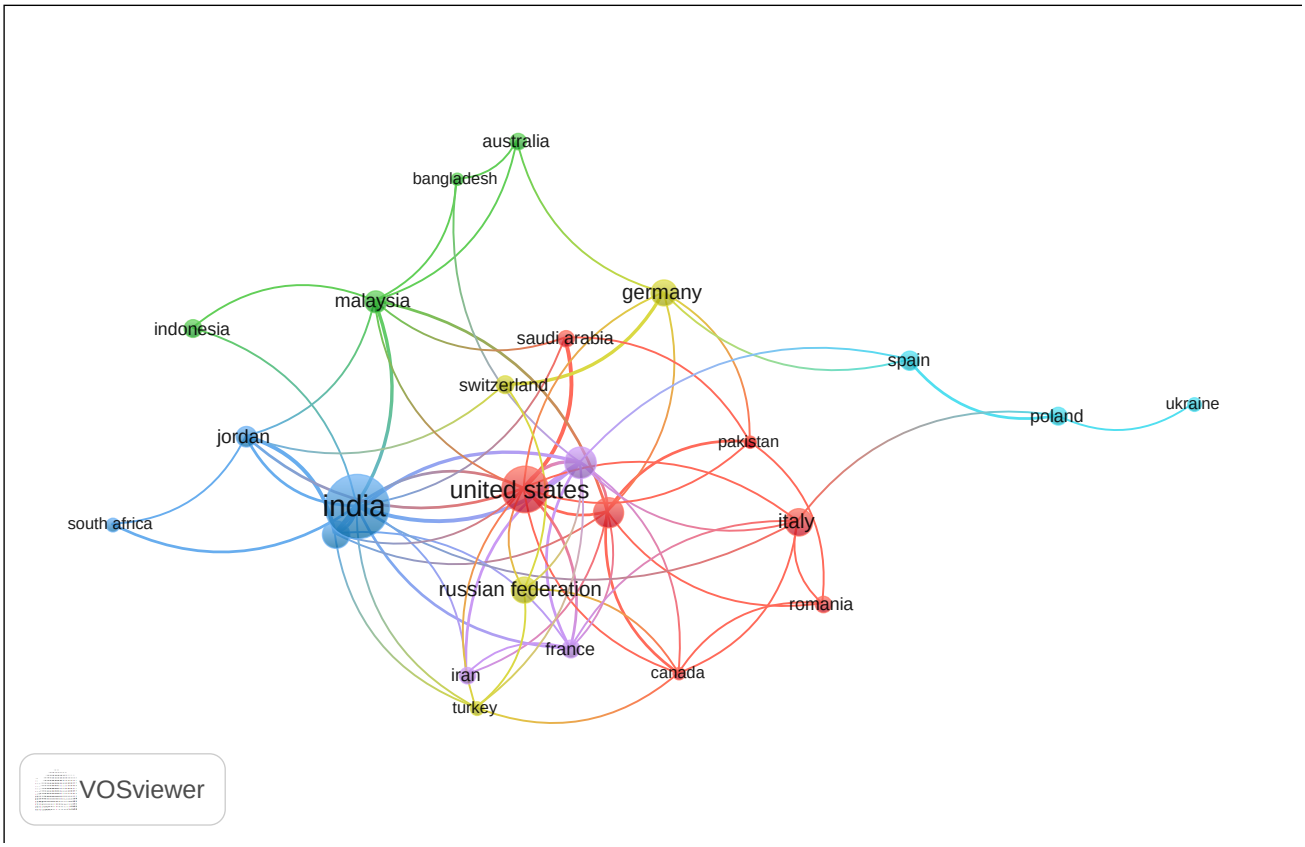

Figure 3. International Co-authorship Network of Countries in Blockchain and Banking Research. *Node size represents publication volume, link thickness indicates collaboration intensity, and colors denote distinct collaboration clusters.*

3.2.1. Co-authorship of Countries

Co-authorship analysis is a bibliometric technique that is employed to study patterns of collaboration among authors, institutions, and countries based on joint publications [65, 66]. At the national level, it reveals international research collaboration, mapping the global dispersion of scientific production and the transnational network structure [67, 68]. Particularly, the analysis reveals leading countries, maps geographical patterns of collaboration, and illustrates the effect of international networks on knowledge production [69, 70].

To explore global collaboration in blockchain research in the banking sector, we conducted a co-authorship analysis at the country level using VOSviewer. We included countries that had at least five documents and 30 citations. This led to 25 out of 88 countries meeting the criteria, with 72 links and a total link strength (TLS) of 105. As shown in Figure 3, the visualization displays six color-coded clusters, where nodes represent countries and links indicate the strength and frequency of co-authorships. Node size reflects publication volume, while link thickness shows collaboration intensity, and TLS quantifies a country's total collaborative strength.

The blue cluster, led by India, comprises the United Arab Emirates, Jordan, and South Africa, indicating close cooperation between South Asia and the Middle East. The central position and large node size of India highlight its high research productivity and its role as a regional leader in blockchain innovation. The participation of the United Arab Emirates and South Africa signifies an escalating level of interest in the financial applications of blockchain among digitally transforming economies.

The red cluster comprises the United States, China, Italy, Romania, Saudi Arabia, Pakistan, and Canada, forming a wide intercontinental network. The U.S. stands out for its high research volume and multiple collaborative ties. This cluster spans North America, Europe, the Middle East, and South Asia, indicating rich interdisciplinary exchanges. China and Italy are major contributors to the technological and regulatory aspects of blockchain, while Saudi Arabia and Pakistan can point to stronger academic connections with the West, possibly underpinned by digitization reforms and plans like the Vision 2030 of Saudi Arabia.

The yellow cluster includes the Russian Federation, Germany, Switzerland, and Turkey. Though geographically spread across Europe and Eurasia, these countries show strategic interest in digital finance and decentralization. Germany and Switzerland lead in fintech, while Russia and Turkey focus on modernizing financial systems, suggesting collaboration based on national strategies for digital transformation.

Moreover, the purple cluster consists of the United Kingdom, France, and Iran. The UK is the middle connection between the Middle East and Western Europe, showing high intra-European cooperation along with historical scholarly ties to the region. France and the UK are high-output researchers, while Iran shows up as a leading Middle Eastern producer of blockchain research. However, the light blue cluster includes Poland, Spain, and Ukraine. The nations, while not central, are reflective of increasing Eastern and Southern European engagement in blockchain research. Their inclusion is reflective of increased cross-border collaboration as well as a willingness to adopt blockchain towards economic modernization.

Overall, the findings of this analysis reveal a dispersed worldwide and interconnected research landscape. Developed and emerging economies are actively engaging with blockchain research in banking.

3.2.2. Co-citation of Authors

Co-citation analysis is a bibliometric technique that is applied to examine the intellectual landscape of a research area through analyzing how frequently two documents, authors, or sources are cited together in subsequent works [71]. A specific type of this analysis, Author Co-citation Analysis (ACA), examines how frequently two authors appear cited in tandem, therefore reflecting the conceptual structure underlying scholarly communication and conceptual evolution in an area [72, 73]. An increased frequency of co-citation between two authors implies a tight thematic correspondence or common influence on the shaping of specific streams of research [74].

In the current study, to better understand intellectual foundations and underlying blockchain research in the banking context, an author co-citation analysis was conducted using VOSviewer software. We applied a minimum threshold of 25 citations per author, resulting in the identification of 102 prominent authors out of a total of 25,779 who met the predefined criteria.

As shown in the network map in Figure 4, the authors were distributed to four distinct clusters, each represented by a different color. This network included 4,921 co-citation links and a total link strength of 56,680. The authors are shown as nodes within the clusters, while the edges illustrate how they have been co-cited. The sizes of the nodes indicate the extent of their co-citation. As a result, authors who are frequently co-cited appear as larger nodes. This pattern reveals a strong trend in scholarly relationships and co-citations, along with the overall growth in research for this field.

The red color is the first cluster in the network map. It is the largest and most central cluster and consists of authors like Chen Y., Chen S., Wang Y., Wang H., Liu J., Zhang Y., and Xu X. These authors have made major contributions in applying blockchain technology, digital technology, and information systems to banking and finance. They are most frequently cited in academic literature, i.e., they are the foundation of theoretical and empirical research on blockchain technology in the field. This cluster is also highly linked to other clusters, which indicates the intellectual power of the cluster over other fields.

In contrast, the second cluster, as can be shown by the blue color, includes prominent authors Kumar S., Khan S., Arner D.W., Zetzsche D.A., Thakor A.V., Kauffman R.J., and Hassan M.K. These authors are mainly involved with financial regulation, law, and policy matters related to blockchain technology. Their co-citation network indicates that they concentrate on the risk, governance, and legal concerns of blockchain implementation in banks. The uniqueness of the cluster indicates the interdisciplinary connection of information systems, law, and finance.

The third cluster, shown in green color, consists of authors such as Nakamoto S., Tapscott D., De Filippi P., Eyal I., Zhang Z., Hassani H., Janssen M., Potts J., and El-haddadeh R. They provide an all-round perspective of the revolutionary role of blockchain technology in banks. They examine cryptocurrencies, decentralization, governance, and innovation. Additionally, their co-citation suggests blockchain research covers a wide range of themes, from technical to legal, economic, and regulatory domains.

Finally, the fourth yellow color cluster comprises the following authors: Dwivedi Y.K., Kshetri N., Gupta S., Gunasekaran A., and Venkatesh V. This cluster also appears to be talking about information systems, models of technology adoption, and regulatory effects of blockchain technology. The cluster suggests that there is a widening of the research landscape on the implementation of blockchain technology in bank operations and business designs, with a concentration on technology adoption and strategic management.

In summary, these findings will be valuable to other researchers, IT professionals, financial service firms, practitioners, and banking professionals looking to consult with the right experts in related services.

3.2.3. Keyword Co-occurrence Analysis

Keyword co-occurrence analysis is a widely used bibliometric method that is employed to map and identify the intellectual structure and thematic evolution of a research field. It measures the frequency with which co-occurring pairs of keywords appear in the same papers, based on the assumption that higher co-occurrence indicates a stronger conceptual relationship between the terms [47]. This technique enables researchers to identify the primary research themes, evaluate the conceptual associations, and detect emerging topics in the literature [45, 75].

In the present study, we conducted a keyword co-occurrence analysis using VOSviewer software to gain a more profound understanding of the thematic context of blockchain technology in the banking sector. This approach has been demonstrated to be effective in identifying the leading research clusters and their connections. This is based on the frequency of using keywords and how they co-occur across publications' titles, abstracts, and keywords.

For this study, a minimum of five occurrences for an author-keyword was applied as an inclusion criterion. This was used to ensure an analytical focus on the most relevant and frequently occurring terms. Of the 1,131 keywords examined, 52 satisfied this initial criterion. In the second stage of our research protocol, we manually refined the dataset of the selected keywords by merging singular and plural terms, such as "cryptocurrency" and "cryptocurrencies," "smart contract" and "smart contracts," and "bank" and "banks." We also consolidated and standardized synonyms, including "distributed ledger" and "distributed ledger technology," "fintech" and "financial technology," "decentralized finance" and "DeFi," and "banking industry" and "banking sector." Furthermore, we eliminated keywords that were not related to our topic, such as "bibliometric analysis and COVID-19." Following the data refinement, the 42 keywords were included in the final analysis. Table 8 presents the most frequently occurring keywords and the data needed to ascertain areas related to blockchain research in banking. The 42 keywords yielded 289 links, with a total TLS of 799, and were organized into six distinct thematic clusters.

Table 8. Top Keywords by Occurrence

Rank	Keyword	Occurrences	TLS
1	blockchain	206.00	373.00
2	fintech	68.00	171.00
3	banking	49.00	125.00
4	blockchain technology	49.00	49.00
5	cryptocurrency	40.00	104.00
6	bitcoin	33.00	92.00
7	artificial intelligence	19.00	54.00
8	financial inclusion	16.00	39.00
9	smart contracts	16.00	30.00
10	finance	14.00	39.00
11	digital banking	13.00	27.00
12	financial services	13.00	36.00
13	innovation	13.00	40.00
14	security	13.00	31.00

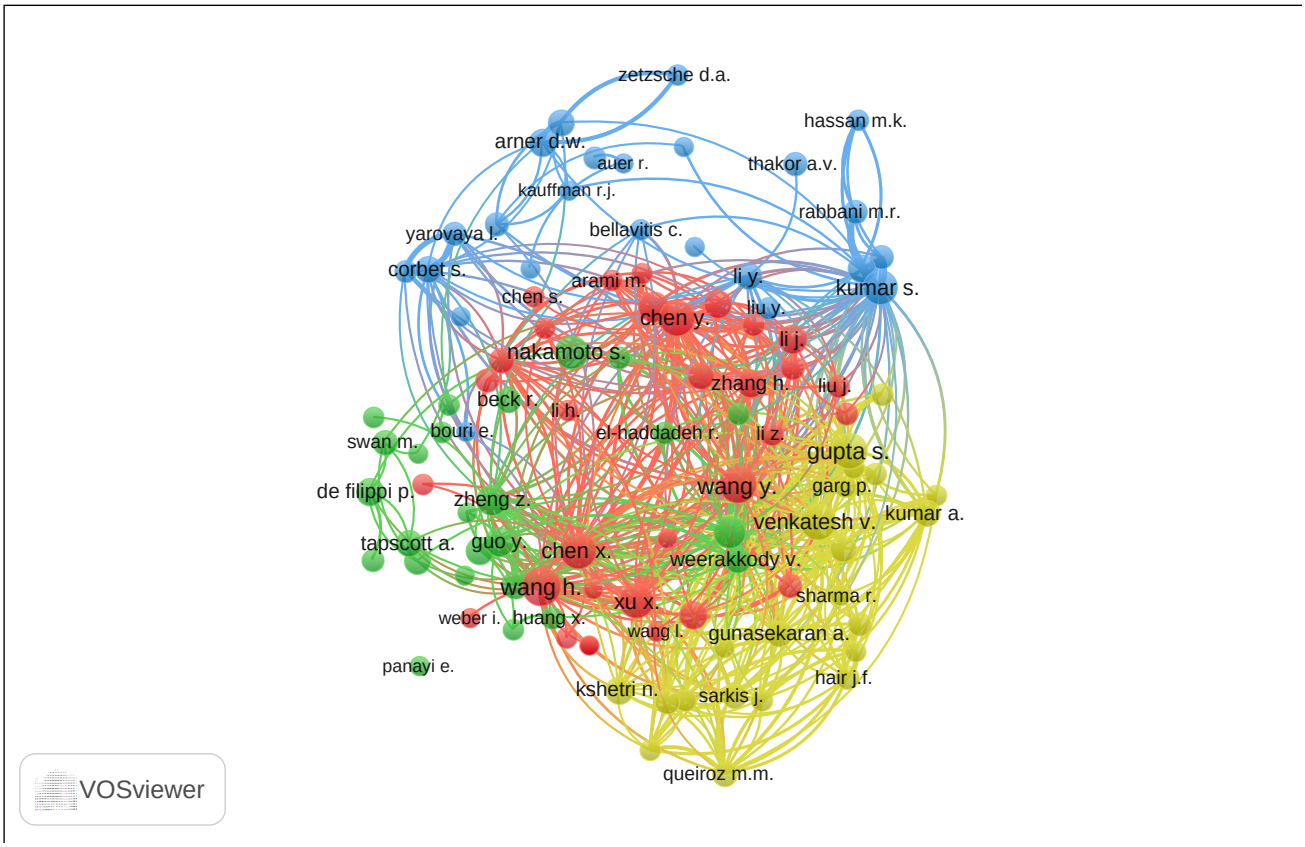

Figure 4. Author Co-citation Network in Blockchain and Banking Research. *Node size corresponds to citation influence, while links indicate co-citation strength. Colors denote major intellectual clusters.*

The network visualization produced (Figure 5) presents these clusters with each node representing a keyword, the node size representing frequency of occurrence, and lines (edges) representing co-occurrence relationships. The thickness of the lines is indicative of the strength of the relationship between terms, with thicker lines denoting a stronger relationship. The closeness of the lines to each other is also a helpful way to determine how related they are.

As shown in the network map, the keyword ”blockchain” is the most central node in terms of frequency of occurrence and interconnectivity. This is indicative of its central position in scientific discourse. Secondary keywords such as ”banking,” ”fintech,” ”cryptocurrency,” and ”Bitcoin,” which are also highly frequent and highly interconnected, emphasize blockchain’s central position in discourse regarding digital change in the finance and banking sector. The visualization (Figure 5) breaks down six distinct thematic clusters based on the following:

The initial cluster (blue) focuses on cryptocurrencies and decentralization, as evidenced by the terms ”blockchain,” ”Bitcoin,” ”cryptocurrencies,” ”decentralization,” ”Ethereum,” ”money,” and ”regulation.” The strong interconnection between these keywords and ”blockchain” indicates the inherent relationship of blockchain technology with digital currencies, particularly Bitcoin and Ethereum, which have always been of academic interest and a research topic in this field. Furthermore, the cluster groups critical words that define the world of cryptocurrency, since Bitcoin, Ethereum, and cryptocurrencies in general have a very close link with terms such as ”decentralization” and ”money.” It is clear that the literature in this cluster provides a comprehensive overview of the history and evolution of blockchain technology as applied to decentralized digital currencies. In addition to this, it provides a detailed discourse on the regulation of crypto assets, which is an inevitable consequence of the disruptive effect that these assets have on traditional financial institutions. This cluster reflects a wide range of studies on how blockchain technology can reshape the structure of money and payment systems, indicating sustained academic interest in decentralized money innovations.

Conversely, the second cluster (red) focuses on banking innovation and technology adoption. This cluster includes both emerging technology keywords, such as machine learning, artificial intelligence, big data, and the Internet of Things, as well as banking applications, including technology adoption, cybersecurity, sustainability, and digital banking. Together, these keywords encapsulate the technological infrastructure necessary to integrate blockchain technology into banking. Furthermore, this suggests that researchers are progressively interested in examining the combination of blockchain with other emerging technologies to re-engineer banking operations and service delivery. The emphasis on cybersecurity and sustainability indicates great concerns about the security and sustainability of innovation within financial institutions.

Similarly, the third cluster (in green) includes the keywords ”banking,” ”fintech,” ”finance,” ”financial services,” ”financial inclusion,” ”crowdfunding,” and ”peer-to-peer lending.” This indicates an awareness of blockchain technology’s macro-level ramifications on the augmentation of access to and efficiency of financial systems. The prevalence of the term ”fintech” in this cluster captures the essence of the transformation in financial intermediation, highlighting the pivotal role of blockchain technology in reengineering financial services. Additionally, the intersection of ”fintech” and

"financial inclusion" suggests a promising research area exploring blockchain's potential to address gaps in the banking sector.

Another notable cluster, marked in purple, focuses on trust-related issues and includes terms such as "trust," "transparency," "security," "privacy," "smart contracts," and "banking." The prevalence of these keywords indicates a persistent academic interest in the technological and ethical dimensions of blockchain technology. Specifically, the focus is on the potential impact of blockchain technology on trust, privacy, and security in banking and financial institutions. This thematic emphasis highlights blockchain technology's central role in addressing data integrity and user trust challenges, both of which are key to maximizing its value in banking applications.

The fifth cluster is represented by light blue and comprises keywords such as "digitization," "innovation," "digital transformation," "banking services," and "Islamic banking." These terms pertain to digital transformation and innovation in the banking sector. This thematic cluster indicates research trends that investigate the impact of blockchain technology on contemporary banking models with the aim of diversification and modernization.

The yellow cluster is particularly significant because it includes the keywords "distributed ledger technology," "decentralized finance," "financial regulation," "central bank digital currency," "cryptocurrencies," and "RegTech." These terms are poised to dominate future discourse concerning regulation and decentralized finance (DeFi). "Regtech" signifies the integration of regulatory control and compliance in blockchain-based banking. The cluster also highlights the pivotal role of policy and governance mechanisms in the adoption of blockchain technology in financial markets.

The network visualization of keyword co-occurrence in (Figure 5) led to the identification of six major clusters, confirming the thematic structure of the field. These clusters show the current research frontiers and common terms used by scholars. For the final synthesis and interpretation of these thematic clusters, please see Section 3.3.

3.2.4. Bibliographic Coupling of Documents

Bibliographic coupling is a bibliometric technique that measures the similarity between two documents based on their shared references. The extent of the overlap between references is indicative of the strength of the implied connection among the documents. This is because it is assumed that they are discussing the same topics or drawing on identical intellectual structures [48]. This technique is particularly useful for identifying stable research streams and the underlying intellectual structure of a research field.

The present study used VOSviewer to perform bibliographic coupling analysis and to visualize the intellectual structure of blockchain literature in the banking sector. Two documents are considered to be bibliographically coupled if they cite one or more of the common references. To enhance interpretability and focus on influential contributions, a minimum of 30 citations per document and a minimum cluster size of 10 documents were applied to be analytically significant. The application of this criterion resulted in the selection of 65 articles, which were subsequently organized into four clusters, each distinguished by a distinct color as shown in Figure 6.

In the resulting network visualization, each node represents an individual academic paper that has been used in the analysis. The size of a node is directly proportional to the number of citations it has received. The presence of larger nodes is indicative of a greater level of scientific influence. Lines linking nodes indicate bibliographic coupling relationships, while the thickness of the lines signifies the number of common citations between the two documents. The thickness of the line is indicative of the strength of the connection, with thicker lines denoting closer intellectual or thematic relationships. Moreover, the visualization map supports two important quantitative indicators. It produced 603 bibliographic links among the 65 documents that have demonstrated exceptional scholarly impact, as evidenced by their substantial citation counts. Additionally, the total link strength (TLS), calculated as the sum of all individual link strengths, is 1,226, reflecting high levels of connectivity and a comprehensive set of blockchain banking studies. The network map in this case provides valuable insight into thematic connectivity among highly cited articles. The clustering reflects how closely related the topics are and how references are linked between publications, which in turn highlights the main themes across the field.

Figure 6 demonstrates that Thakor's (2020) work exhibits considerable scholarly influence, characterized by its substantial node and cross-cluster edges, thereby establishing a significant connection between the domains of mainstream banking and blockchain literature. Dai (2017), Minoli (2018), and Schuetz (2020) have also been revealed to be central and highly connected nodes, forming a dense core within the red cluster. The significant overlap between these fields could potentially indicate an underlying contribution, particularly to blockchain technology and financial applications. In contrast, Auer (2022), Rehman (2023), and Kumar (2018) have focused their attention on peripheral areas, suggesting the existence of niches or novel research avenues that are less directly connected to the central literature. The peripheral nodes in this case reflect the growing bifurcation of topics such as DeFi and cryptocurrency regulation. As shown in Figure 6 6, the map visualization demonstrates the following clusters:

Cluster 1 (Red) is dominated by influential documents, including Dai (2017), Peters (2016), Schuetz (2020), Alhuwalia (2020), Hooper (2020), Shoaib (2020), and Cuccuru (2017). The cluster forms the theoretical basis of the field and focuses on blockchain technology infrastructure, settlement processes, transparency, auditability, and value creation within financial systems. This cluster constitutes a pivotal theoretical construct, establishing intricate internal relationships and exhibiting notable coupling strength.

Cluster 2 (Green), to which Thakor (2020), Minoli (2028), Chen (2017), Bayram (2022), Naimi-Sadigh (2022), Sangwan (2020), and Kimani (2020) belong, is characterized by its high level of interconnectedness and its tendency to explore blockchain convergence with FinTech innovation and financial inclusiveness for transforming banking services. This tendency is underpinned by a focus on empirical rationales and case-study findings.

Cluster 3 (Blue) consists of the following documents: Javaid (2022), Khalil (2022), Menon (2024), Elbashbishy (2022), Choo (2020), Rehma (2023), and Schlatt (2022). This cluster emphasizes digital transformation, service innovation, and customer-focused approaches to blockchain banking. The significant number of connections within this cluster indicates the presence of an emergent yet cohesive scholarly conversation.

Cluster 4 (yellow) is led by Garg (2021), Osmani (2021), Kumar (2018), Le Nguyen (2018), and Auer (2022). This cluster presents a network that also focuses on blockchain adoption models, consumer trust, and theories of innovation diffusion. This cluster is grounded in extant literature on the behavior and diffusion of innovation, thereby establishing a relationship at both technical and organizational levels.

The high interconnectivities among clusters emphasize the interdisciplinary nature of blockchain research in banking, due to the convergence of technology, economics, regulation, and behavioral perspectives. The prevalence of strong coupling relationships and numerous thematic avenues also suggests that, despite the fact that the field is still in its infancy, it has attained some level of maturity with well-defined but interrelated subfields.

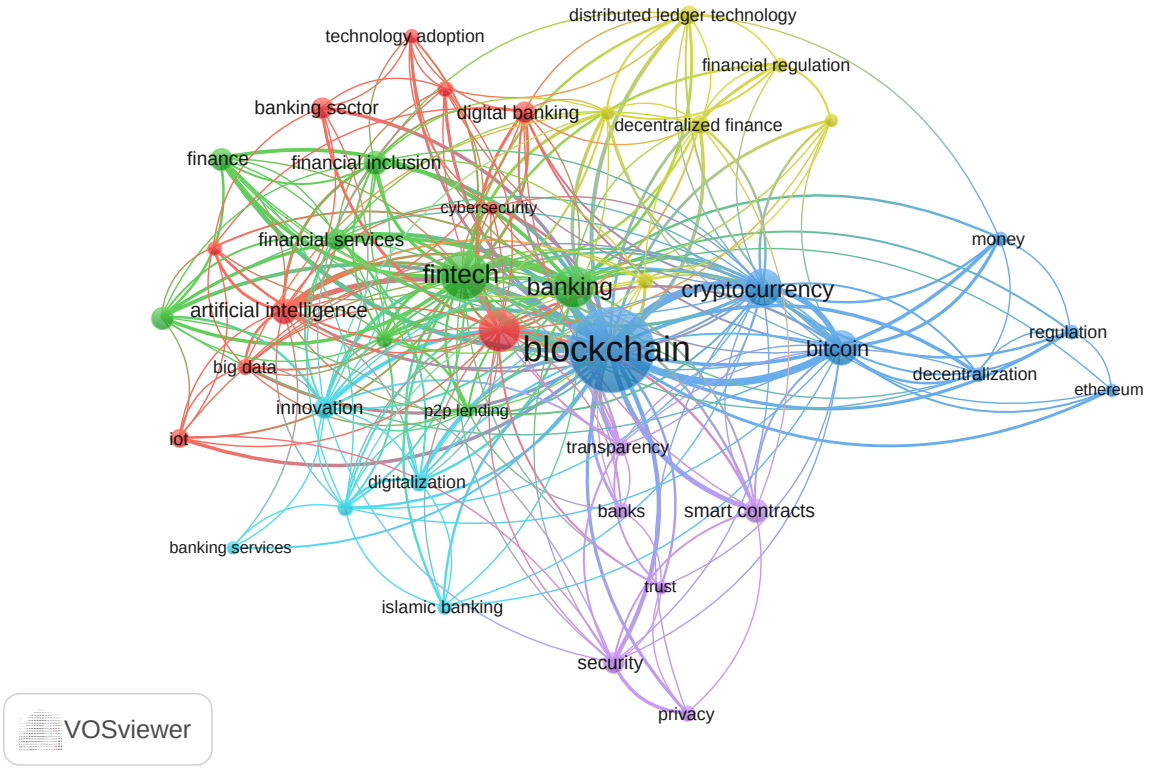

Figure 5. Keyword Co-occurrence Network of Blockchain and Banking Research. *Node size reflects keyword frequency, link strength indicates co-occurrence intensity, and clusters represent dominant thematic areas.*

3.3. Content Analysis and Thematic Clustering

In order to address Research Question 2 (RQ2), this section presents a qualitative thematic analysis of literature on blockchain technology in banking, which was systematically performed with the aim of identifying the main themes and providing a comprehensive understanding of the research landscape. Instead of repeating the bibliometric analyses provided in Section 3.2, this section builds on those quantitative findings to provide contextual interpretation, conceptual validation, and thematic coherence.

As outlined in the research methodology section, the initial identification of the major themes was derived using two methods: keyword co-occurrence and bibliographic coupling (as described in Sections 3.2.3 and 3.2.4). Keyword co-occurrence and bibliographic coupling highlight the closest relationships in terms of their relationship, or co-occurrence with each other, based on the frequency with which they were cited by authors and published in peer-reviewed journals [48, 76].

The previously described bibliometric research methods are helpful for creating a high-level map of the research domain. However, they do not provide a detailed explanation of the substantive content within the identified thematic clusters. To address this gap in the literature, we conducted a qualitative content analysis to synthesize, triangulate, and validate the mapped bibliometric thematic clusters.

To achieve this qualitative synthesis, we employed Braun and Clarke's thematic analysis framework [49]. First, we identified a dataset of 70 articles selected in previous sections of this paper. We then reviewed the articles manually to determine if the thematic clusters contained similar semantic meanings and if the cluster contents were conceptually consistent. Finally, we examined whether the thematic clusters contained relevant theories.

As illustrated in Table 9, this methodological approach yielded six robust thematic clusters that collectively define the intellectual structure of blockchain research in the banking sector from 2015 to May 2025. These thematic clusters represent the analytical framework through which to understand how blockchain influences financial intermediation, business processes, compliance with regulation, innovation strategy, trust creation, and integration with next-generation technology.

The following discussion focuses on the conceptual significance of these themes, providing a concentrated and analytical summary of the key intellectual trends in the field. This fulfills the mandate of the systematic content review phase.

3.3.1. Cluster 1: Blockchain Applications for Transforming Banking Operations and Financial Intermediation.

This cluster represents the most foundational and established body of literature on blockchains in banking, focusing on their ability to improve efficiency, smooth transaction frictions, or transform core banking systems. More conceptually, the literature in this stream is concerned with the idea that the value of blockchains is not found in isolated pilot projects but rather in their integration into back-office functions, interbank settlement mechanisms, and audit and compliance processes.

Foundational studies, such as [55, 56], establish the theoretical frameworks that describe how blockchain technology helps automate

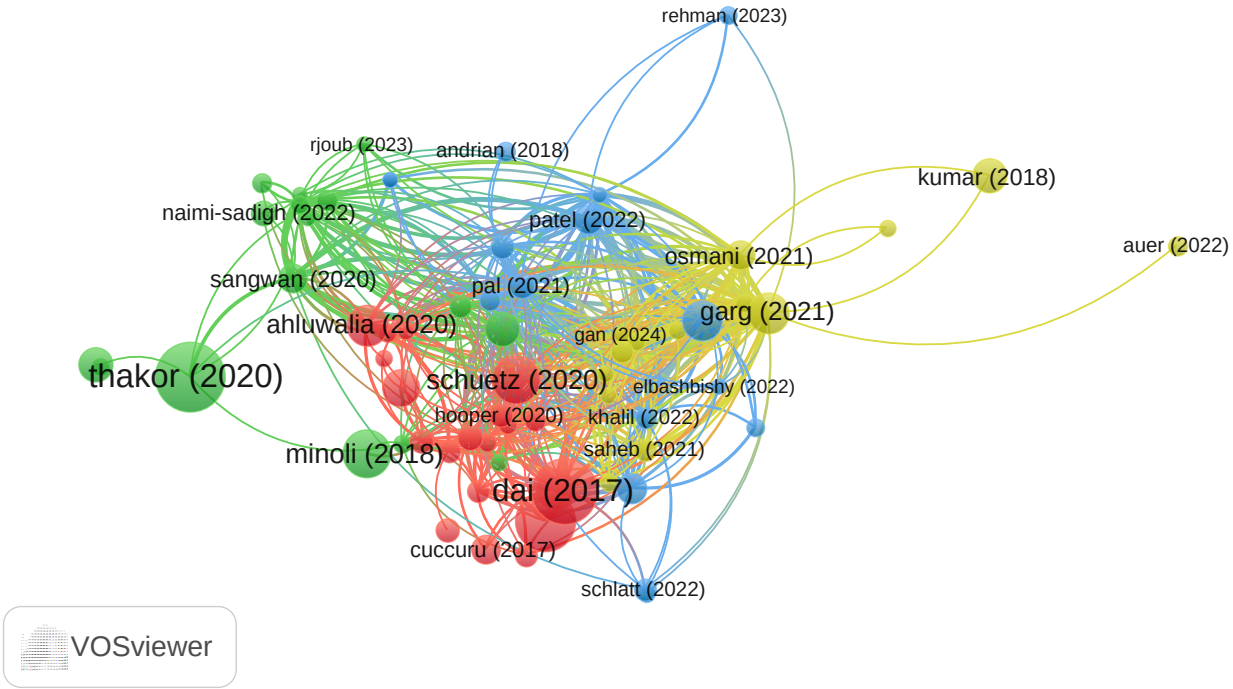

Figure 6. Document–Bibliographic Coupling in Blockchain and Banking Research. *Nodes represent documents, node size reflects citation influence, links indicate bibliographic coupling strength, and colors represent major intellectual and thematic clusters.*

Table 9. Identified Thematic Clusters in Blockchain Banking Research.

No.	Cluster Thematic	Main Themes	Sample References
1	Blockchain Applications for Transforming Banking Operations and Financial Intermediation	Real-time accounting, automation, reconciliation, operational efficiency, startup finance, and cost reduction.	[26], [55, 56],[61, 62],[77–80]
2	Decentralized Finance (DeFi) and Cryptocurrencies Enabled by Blockchain	DeFi, ICOs, remittances, financial decentralization, ethics of crypto, speculative behavior.	[81–87]
3	Blockchain as an Enabler of Digital and Financial Technology Convergence	Integration with IoT, AI, ML, FinTech, KYC, smart contracts, and digital ID; enhancing automation and inclusion.	[46], [54], [58], [88–92]
4	Trust-Related Dimensions in Blockchain-Based Banking	Trust, transparency, data privacy, organizational confidence, strategic alignment, adoption barriers.	[1], [60], [91], [93–96],
5	Regulatory, Legal, and Institutional Frameworks for Blockchain Governance	Smart contracts and law, compliance, anti-money laundering (AML), CBDCs, DeFi regulation, policy adaptation.	[59], [97–101]
6	Strategic Modernization of Banking Business Model Enabled by Blockchain	Disruption, competitive strategy, sandboxes, sustainable development.	[16], [37], [102]

banking ledgers, enhances settlement efficiency and reconciliation accuracy, and improves auditability. This technology also enables continuous quality assurance and real-time accounting systems. Building on this conceptual foundation, empirical evidence, notably from the Sponta Banca initiative, shows that blockchain frameworks significantly reduce settlement timeframes, enhance data traceability, and increase the reliability of interbank data exchange [77].

A large body of literature on this cluster, such as works by [26, 62, 80, 103, 104], consistently emphasizes the advantages of blockchain technology. Compared to traditional systems, blockchain technology enhances operational efficiency in terms of cost savings, risk mitigation, transaction security, transparency, and privacy. Also, this technology helps minimize information asymmetry and startup capital costs [61]. These benefits extend beyond payments to credit information systems, international settlements, and broader financial data networks. This reinforces the idea that blockchain technology is fundamental rather than limited in application.

Furthermore, this cluster emphasizes the strategic and organizational factors that facilitate successful blockchain implementation.

Research using technology adoption models [79] and innovation capability frameworks [105] identifies critical factors that mediate the operational effectiveness of blockchain technology, including trust, management commitment, and resource readiness. Furthermore, studies focusing on emerging markets [78, 106] indicate that banks' ability to achieve efficiency improvements is significantly affected by institutional maturity and technological infrastructure.

Overall, these findings underscore the importance of blockchain technology as a key tool capable of reducing operational costs, automating complex verification tasks, and promoting resilient financial systems with low response times. However, the studies also point to ongoing challenges, particularly with regard to scalability and institutional readiness, which continue to affect the speed and scope of practical implementation.

3.3.2. Cluster 2: Decentralized Finance (DeFi) and Cryptocurrencies Enabled by Blockchain

This thematic cluster focuses on an increasingly significant body of research that examines blockchain technology as the core infrastructure for decentralized finance (DeFi) and cryptocurrency-driven financial systems. Theoretically, research presents blockchain as a tool that eliminates intermediaries in conventional financial operations by allowing direct peer-to-peer value exchange, automating processes thr-ough smart contracts, and fostering transparent financial frameworks that function independently of central authorities. The core idea that emerges from this stream is that decentralized finance not only improves current banking processes but also radically challenges traditional models of financial intermediation.

Groundbreaking research indicates that decentralized finance offers an alternative financial structure capable of replicating essential banking activities or services, such as lending, borrowing, and asset trading, through decentralized protocols that are governed by code rather than traditional institutions [81]. This viewpoint is further reinforced by theoretical contributions that depict blockchain as a "trust protocol," highlighting its function in enabling transparency, immutability, and the automated execution of financial transactions [86]. Collectively, this body of literature lays the theoretical groundwork for comprehending how decentralized systems challenge conventional banking frameworks.

Furthermore, empirical and analytical studies within this thematic cluster reveal a more nuanced and diverse landscape. While blockchain-based money transfer systems and tokenized financial instruments show the potential to reduce costs and increase efficiency, evidence suggests that adoption of cryptocurrencies is often driven by speculative behavior rather than dissatisfaction with traditional banking services [85, 87]. Furthermore, research highlights persistent concerns about market volatility, governance ambiguity, and regulatory uncertainty, which continue to shape the risk profile of decentralized finance (DeFi) systems [82–84].

In addition to technical and economic factors, this research highlights the ethical, behavioral, and institutional consequences of DeFi. Studies focusing on accountability, financial inclusion, and ethical responsibilities caution that the decentralization of financial authority introduces new challenges associated with consumer protection, systemic risk, and regulatory supervision [82, 83, 107]. These findings imply that the transformative capacity of DeFi is closely connected to governance and public policy factors.

In summary, these studies affirm that decentralized finance (DeFi) and cryptocurrencies signify a groundbreaking extension of blockchain technology with the potential to transform financial intermediation. However, the research notes that the long-term viability of DeFi and its integration into mainstream banking systems depends on establishing regulatory frameworks, governance structures, and empirical evaluations of systemic risks.

3.3.3. Cluster 3: Blockchain as an Enabler of Digital and Financial Technology Convergence

This thematic cluster includes studies that look at blockchain as a fundamental infrastructure that supports and enhances the functionality of other emerging digital and financial technologies, such as artificial intelligence (AI), machine learning (ML), the Internet of Things (IoT), FinTech platforms, smart contract applications, and digital identity systems. Conceptually, the literature in this stream portrays blockchain not as an isolated solution but as a coordination and trust layer that improves interoperability, automation, and data integrity across complex digital ecosystems.

Key contributions within this cluster highlight the potential of blockchain to reshape financial value chains by facilitating decentralized data exchange, automated decision-making, and secure identity management [54]. In addition to financial services, this stream also highlights the role of blockchain technology in securing Internet of Things (IoT) systems by preventing data manipulation and enabling decentralized control, particularly in environments that require high levels of reliability and trust [58]. These studies portray blockchain as a complementary technology that enhances the reliability and transparency of data-driven financial services while paving the way for innovative digital intermediation. In this context, blockchain technology enables the secure integration of diverse technologies that typically operate in isolated locations.

Empirical studies further indicate that the convergence of blockchain with AI, big data analytics, cloud computing, and mobile banking technologies can lead to significant performance enhancements in the delivery of financial services, especially in lending, risk assessment, and customer onboarding processes [89, 90, 92, 107]. Evidence from banking applications points out that such technological convergence improves predictive accuracy, operational scalability, and financial inclusion, particularly for small and medium-sized enterprises and underrepresented populations.

A notable subtheme within this cluster focuses on digital identity management and automated compliance processes. Research on blockchain-based self-sovereign identity and smart contract–enabled Know Your Customer (KYC) processes shows significant advances in privacy protection, cost-effectiveness, and regulatory compliance [91]. Similarly, research on block-chain-enabled access control mechanisms highlights its potential to improve data management and security across interconnected digital platforms [88]. These applications demonstrate blockchain's potential to address long-standing inefficiencies in identity verification and data governance within financial institutions.

In summary, this cluster emphasizes the importance of blockchain as a key driver of technological convergence in digital finance. However, the literature also indicates ongoing challenges related to the system's compatibility, organizational coordination, and institutional compatibility. However, the literature also emphasizes ongoing challenges concerning system interoperability, regulatory harmonization, and compatibility. These limitations imply that the advantages of blockchain integration hinge on supportive institutional frameworks and the maturity of related technologies.

3.3.4. Cluster 4: Trust-Related Dimensions in Blockchain-Based Banking

This cluster synthesizes literature examining the impact of trust on the use of blockchain technology in banking. Cryptographic

verification and decentralized consensus have often led to characterizing blockchain as a "trustless" technology; however, existing studies continually highlight the importance of trust between organizations, user confidence, and the legitimacy of institutions when implementing blockchain within the financial sector. From a conceptual framework, research within this stream illustrates that whilst blockchain does not remove trust, it re-establishes it, moving it from centralized intermediaries to the technology itself, to governance structures, and to the institutions.

Empirical research indicates that, for both users and banks, perceived usefulness, transparency, and security are strong motivators for the adoption of blockchain technology, while technical capability is not as significant [1, 60, 93]. These results indicate that both types of trust (in technology and in the institution) interact with each other rather than exist separately.

A second theme in this cluster discusses blockchain's effects on increasing transparency and providing customers with greater data integrity and privacy. The research has indicated that the implementation of blockchain-based architectures can decrease the level of information asymmetry between lenders and borrowers, provide an increased level of auditing capabilities, and create greater levels of confidence in financial transactions through various regulatory processes, including lending [95, 96]. However, the literature points out that certain organizational barriers to establishing trust exist within financial industries, such as resistance to changing current ways of distributing credit and the lack of standardization, and the uncertainty regarding accountability, i.e., which party or parties are ultimately responsible in any given transaction [94].

Another prominent sub-theme is connected to digital identity and the privacy-preserving elements of the associated trust mechanism. Research examining digital identity management through blockchain and the application of KYC frameworks has illustrated that decentralized identity models will augment user control over their personal data and enable compliance with regulatory KYC requirements, while also assisting banks and regulators in forming a greater degree of institutional trust [91]. Furthermore, current research has demonstrated that the manner in which a digital identity is constructed has a direct impact on the level of trust between banks, regulatory authorities, and their customers.

In summary, the literature supporting this stream clearly establishes trust as a multi-dimensional construct that acts as an intermediary factor in the adoption of blockchain technology in the financial industry. While blockchain technologies provide a structure to increase transparency and security, the literature confirms that accepting blockchain technology into an organization must reach the appropriate balance between the institution's expectations regarding the reliability of the technology, the organizational readiness to use the technology, the availability of clear laws and regulations related to the use of the technology, and the overall level of acceptance by society at large.

3.3.5. Cluster 5: Regulatory, Legal, and Institutional Frameworks for Blockchain Governance

This thematic cluster synthesizes research on the impact of regulations, laws, and institutional frameworks on the use and adoption of blockchain technology in financial institutions. In theory, and according to the literature in this stream, blockchain technology contributes to greater transparency, process automation, and increased efficiency. However, institutions are unable to fully leverage this potential due to the uncertainty surrounding the regulation of this technology and because the current limited regulatory and legal structures are unable to keep pace with the transformation brought about by blockchain technology.

This theme focuses primarily on how enforcement and governance issues related to blockchain applications and the use of smart contracts are evolving. Many researchers point to numerous areas where the mechanisms for creating automatically enforced records conflict, as well as many unresolved issues related to accountability, jurisdiction, and the enforceability of programming-based agreements [97]. These challenges illustrate the difficulty of applying standard regulatory structures to decentralized financial systems.

Other important areas in this thematic cluster are compliance and risks that may threaten the integrity of the financial system and the systemic risks of blockchain technology. The use of blockchain technology for pseudonyms in financial transactions poses a potential dilemma for financial regulators [73] [99, 74]. The ease of creating anonymous accounts gives users easier access to money laundering [98]. At the same time, technologies enabled by blockchain, such as automated reporting, automated audit trails, and early warning systems, enhance transparency and regulatory effectiveness [100].

Additionally, studies indicate that regulatory approaches are necessary to support blockchain technology innovations. Regulatory sandboxes serve as tools for managing the relationship between innovation and risk through controlled testing, contributing to opportunities for learning, public policy development, and institutional adaptation [26]. Researchers are also exploring ways to integrate regulation into decentralized finance (DeFi) applications, emphasizing the need to incorporate governance and compliance mechanisms into system design as a means of mitigating the risks associated with decentralization [59].

Finally, studies on central bank digital currencies (CBDCs) show how the introduction of blockchain technology has prompted public authorities to develop hybrid governance models. Evidence from digital currency projects shows central banks' efforts to combine technological advances with centralized oversight to achieve financial stability objectives and ensure the effective transmission of monetary policy [101].

In conclusion, this research corpus reinforces the three essential ingredients for the long-term success of blockchain technology in the banking sector: regulatory clarity, institutional flexibility, and adaptive governance. In all three areas, the literature shows that sustainable governance of blockchain technology requires a balance between providing an environment conducive to innovation, ensuring legal certainty for consumers, and maintaining systemic financial stability.

3.3.6. Cluster 6. Strategic Modernization of Banking Business Model Enabled by Blockchain

This thematic cluster focuses on the role of blockchain as a mechanism for modernizing conventional business models in the banking industry, specifically as a type of strategic transformation. While much research refers to blockchain for its greater operational efficiency, the literature in this stream points out that blockchain's influence will create long-term economic and social governance systems by creating new biases toward competition and allowing for entirely new financial service architectures.

The literature in this cluster collectively conceptualizes blockchain technology as disruptive rather than complementary to existing systems and processes. This body of literature recognizes that blockchain platforms disrupt the traditional centralized structure of the banking industry by enabling the delivery of new services to customers and allowing peer-to-peer interactions to create value without going through a bank or intermediary. Consequently, banks are under increased pressure to reevaluate their strategic positioning, organizational structure, and competitive response to their evolving roles in the digital financial service environment [16, 37].

In addition, this cluster of research has further explored how business model innovation driven by blockchain technology can support financial inclusion and global sustainable development.

Studies have identified ways in which blockchain can provide expanded access to financial services, decrease transaction costs, and improve transparency in areas such as payments, savings, credit, and insurance, particularly inunderserved areas and regions [102]. However, the literature of this cluster has also emphasized that, for these potential strategic benefits to be realized, a supporting institutional framework is necessary.

In general, this cluster validates the assertion that blockchain is a strategic enabler of banking modernization, encompassing more than incremental process improvements. That said, the findings also indicate that the effect of blockchain on banking ultimately depends on how well financial institutions use and integrate the new technology into their organizational strategies and adapt to achieve organizational compliance and advance organizational goals in a changing economy and broader social structure.

4. Research Implications

4.1. Theoretical Implications

This review enhances blockchain adoption theory by broadening primarily individual-level acceptance models (e.g., TAM, UTAUT) and organization-centered readiness viewpoints (e.g., TOE, RBV) into a multi-tiered, ecosystem-based comprehension of blockchain dissemination in tightly regulated financial contexts. The bibliometric clustering demonstrates that blockchain adoption in the banking sector is influenced not only by technological preparedness or perceived value but also by the interplay of regulatory legitimacy, institutional trust, cross-organizational interoperability, and strategic resource management throughout financial networks. This observation refines traditional technology adoption models by highlighting that disruptive financial technologies face diffusion constraints imposed by governance frameworks and regulatory compliance demands, resulting in adoption pathways that are fundamentally different from those seen in cons-umer-oriented digital technologies.

Additionally, the thematic evolution indicates a theoretical shift within the literature from initial techno-optimistic narratives to analytical perspectives that focus on institutional, risk-oriented, and governance issues. This progression marks a shift from exploratory research on technology diffusion to integrated frameworks that regard blockchain as a facilitator of organizational transformation rather than simply a discrete operational tool. Therefore, this review presents a cohesive conceptual framework that incorporates technological, organizational, regulatory, and ecosystem dynamics into a comprehensive explanatory model for blockchain-driven financial innovation.

By synthesizing bibliometric findings with qualitative thematic analysis, this study presents an established, multi-level framework that describes the process by which the banking sector adopts blockchain technology as a broader ecosystemic and governance-driven process rather than a technology-driven phenomenon.

4.2. Managerial Implications

In addition to outlining technological advantages, the current findings suggest a strategic rethinking of blockchain as a tool for organizational transformation rather than a mere digital upgrade. By synthesizing insights from bibliometric and thematic clusters, this research shows that the success of adoption is more dependent on banks' capacity to implement coordinated process reengineering, cross-unit integration, and alignment of institutional governance than on technical installation.

The thematic clusters that highlight operational efficiency, cost savings, and process automation imply that blockchain should be viewed not just as a technological asset but also as a driver of operational reorganization. Therefore, banking managers are urged to re-evaluate current workflows and identify areas where distributed ledger technologies can optimize accounting processes, enhance reconciliation accuracy, and decrease overhead expenses through smart contract automation [55, 62].

Moreover, the findings stress the growing importance of security, transparency, and trust in modern banking practices. With increasing cyber threats and regulatory compliance demands, blockchain-based systems provide solutions for ensuring data integrity, tracing audit trails, and automating contract enforcement. These features are particularly pertinent to Know Your Customer (KYC) and Anti-Money Laundering (AML) compliance frameworks, where blockchain applications can support regulatory adherence while simultaneously enhancing institutional credibility [98, 103].

Similarly, the rise of decentralized finance (DeFi) and token-based ecosystems indicates a fundamental shift in banking business models. As a result, managers must look beyond incremental enhancements to investigate new service architectures, such as peer-to-peer intermediation platforms, blockchain-enabled payment systems, and digital asset tokenization. This shift requires innovation-driven leadership cultures, investment in blockchain-related expertise, and strategic alliances with fintech developers to maintain a competitive advantage.

Lastly, the noted decrease in citation impact alongside increasing publication volumes highlights the need for more practically oriented blockchain initiatives. Banking leaders must connect blockchain adoption to clearly defined institutional objectives, quantifiable performance metrics, and stepwise implementation strategies to ensure that investments yield tangible benefits rather than remaining symbolic or experimental.

In summary, these managerial implications illustrate that the adoption of blockchain is primarily a challenge of leadership, governance, and change management, rather than solely a decision related to technological procurement.

4.3. Practical Implications

From a practical viewpoint, this review indicates that blockchain technology generates its most significant benefits when it is integrated within regulatory and transactional frameworks rather than operated as a standalone pilot initiative. The most pronounced empirical focus in the literature pertains to cross-border settlements and interbank transaction clearing, where inefficiencies are still common. Incorporating blockchain into these areas has the ability to speed up settlement times, lower operational expenses, and reduce the risks of fraud [26, 56, 60].

Concurrently, blockchain provides capabilities for automating regulatory processes and managing identities. Smart contracts and decentralized identity systems can improve compliance precision and operational transparency, yielding considerable cost savings in fulfilling KYC, AML, and financial reporting requirements [80, 98]. Therefore, regulatory bodies and financial institutions are urged to consider RegTech-driven blockchain solutions not merely as additional controls but as comprehensive compliance frameworks.

The literature also highlights the inclusive potential of blockchain, especially via DeFi-enabled microfinance platforms, crowdfunding opportunities, and mobile-focused peer lending initiatives[59, 85, 108]. Such models create avenues for underserved communities to obtain financial services without reliance on traditional intermediaries. Implementation efforts should, therefore, prioritize areas with high rates of financial exclusion, particularly

in emerging and developing economies. For technology developers and consulting agencies, the insights point to key areas for development that include secure audit platforms, green finance traceability systems, decentralized asset management frameworks, and interoperable payment solutions. Collaborative design partnerships with financial institutions are essential to ensure that technological models closely correspond with sector-specific regulatory and operational needs.

Ultimately, the effective implementation of blockchain in the banking sector necessitates not only experimental adoption but also ongoing institutional coordination that encompasses regulatory dialogue, workforce education, governance adaptation, and strategic oversight. Thus, the full potential of blockchain is realized when technical advancements are aligned with organizational preparedness and policy coherence.

5. Conclusion and Future Research

5.1. Conclusion

This research comprehensively examined the evolving intellectual landscape and thematic development of blockchain studies within the banking industry from 2015 to 2025 using a hybrid approach that combines bibliometric analysis with qualitative systematic synthesis. The analysis of 389 peer-reviewed articles highlighted distinct developmental stages—from initial conceptual exploration to thematic broadening and into the current phase of applied governance and integration studies.

An analysis of geographic contributions revealed disparities, with the majority coming from India, the United States, and the United Kingdom, while newer research centers in China, the United Arab Emirates, and various parts of Europe are progressively influencing the empirical direction of the field. At the levels of institutions and authorship, research networks show both fragmentation and cross-regional collaboration, indicating that global integration in research is inconsistent.

Six key thematic clusters delineate the structure of disciplinary knowledge: financial intermediation and operational efficiency, decentralized finance (DeFi) and cryptocurrencies, convergence of blockchain technology, infrastructures for trust and transparency, regulatory and governance frameworks, and modernization strategies in banking. Together, these aspects characterize blockchain as not just a standalone technological fix but as an integrated transformation platform that concurrently impacts organizational frameworks, regulatory systems, and financial ecosystems.

Although the volume of publications is on the rise, the literature remains empirically scattered. Studies focusing on large-scale industry adoption are limited, the interactions between blockchain and complementary technologies (such as AI and IoT) are insufficiently theorized, and long-term evaluations of financial stability and systemic risk are scarce. Governance research, especially in areas of regulatory enforcement and international coordination, is also still underexplored.

In addition to mapping thematic growth, this review offers an integrative theoretical framework based on our synthesis of the six thematic clusters. This framework improves our understanding of blockchain adoption by presenting it as an innovation process influenced by regulatory legitimacy, organizational governance, and ecosystem interoperability, rather than merely a technical event. This integrative view distinguishes the current review from previous bibliometric analyses because it clearly articulates the causal relationships connecting our validated knowledge structure to the broader agenda of organizational transformation, regulatory alignment, and strategic value creation in finance.

As a result, this study provides a cohesive theoretical groundwork for future empirical research and offers practical insights for banking professionals and policymakers as they navigate the implementation of blockchain technologies in regulatory environments undergoing transition.

5.2. Future Research Directions

To improve our understanding of this research area, more research should be conducted on the six thematic clusters discussed earlier. Since research on blockchain technology in the banking sector is in its infancy, identifying and defining possible areas for future research is crucial. These research directions are derived from existing literature and reflect the gaps, constraints, and prospects identified by previous researchers.

Existing studies have identified that blockchain has the potential to transform operational processes in the banking sector for greater effectiveness, financial inclusion, and decentralized finance (DeFi), as well as to completely modernize business models [55, 81, 86]. However, serious issues remain regarding regulatory ambiguity [59], interoperability [26], adoption of trust [93], and integration into future-proof technologies [90]. Thus, future research must bridge these gaps through empirical, interdisciplinary, and cross-regional studies.

Table 10 shows directions reflecting both conceptual and practical priorities. These directions provide a research map for charting blockchain scholarship and positioning policymakers, financial institutions, and technology providers toward the development of secure, ethical, and scalable distributed ledger technology applications.

5.3. Limitations of the Study

Despite providing an overall bibliometric and thematic analysis, this study has some limitations that should be acknowledged. First, the dataset was derived exclusively from the Scopus database. Although Scopus provides the widest coverage of peer-reviewed journals related to finance, management, and information systems research, the exclusion of other databases (such as Web of Science, IEEE Xplore, and Google Scholar) may have resulted in the omission of some relevant publications, particularly conference proceedings and technically oriented studies. Nevertheless, this review focuses primarily on the social, economic, managerial, and organizational aspects of blockchain technology in the banking sector, rather than on the development of engineering or cryptographic systems, which are typically covered in technical databases.

Furthermore, the study examined 389 peer-reviewed articles from 2015 to May 2025. Due to Scopus's dynamic nature, the database used for the study might not include the newest publications at the cutoff time of the final submission, which could slightly affect the bibliometric results. The study only used VOSviewer to map and visualize bibliometric networks. Although VOSviewer is a popular tool, other tools, such as Gephi or CiteSpace, could have been used to provide additional bibliometric measures, including network centrality, modularity, and mediation scores.

Furthermore, this research did not propose a conceptual model for how banks adopt blockchain technology. Therefore, subsequent studies can build on this research to develop a more extensive model that encapsulates the multidimensionality of blockchain applications. Despite its limitations, the research provides a preliminary examination of the intellectual structure and thematic history of blockchain research in the banking sector.

Ethical Statement

No ethical approval was required for this study, as it did not involve human or animal subjects.

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Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article. Moreover, they assert that no conflicts of interest exist.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the author(s) used language editing tools/services, including DeepL and Grammarly, to improve grammatical accuracy and readability. The author(s) subsequently reviewed and edited the contents thoroughly for accuracy and integrity after utilizing these tools/services and are fully responsible for the final version of the manuscript.

Data Availability Statement

The bibliometric dataset supporting the findings of this study, including the Scopus CSV file used for VOSviewer analyses, is publicly available on Zenodo at:

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Credit authorship contribution statement

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Table 10. Blockchain Themes and Future Research Directions in Banking.

No.	Cluster Theme	Future Research Directions	References
1	Blockchain Applications for Transforming Banking Operations and Financial Intermediation	• Carry out comparative empirical research assessing the effects of smart contracts on transaction settlement durations and operational costs in various banks. • Create process-mapping models to quantify the reduction of reconciliation steps in interbank clearing attributable to blockchain (utilizing Business Process Model and Notation "BPMN" and time–motion analysis). • Perform cross-country econometric evaluations to determine how blockchain-based remittance solutions impact transfer expenses and delivery times in developing compared to developed nations. • Employ UTAUT2 or TOE frameworks to pinpoint the factors influencing blockchain adoption in retail versus corporate banking sectors. • Employ UTAUT2 or TOE frameworks to pinpoint the factors influencing blockchain adoption in retail versus corporate banking sectors. • Conduct case studies in low-income nations to uncover obstacles to scalability, interoperability, and institutional integration.	[56],[61, 62], [77],[79], [103],[105]
2	Decentralized Finance (DeFi) and Cryptocurrencies Enabled by Blockchain	• Model contagion and systemic risks within DeFi ecosystems through network analytics and simulation methodologies (e.g., agent-based modeling). • Conduct studies on regulatory impacts, comparing the effectiveness of various legal frameworks in mitigating fraud and protecting consumers in DeFi lending platforms. • Conduct studies on regulatory impacts, comparing the effectiveness of various legal frameworks in mitigating fraud and protecting consumers in DeFi lending platforms • Evaluate the influence of DeFi credit markets on the liquidity, profitability, and risk parameters of commercial banks. • Carry out behavioral studies to examine how cultural differences shape motivations for adopting cryptocurrencies (speculation versus utility).	[81–83],[85–87]
3	Blockchain as an Enabler of Digital and Financial Technology Convergence	• Design and evaluate blockchain–IoT prototypes for real-time Know Your Customer (KYC) / Anti-Money Laundering (AML) monitoring within banking data streams. • Assess the effectiveness of AI-enhanced smart contracts in dynamic access control through penetration testing and cybersecurity evaluations. • Create machine-learning models using blockchain transaction data to forecast credit risk or fraud patterns, and validate using actual banking datasets. • Develop and assess (Self-Sovereign Identity) SSI-based identity frameworks in partnership with banks to gauge improvements in onboarding efficiency and KYC compliance.	[58], [88],[90],[91]
4	Trust-Related Dimensions in Blockchain-Based Banking	• mixed-methods surveys and interviews to evaluate the impact of human trust and organizational culture on blockchain adoption within banks. • Establish a standardization readiness index to evaluate how system compatibility, legacy systems, and regulations impede blockchain integration. • Design blockchain-based credit scoring prototypes and assess their effectiveness in diminishing information asymmetry in SME lending. • Implement longitudinal studies to track how increased transparency through blockchain influences customer trust over time.	[60],[93], [95],[96]
5	Regulatory, Legal, and Institutional Frameworks for Blockchain Governance	• Propose and evaluate blockchain-enabled AML/CFT (Countering the Financing of Terrorism) monitoring systems and measure their detection accuracy compared to traditional systems. • Examine the efficacy of regulatory sandboxes by monitoring innovation outputs (patents, pilots, startups) preceding and following sandbox involvement. • Develop automated reporting and cryptographic proof systems for embedded supervision models in DeFi. • Analyze real-world CBDC pilot projects (e.g., e-CNY) to gauge privacy risks, transaction speeds, and impacts on monetary policy using macro-financial models.	[26],[59],[97],[98],[101]
6	Strategic Modernization of Banking Business Model Enabled by Blockchain	• Employ scenario analysis to illustrate how blockchain influences competition between neobanks and traditional banks. • Perform studies on the effects of financial inclusion by evaluating blockchain-based microfinance initiatives in rural or underserved areas. • Chart out policy, infrastructure, and institutional elements that contribute to successful blockchain-driven transformation using the PESTEL (Political, Economic, Social, Technological, Environmental, and Legal) framework and multi-country case research.	[16],[37],[102]

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