Research on the Application of Blockchain Technology in the Financial Field

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Abstract

With the advancement of information technology, the integration of technology and finance has become a major focus, triggering an innovation wave in the financial industry and technology sector. The emergence of Bitcoin brought blockchain technology into public view. As the underlying framework for Bitcoin, blockchain is a decentralized, distributed ledger system that effectively addresses three core challenges in traditional internet architectures: centralization, data security, and trust. Over recent decades, significant research has been conducted on cryptocurrencies and blockchain, particularly within financial field. However, existing literature has seldom been comprehensively reviewed, leading to limited in-depth understanding of cutting-edge research and a lack of definitive conclusions. To address this gap, this paper aims to analyse current research on blockchain applications in finance, thereby constructing a clear and systematic map of current literature and identifying the challenges and future research directions of blockchain in the financial field.

Keywords

Blockchain technology, finance, Decentration.

1. Introduction

1.1. Overview of Blockchain Technology

Blockchain is the underlying technology of Bitcoin and other cryptocurrencies, maintained by a decentralized network of computers [1]. It is regarded as an open ledger, with each block representing a node of the participants and every transaction being clearly recorded in the ledger [2]. Anyone can connect, send or verify transactions. In the long run, they potentially became powerful tools for reducing costs and bringing about significant changes in the financial field [3].

The development of blockchain can be divided into three stages [4]. The first stage of blockchain is digital currency, which uses blockchain to issue decentralized cryptocurrencies and achieve peer-to-peer transactions and circulation, transforming the payment system [5]. The second stage is smart contracts, which are used to create user-defined decentralized applications, such as option contracts, credit default swap contracts, voting systems, and independent applications for governance [6-9]. The third stage is to enhance performance. Due to capacity issues on the main chain, some transactions are transferred to side chains for continued processing [10,11]. During this period, applications outside the financial field emerged, driving reforms in other industries [12].

1.2. Features of Blockchain Technology

1.2.1. Decentration

The blockchain system does not rely on a central node for management. All nodes participating in the system have equal rights ,and the absence of information will not affect the overall operation [13-15]. The blockchain system allows any node to join or leave, and the consensus mechanism ensures that a certain degree of node damage does not affect the validity of the block [16].

1.2.2. Privacy

Blockchain has a unique method of implicit protection [17]. Transactions on the blockchain obey the accounting transaction rules and are signed by private keys. Therefore, it uses cryptography to block the connection with real identities in real life, which effectively protects users' privacy.

1.2.3. Open and Transparent

The consensus mechanism and smart contracts in blockchain are all open and transparent [18-20]. Nodes participating in transactions do not need to confirm each other's true identities. Meanwhile, the encryption technology and consensus mechanism of blockchain also prevent any deceptive behavior among nodes from tampering with any data.

1.2.4. Consensus Mechanism

The consensus mechanism is a set of digital procedures,aiming to ensure the accuracy and consistency of stored information among participating nodes [21]. The most distinctive feature of blockchain is the consensus mechanism, which uses a proof to verify the amount of work completed by each person, enabling the confirmation of ownership beyond the constraints of time and space [22]. During the process of decentralization, all nodes must reach an agreement on the rules, thus the requirement for consensus is even higher.

2. Research Status

2.1. Research on the Application of Blockchain Technology in the Financial Field

As the underlying technology of cryptocurrencies, like Bitcoin, blockchain technology is naturally suitable for the financial field and has a connection with finance. It was first widely explored and applied in the financial field.Currently, the specific application scenarios of "blockchain + finance" include:

2.1.1. Decentralized Cryptocurrencies

The issuance of decentralized cryptocurrencies through blockchain enables peer-to-peer transactions and circulation. These cryptocurrencies are essentially virtual currencies without intrinsic value and do not possess monetary attributes such as legal tender status and enforceability. They also do not have the same legal status as currency. For instance, Bitcoin is not issued by the central bank but generated by mining at various nodes. Moreover, its price fluctuates greatly and does not meet the conditions to be a legal tender.

Currently, many researchers compare the cryptocurrency market with the traditional financial market to analyze cryptocurrencies. The researches mainly focus on privacy protection and empowerment technology, but there is a lack of private key management and in-depth research.

2.1.2. Cross-border Payment

The cross-border payment system of the blockchain system only requires a common ledger to enable both parties to participate in supervision and management. Through a certain standard protocol for financial transactions, it can execute point-to-point transactions between global

banks, enterprises or individuals, thereby achieving direct cross-border payments without intermediaries, reducing payment time and costs, and enhancing payment security. The cross-border ledger of Ripple has also achieved great success. Currently, 17 banks worldwide have joined the system. Ripple has an independent developed protocol and completes point-to-point transactions through a consensus mechanism. Compared with the Bitcoin system, the Ripple system only verifies the latest ledger and has less work proof.

At present, research on the application of blockchain in cross-border payments mainly focuses on solving the "information silo" problem between different blockchains and improving performance. However, there is a lack of in-depth research and practical business models.

2.1.3. Asset Securitization

Asset securitization involves packaging an asset that will generate cash flow in the future and selling it in the form of securities. Currently, asset securitization faces some difficulties. The huge amount of information brings a significant challenge to traditional management and settlement. With the emergence of a public distributed ledger, the issue of fund settlement among multiple institutions can be well addressed, enabling faster settlement and reduced transaction costs. At the same time, "blockchain + asset securitization" can also alleviate the problem of information asymmetry, allowing both parties to better understand each other's credit and asset status, promote mutual trust, and thus complete transactions more effectively.

At present,the research mainly focuses on the problems and solutions faced by smart contracts and blockchain, but many of these studies lack practical performance evaluations.

2.1.4. Insurance Management

Blockchain can replace the current intellectual property and insurance management systems. Its working principle is to compress a file into a 64-bit hash code through an algorithm, with a one-to-one correspondence between the code and the file. The size of the file does not affect the reverse calculation, and the hash value will be recorded in the blockchain transaction and a timestamp indicating the existence of the digital asset at this moment will be added. Therefore, when the customer's information is input into the blockchain, it will automatically match the corresponding product, simplifying the process and improving the efficiency of insurance application. The consensus mechanism, tamper-proof and traceability of blockchain can effectively solve the problem of insurance fraud in the market. The smart contract of blockchain will automatically generate an insurance policy and make claims when an accident occurs, protecting the rights and interests of the insured. At the same time, the consensus mechanism and transparency of blockchain will also ensure that multiple claims do not occur.

The research on blockchain in insurance management presents a pattern of "strong in the middle and weak at both ends". Research on technical solutions for business process optimization is very active and specific.However, research on infrastructure and processes to ensure the credibility of real-world data on the blockchain is weak.And there is also a lack of research on legal compliance, user experience, and business models.

2.2. Research in the Field of Blockchain Regulation

2.2.1. Establish Alliances and Cooperation among Different Industries

Due to the involvement of numerous different types of subjects or organizations ranging from blockchain technology research to financial industry application, it increases the complexity of blockchain technology. Financial market participants, technology companies, regulatory authorities, and other entities need to enhance communication and coordination to establish effective, long-lasting, and in-depth cooperation mechanisms.

2.2.2. Strengthen Financial Regulation and Management of Blockchain

To improve the quality of services provided by blockchain in finance and the economy, regulatory authorities can utilize smart contracts to track criminal activities. At the same time,

authorities should continuously improve regulatory measures and strengthen international regulation and management of blockchain finance. Considering the complexity of blockchain technology and the potential legal issues , multiple institutions are needed to properly regulate activities related to blockchain . The regulatory issues faced by government agencies are also very sensitive and challenging, as it is necessary to ensure that the technology is not used for criminal activities. Therefore, a large number of legal issues still need to be addressed .

3. Methodology

As reported in Fig.1, we used Vosviewer to develop the cartographic analysis,which finds the occurrence and relevance to blockchain in the financial industries. By inputting the papers in the sample, we output a map of keywords to illustrate the occurrence of such words. According to Van Eck and Waltman (2010), the co-occurrence of words in papers are examined to assess relatedness. The cartographic analysis facilitates understanding the topics and issues that simulate researchers' interest. Since articles with the same keywords represent similar research directions, the graph analysis clusters all these keywords together."blockchain","cryptocurrency","financial technology" are the most recurrent words in the field of blockchain in finance.Moreover, the words "fintech" and "smart contracts" frame a cluster, similarly, the words "data privacy" and "fintech" also construct a cluster. Fig. 1 shows the cartographic analysis based on a minimum of 29 occurrences of a word among the papers in the sample.

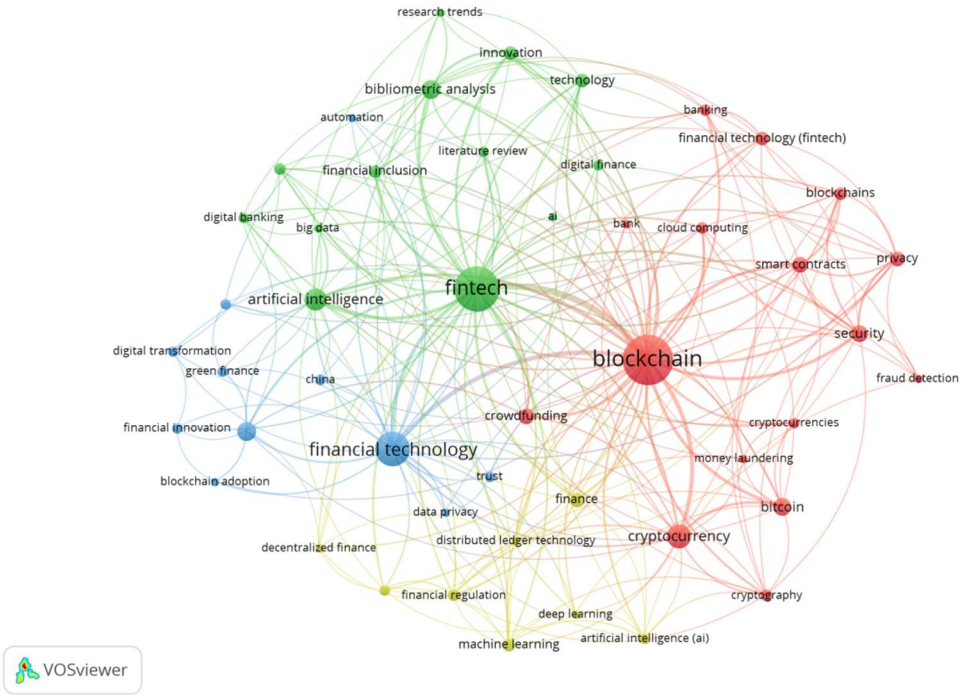

Fig. 1 Cartographic Analysis.

4. Conclusion and Future Research Agenda

4.1. Conclusion

This paper analyse current research on blockchain applications in finance,thereby constructing a clear and systematic map of current literature and identifying the challenges and future research directions of blockchain in the financial field. We analysed 3881 articles from the Web

of Science databases covering the period 2008–2024. We used the VOSviewer software for the bibliometric analysis and focus on cartographic analysis. We provide a content analysis of the literature:

Blockchain Technology applied in the Financial Field.Blockchain technology is widely applied in the financial field and can solve many significant problems. However, the issues brought by blockchain technology , like the uncertainties, high energy consumption, low throughput, and security, must be addressed before it can be widely used.

Blockchain Technology applied in the Regulatory Field.At present,the blockchain technology is not matural,so we need to establish alliances and cooperation among different industries.And since the development of the blockchain is complex, it requires higher demands on the data processing and risk response capabilities of the regulatory authorities.Therefore, we need to strengthen financial regulation and management of blockchain.

4.2. Future Research Agenda

As the application of blockchain is so broad, we need to record a lot of information. Therefore,we can not only use one blockchain to solve all issues.The diversified blockchains are the trend of the future.At present, the development of blockchain are still not mature. Many applications are only at the imagination stage and are still far from being implemented. Blockchain technology will first be experimented in some financial markets with infrequent transactions. Through continuous trial and error, the technology will be improved and eventually applied to the entire financial field.In the future, blockchain technology will be integrated with more fields to create the "blockchain +" situation.

References

[1] Luz, M. A. D., & Farias, K. (2020, November). The use of blockchain in financial area: A systematic mapping study. In Proceedings of the XVI Brazilian Symposium on Information Systems (pp. 1-8).

[2] Wu, B., & Duan, T. (2019, March). The application of blockchain technology in financial markets. In Journal of Physics: Conference Series (Vol. 1176, No. 4, p. 042094). IOP Publishing.

[3] Patel, R., Migliavacca, M., & Oriani, M. E. (2022). Blockchain in banking and finance: A bibliometric review. Research in International Business and Finance, 62, 101718.

[4] Kazi, J., Khandare, S., Kumari, R., Suryam, A., & Vinod, D. (2024, March). Decentralized Cryptocurrency Trading Application. In 2024 5th International Conference on Innovative Trends in Information Technology (ICITIIT) (pp. 1-6). IEEE.

[5] Luz, M. A. D., & Farias, K. (2020, November). The use of blockchain in financial area: A systematic mapping study. In Proceedings of the XVI Brazilian Symposium on Information Systems (pp. 1-8).

[6] Bello, G., & Perez, A. J. (2019, April). Adapting financial technology standards to blockchain platforms. In Proceedings of the 2019 ACM Southeast conference (pp. 109-116).

[7] Nguyen, Q. K. (2016, November). Blockchain-a financial technology for future sustainable development. In 2016 3rd International conference on green technology and sustainable development (GTSD) (pp. 51-54). IEEE.

[8] Pal, A., Tiwari, C. K., & Behl, A. (2021). Blockchain technology in financial services: a comprehensive review of the literature. Journal of Global Operations and Strategic Sourcing, 14(1), 61-80.

[9] Zhang, L., Xie, Y., Zheng, Y., Xue, W., Zheng, X., & Xu, X. (2020). The challenges and countermeasures of blockchain in finance and economics. Systems Research and Behavioral Science, 37(4), 691-698.

[10] Ren, Y. S., Ma, C. Q., Chen, X. Q., Lei, Y. T., & Wang, Y. R. (2023). Sustainable finance and blockchain: A systematic review and research agenda. Research in International Business and Finance, 64, 101871.

[11] Gan, Q., & Lau, R. Y. K. (2024). Trust in a 'trust-free'system: Blockchain acceptance in the banking and finance sector. Technological forecasting and social change, 199, 123050.

[12] Gong, Y., Zhang, Y., & Alharithi, M. (2022). Supply chain finance and blockchain in operations management: A literature review. Sustainability, 14(20), 13450.

[13] Ma, S., Cai, J., Wang, G., Ge, X., Teng, Y., & Jiang, H. (2024). Research on Decision Analysis with CVaR for Supply Chain Finance Based on Blockchain Technology. Mathematics, 12(3), 438.

[14] Vinayak, M., Panesar, H. A. P. S., dos Santos, S., Thulasiram, R. K., Thulasiraman, P., & Appadoo, S. S. (2018, July). Analyzing financial smart contracts for blockchain. In 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData) (pp. 1701-1706). IEEE.

[15] Dong, S., Abbas, K., Li, M., & Kamruzzaman, J. (2023). Blockchain technology and application: an overview. PeerJ Computer Science, 9, e1705.

[16] Makka, S., Prasad, M. D. V., Theja, R., Kamal, P. S. S., & Srikesh, S. (2024, December). Transforming Finance Through Blockchain using Smart Contract. In 2024 2nd International Conference on Artificial Intelligence Trends and Pattern Recognition (ICAITPR) (pp. 1-6). IEEE.

[17] Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. scientometrics, 84(2), 523-538.

[18] Tsao, Y. C., & Vu, T. L. (2022). A decentralized microgrid considering blockchain adoption and credit risk. Journal of the Operational Research Society, 73(9), 2116-2128.

[19] Smith, K. J., & Dhillon, G. (2020). Assessing blockchain potential for improving the cybersecurity of financial transactions. Managerial Finance, 46(6), 833-848.

[20] Savona, P. (2022). Prospects for reforming the money and financial system. Open Economies Review, 33(1), 187-195.

[21] Yoo, S. (2017). Blockchain based financial case analysis and its implications. Asia Pacific Journal of Innovation and Entrepreneurship, 11(3), 312-321.

[22] Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. Applied innovation, 2(6-10), 71.