ARTICLES

Beyond Speculation

The Transformative Power of Blockchain Technology in Various Industries

*Hatem Mabrouk**

Abstract

Blockchain technology has the potential to revolutionize several industries, from supply chain management and financial services to healthcare and voting systems. This article discusses how blockchain technology has begun transforming those industries by presenting real use cases demonstrating that blockchain is much more than just a tool for speculation. The article concludes by underlining blockchain's potential for future innovation and growth.

Keywords: blockchain technology, industries, transformation, applications, adoption.

A   Introduction

Due to its decentralized, open access and unregulated character, blockchain technology and its ability of securing and transferring monetary value in digital format have turned into a haven for speculators and fraudsters. The cryptocurrency market is mostly fuelled by speculative activity, with values being determined by daily news and emotions of market participants rather than by practical applications of the technology. In recent years, poor financial management, poor oversight and enforcement of corporate governance rules and the volatile nature of the cryptocurrency market led to the collapse of billion dollar 'unicorns' like Luna/Terra, FTX and BlockFi.[1] This emphasizes the inherent hazards of the cryptocurrency business and the need for more monitoring and regulation to protect investors

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1   Sánchez, S. (2022). 'La CNMV: "Las irregularidades de FTX no son una excepción" en el mercado de las criptos', Expansión Spain (Spain), 29 November, (online NewsBank). Available at: expansion.com/mercados/bitcoin/2022/11/29/6385c959468aeb79588b45c2.html?cid=BESOCYEXP01&utm_source=facebook&utm_medium=social_besocy&utm_campaign=BESOCYEXP01.

from fraud.[2] Undeterred by these collapses and problems, new businesses and investors are attempting to capitalize on blockchain technology and continue to invest heavily into the development of business applications. As a result, despite the difficulties, the cryptocurrency market thrives.

At its core, a blockchain is a distributed ledger that allows the recording of information, like the ownership and transfer of value and assets in any form, without the help of intermediaries like central banks, commercial banks, stock markets and brokers, government agencies, public registries for land or intellectual property ownership and so on. By cutting out middlemen and various steps and by incorporating artificial intelligence, it can improve processes and reduce the costs of transactions. That is why a growing body of evidence suggests that blockchain technology has strategic value for organizations and can disrupt various industries.[3]

Blockchain is transforming the financial sector. Banks and other financial organizations have been looking into using blockchain technology for cross-border payments and trade financing and to simplify the management of complicated financial products like derivatives. Several distributed ledger technology (DLT) applications are being developed in a variety of other industries, including healthcare and supply chains.[4] Among the benefits provided by DLT is the fact that information can be shared in a trustless environment with multiple participants while being kept immutable and in perpetuity.

Blockchain technology can increase patient confidentiality and security in the healthcare industry by generating safe and decentralized medical records and lowering the likelihood of medical errors. Blockchain technology can improve supply chain management by tracking the movement of medical goods from manufacturer to patient, reducing the possibility of counterfeit drugs and guaranteeing that patients receive the correct prescriptions at the appropriate time.[5]

In supply chain management, blockchain technology enables the construction of a secure and transparent record of a product's passage from origin to end-point. This leads to operational efficiencies and reduced fraud risk. The use of a decentralized ledger, managed by multiple nodes, enhances product authenticity

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2   *The Guardian* (2022). '"Complex and Volatile": Cryptocurrencies Should Be Regulated by Financial Watchdogs, Say Consumer Advocates; Treasury Inquiry Told "Crypto Is High-Risk and Unsophisticated Investors Are at High Risk of Losing Significant Funds" Get Our Free News App; Get Our Morning Email Briefing', 30 May. Available at: https://www.theguardian.com/technology/2022/may/31/complex-and-volatile-cryptocurrencies-should-be-regulated-by-financial-watchdogs-say-consumer-advocates (last accessed 16 February 2023).
3   Verma, S. and Sheel, A. (2022). 'Blockchain for Government Organizations: Past, Present and Future', *Journal of Global Operations & Strategic Sourcing*, 15(3), pp. 406-430, 419. doi:10.1108/JGOSS-08-2021-0063.
4   Weerawarna, R., Miah, S.J. and Shao, X. (2023). 'Emerging Advances of Blockchain Technology in Finance: A Content Analysis', *Personal and Ubiquitous Computing*, pp. 1-14, 4. doi:10.1007/s00779-023-01712-5.
5   Villarreal, E.R.D. et al. (2023). 'Blockchain for Healthcare Management Systems: A Survey on Interoperability and Security', *IEEE Access*, 11, pp. 5629-5652, 5629. doi:10.1109/ACCESS.2023.3236505.

and eliminates the possibility of counterfeiting by ensuring products are sourced from reputable and sustainable sources.[6]

The potential for transformation brought about by blockchain technology is not just a theoretical concept but is being actualized across several industries. With its ability to maintain secure and transparent records, blockchain technology can enhance efficiency, cut costs and boost security, transforming the traditional business landscape and opening new avenues for innovation and growth. In a variety of ways, DLT is already revolutionizing very nearly everything we do on the internet. Therefore, applications of blockchain technology are also being referred to as 'Web3', the latest upgrade for the WorldWideWeb, based on decentralization, blockchain technology and recordkeeping and the use of cryptocurrencies and tokens.

B The Transformative Power of Blockchain Technology: Real-World Applications

According to Statista, 'in 2021, global spending on blockchain solutions is projected to reach 6.6 billion dollars. Forecasts suggest that spending on blockchain solutions will continue to grow in the coming years, reaching almost 19 billion U.S. dollars by 2024'.[7] This section presents some use cases related to the implementation of blockchain technology across various sectors.
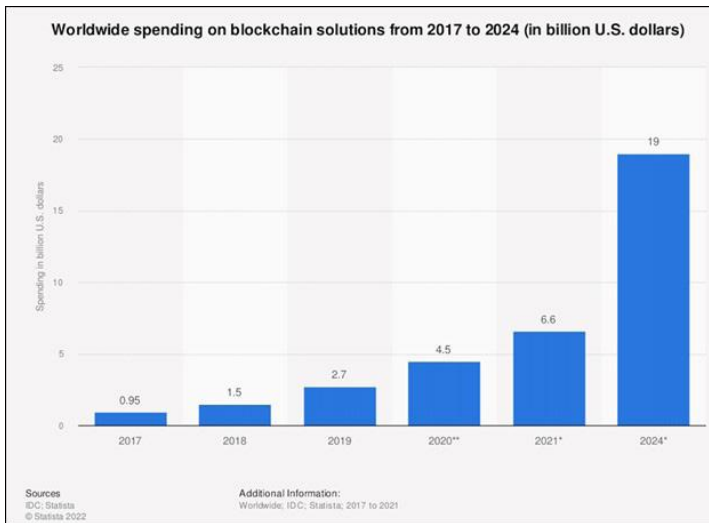
I Supply Chain

Supply chain management ensures the smooth transfer of goods/services from their point of origin to the final consumer. There is a continuous need for efficient supply chains because global trade and e-commerce have been growing. However, traditional supply chains face a lack of transparency, traceability, high costs and the possibility of fraud.

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6   Wu, H., Jiang, S. and Cao, J. (2022). 'High-Efficiency Blockchain-Based Supply Chain Traceability', p. 2. Available at: https://ieeexplore.ieee.org/document/10050199 (last accessed 16 February 2023).
7   IDC (2021). 'Worldwide Spending on Blockchain Solutions from 2017 to 2024 (in billion U.S. dollars)', *Statista*. Statista Inc. Available at: https://www.statista.com/statistics/800426/worldwide-blockchain-solutions-spending/ (last accessed 20 February 2023).

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Figure 1 *IDC (2021). 'Worldwide Spending on Blockchain Solutions from 2017 to 2024 (in billion U.S. dollars)'.[8]*

Worldwide spending on blockchain solutions from 2017 to 2024 (in billion U.S. dollars)

Year	Spending (billion U.S. dollars)
2017	0.95
2018	1.5
2019	2.7
2020**	4.5
2021*	6.6
2024*	19

Sources
IDC; Statista
© Statista 2022

Additional Information:
Worldwide; IDC; Statista; 2017 to 2021

Before blockchain technology, supply chain management was mainly based on manual processes and intermediaries, with no real-time information. This makes it difficult to track products and services. In addition, resorting to paper-based documentation consumed so much time and led to errors, delays and increased costs. Blockchain technology provides solutions to the challenges faced by traditional supply chain management.[9]

The capacity of blockchain technology to produce a safe and transparent record of a product's path from origin to destination is one of the technology's primary advantages in supply chain management. This is accomplished by developing a decentralized ledger that is kept up to date by a network of nodes, giving the supply chain visibility and real-time information. As middlemen are no longer required for transaction verification and recording, this lowers the risk of fraud while increasing operational efficiency.[10]

Enhancing product authenticity is another important advantage of blockchain technology in supply chain management. The impact of blockchain technology on supply chains and the logistics sector promises to be truly revolutionary. Put simply, Blockchain – shared digital data that allow transactions to be recorded and

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8   Statista. Statista Inc. Available at: https://0-www-statista-com.biblioteca-ils.tec.mx/statistics/800426/ worldwide-blockchain-solutions-spending/?locale=en (last accessed 20 February 2023).
9   Casino, F. et al. (2021). 'Blockchain-Based Food Supply Chain Traceability: A Case Study in the Dairy Sector', *International Journal of Production Research*, 59(19), pp. 5758-5770, 5759. doi:10.1080/00 207543.2020.1789238.
10   Yerpude, S., Sood, K. and Grima, S. (2023). 'Blockchain-Augmented Digital Supply Chain Management: A Way to Sustainable Business', *Journal of Risk & Financial Management*, 16(1), pp. 5, 7. Available at: https://www.researchgate.net/publication/366624452_Blockchain-Augmented_Digital_Supply_ Chain_Management_A_Way_to_Sustainable_Business (last accessed 16 February 2023).

verified on a computer network –increases the transparency of the supply chain, drastically reducing costs, especially onerous and complex bureaucracy. It also increases understanding of the global flow of trade, tracking specific items at each stage of their journey and the associated risks, enabling better management and mitigation of these risks, lowering the possibility of counterfeiting and improving the product's reputation, which ultimately benefits both the manufacturer and the final consumer.[11]

Due to the encryption and security of the data kept on the blockchain, blockchain technology can also assist in lowering the risk of data breaches. This is essential in sectors like healthcare where it is important to preserve private medical data.[12]

IBM and Maersk together developed the blockchain-based supply chain management platform known as TradeLens. By offering a safe and decentralized platform for tracking items as they move through the supply chain, it seeked to increase the efficiency and transparency of international trade. The platform employed smart contracts to automate and safeguard the tracking of commodities and was developed on top of the Hyperledger Fabric blockchain infrastructure.[13]

TradeLens' had the capacity to boost supply chain transparency. The permanent and tamper-proof record of transactions provided by blockchain technology aids in building trust among supply chain actors. This is important in a sector where suppliers, transporters and consumers must be able to see how items are being moved. All supply chain players were able to access a single source of truth with TradeLens, giving them real-time visibility into the status of their shipments.[14]

TradeLens not only improved transparency but also cut down on the time and expense of manual operations. The implementation of smart contracts made it possible for pre-agreed criteria to be automatically carried out, streamlining the supply chain and lowering the likelihood of mistakes or delays. When a package was delivered, for instance, the platform could release payment to the carrier, saving time and money that would otherwise be spent on laborious invoicing and payment procedures.[15]

TradeLens had the capacity to offer a safe platform for the supply chain management. A high level of security was provided by blockchain technology because of its decentralized structure and usage of cryptographic algorithms. This lessened the possibility of fraud or data breaches by preventing unauthorized access to critical information. The Hyperledger Fabric blockchain framework, which offers a secure and scalable platform for corporate blockchain applications, is also the foundation upon which TradeLens was based. Individual-distributed

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11 *Ibid.*
12 Omar, I.A. et al. (2021). 'Automating Procurement Contracts in the Healthcare Supply Chain Using Blockchain Smart Contracts', *IEEE Access*, 9, pp. 37397-37409, 37406. doi:10.1109/ACCESS.2021.3062471.
13 TradeLens (2022). 'What Is TradeLens?' Available at: https://www.tradelens.com.
14 Manila Bulletin (2020). 'ICTSI Connects Global Network to TradeLens Blockchain', 10 November. Available at: https://mb.com.ph/2020/11/10/ictsi-connects-global-network-to-tradelens-blockchain (last accessed 16 February 2023).
15 Chen, W. et al. (2022) 'A Transaction Cost Perspective on Blockchain Governance in Global Value Chains', *Strategic Change*, 31(1), pp. 75-87, 81. doi:10.1002/jsc.2487.

blockchain nodes could be hosted and managed by TradeLens, such as a participant, like a maritime shipper, or an authority. This method promoted separation among participants, who may be competing against each other. Each node contained both the blockchain platform components and dedicated blockchain-managed document storage for that node.[16]

Figure 2   *TradeLens' Blockchain Component with Distributed Nodes[17]*
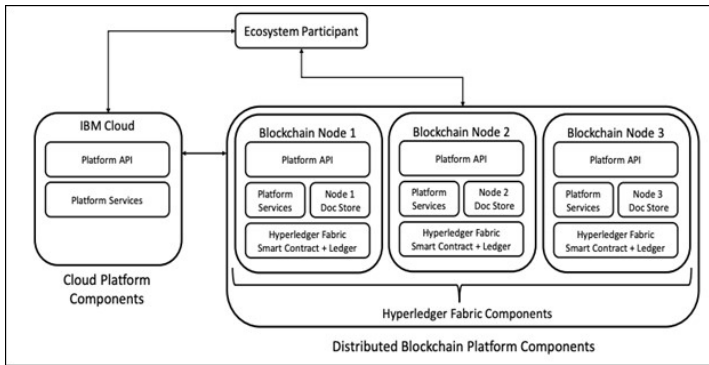
Moreover, TradeLens has attracted the attention of industry participants. By the first quarter of 2023, the platform had over 100 participants, including port operators, customs authorities and shipping companies, all of which processed 10 million+ shipping events on the platform.[18]

TradeLens increased transparency, minimized manual operation time and costs and provided a secure supply chain management platform. The implementation of blockchain technology provided tamper-proof and immutable transaction records, enabled the automatic execution of smart contracts and provided a high level of security.[19]

There are still certain challenges facing the implementation of blockchain in supply chain management. First, implementing blockchain-based supply chain solutions can be quite expensive and may require enormous expertise, which explains why the TradeLens team took action to discontinue the platform. For that reason, small- and medium-sized enterprises may struggle with implementing blockchain technology. In addition, the demand for standardized protocols and regulations is one of the major difficulties. Because there is no uniform standard, there are issues with interoperability, additional prices and complex procedures. Because blockchain technology has no specific version, it discourages new developers and investors from entering the industry. Scalability may be hampered

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16   Jensen, T., Hedman, J. and Henningsson, S. (2019). 'How TradeLens Delivers Business Value With Blockchain Technology', *MIS Quarterly Executive*, 18(4), pp. 221-243, 271. doi:10.17705/2msqe.00018.

17   Jensen, T., Hedman, J. and Henningsson, S. (2019). 'How TradeLens Delivers Business Value With Blockchain Technology', MIS Quarterly Executive, 18(4), pp. 221-243, 271. doi:10.17705/2msqe.00018.

18   TradeLens (2022). 'Network. TradeLens'. Available at: https://www.tradelens.com/network.

19   Goldsby, C. and Hanisch, M. (2022). 'The Boon and Bane of Blockchain: Getting the Governance Right', *California Management Review*, 64(3), pp. 141-168, 157. doi:10.1177/00081256221080747.

by blockchain networks' capacity to handle a huge volume of transactions. Because of the enormous number of transactions, more efficient and scalable blockchain technology should be employed for supply chain management.[20]

In summary, blockchain technology can completely transform supply chain management by producing secure and transparent records of product origin and destination. By reducing the risk of fraud and improving operational efficiency, businesses and end-users ultimately benefit. Major challenges such as scalability, high installation costs and the requirement for consistency must all be resolved before blockchain technology can fully realize its promise in supply chain management.

II   Finance

Blockchain works like an account book, where purchases, sales or any transaction is recorded. One of the advantages of this tool is providing the possibility of making economic transactions quickly and safely against possible fraud and manipulation since it uses encryption and coding. This allows companies to offer a more global payment alternative to customers, without jeopardizing the security of all the parties involved in the transaction, that is, the buyer and the seller. Another great benefit to using blockchain is the possibility of implementing a completely transparent business system in which we can all see the up-to-date status of the accounts registered in the blockchain book/ledger, that is, what goes in and what goes out, in real time and at a low cost.

According to Statista, in 2021, 'cross-border payments and settlements were considered the largest individual blockchain technology use case, accounting for close to 16 percent of the global blockchain technology market. Lot lineage and provenance also accounted for a larger portion of the market share, with 10.7 percent'.[21]

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20   Dutta, P. et al. (2020) 'Blockchain Technology in Supply Chain Operations: Applications, Challenges and Research Opportunities', *Transportation Research Part E*, 142, p. 17. doi:10.1016/j.tre.2020.102067.
21   IDC (2021). 'Blockchain Technology Market Share Forecast Worldwide in 2021, by Use Case', *Statista*. *Statista Inc*. Available at:
https://www.statista.com/statistics/982566/worldwide-top-use-cases-blockchain-technology-by-market-share/#:~:text=Top%20use%20cases%20for%20blockchain%20technology%20in%20terms%20of%20market%20share%20worldwide%202021&text=In%202021%2C%20cross%2Dborder%20payments,the%20global%20blockchain%20technology%20market.
(last accessed: 16 February 2023).

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Figure 3   *Worldwide blockchain technology market share forecast in 2021, by use case[22]*
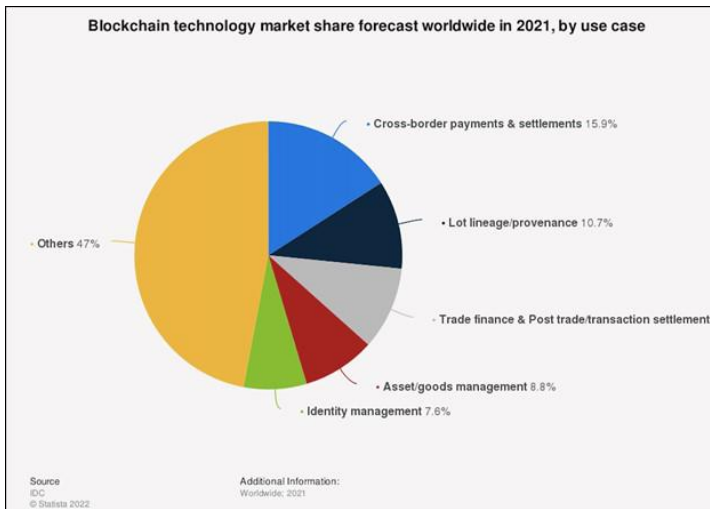
The development of stablecoins is one use of blockchain technology in the financial sector. Stablecoins can be used for cross-border payments on blockchain networks. A stablecoin is a cryptocurrency that is linked to the value of a selection of commodities, assets or fiat currencies. Stablecoins are excellent for financial transactions and as value storage due to their stability.[23]

USDT (Tether) is a typical illustration of a stablecoin. In comparison to conventional wire transfers, it has cheaper transaction costs and quicker processing times. It is anchored to the US dollar and may be used to send money internationally. Stablecoins open new options for people and companies in the cryptocurrency economy by allowing for lending, borrowing and other financial transactions. Using stablecoins improves the speed and security of financial transactions since blockchain is a decentralized and open ledger.[24] Additionally, the capacity to move stablecoins without the need for middlemen can provide individuals and companies with more financial flexibility and access.

Even though numerous stablecoins use the US dollar as collateral, three of these digital assets were far more valuable than the others. Tether, USD Coin and Binance Coin are the most well-known examples of collateralized stablecoins that

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22   IDC. [2021]. 'Blockchain Technology Market Share Forecast Worldwide in 2021, by Use Case', Statista. Statista Inc. Available at: https://0-www-statista-com.biblioteca-ils.tec.mx/statistics/982566/worldwide-top-use-cases-blockchain-technology-by-market-share/ (last accessed 16 February 2023).

23   Łęt, B. et al. (2023). 'What Drives the Popularity of Stablecoins? Measuring the Frequency Dynamics of Connectedness between Volatile and Stable Cryptocurrencies', *Technological Forecasting & Social Change*, 189, pp. 1-2. doi:10.1016/j.techfore.2023.122318.

24   Saengchote, K., Putniņš, T. and Samphantharak, K. (2022). 'Does DeFi Remove the Need for Trust? Evidence from a Natural Experiment in Stablecoin Lending', p. 11. Available at: https://0-search-ebscohost-com.biblioteca-ils.tec.mx/login.aspx?direct=true&db=edsarx&AN=edsarx.2207.06285&lang=es&site=eds-live&scope=site (last accessed 18 February 2023).

are backed up by a reserve asset. Stablecoins have frequently been associated with their close relationship to 'real-world' fiat currencies to achieve price stability and ensure the value of the digital asset, most notably the US dollar. Because of this, Tether, USD Coin and Binance Coin were all ranked among the top cryptocurrencies in the world in June 2022. There are, however, other assets that can be used to back a stablecoin.[25]

Figure 4   *Market capitalization of US dollar-backed stablecoins from June 2017 to June 2022*[26]
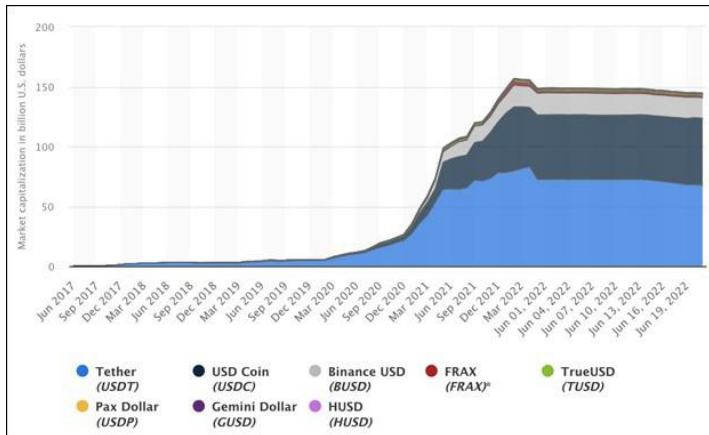
Decentralized exchanges (DEXs) are one of the most important advancements built on top of blockchain technology. Cryptocurrency traders may use those exchanges to buy and sell cryptocurrencies. DEXs allow users control over their keys and personal assets, making them less vulnerable to theft and hacking than centralized exchanges (CEXs), which retain users' funds under the exchange's authority. Because they are not subject to the same rules and regulations as CEXs, DEXs can provide better resilience to privacy and censorship, but they can also become attractive places for scammers to list their scam cryptocurrencies there.[27] That is why due diligence and research are always needed in a decentralized world.

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25   Statista (2022). 'Estimate of the Market Capitalization of Fiat-Backed Stablecoin with a Focus on the USD, from June 2017 to June 21, 2022 (in billion U.S. dollars)', *Statista*. Statista Inc. Available athttps://www.statista.com/statistics/1316079/usd-backed-stablecoin-market-value/ (last accessed 18 February 2023).

26   Statista (2022). Market capitalization of US dollar-backed stablecoins from June 2017 to June 2022, 'Estimate of the Market Capitalization of Fiat-Backed Stablecoin with a Focus on the USD, from June 2017 to June 21, 2022 (In Billion U.S. Dollars)', Statista. Statista Inc. Available at: https://0-www-statista-com.biblioteca-ils.tec.mx/statistics/1316079/usd-backed-stablecoin-market-value/ (last accessed 18 February 2023).

27   Over 10K scam tokens and scam liquidity pools were identified in Uniswap. See Xia, P. et al. (2021) 'Trade or Trick? Detecting and Characterizing Scam Tokens on Uniswap Decentralized Exchange', p. 3. Available at: https://arxiv.org/abs/2109.00229 (last accessed 19 February 2023).

Uniswap and PancakeSwap are examples of DEXs. They enable users to transact in cryptocurrencies in an automated, decentralized fashion without the involvement of middlemen. One of the most prominent features of DEXs is that they allow companies and start-ups to create liquidity pools and list their tokens on the DEXs with just a few clicks so that users could buy those tokens and use them to pay for utilities/services offered by the companies and start-ups, unlike listing on CEXs where know your customer (KYC) requirements shall be complied with and listing fees shall be paid, not to forget to mention that listing on CEXs consumes so much time and effort throughout the listing process.[28]

Figure 5   ***Interacting with Uniswap V2 and the major participants***[29]
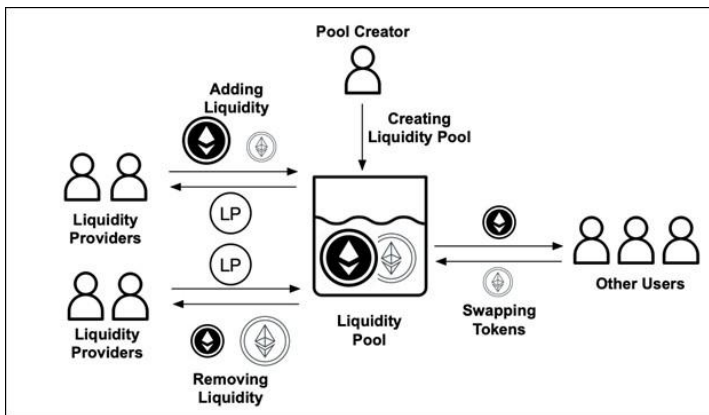
LinkBridge is a legitimate start-up registered and based in Monterrey, Mexico. It is offering an ecosystem aiming at connecting start-ups with investors and professionals.[30] The company is offering multiple services for three types of users, including staking and the ability to sign up for premium packages through the LinkBridge platform.[31] To take advantage of the premium services and the staking mechanism, the users use a blockchain-based token called LNKB.[32] LinkBridge made its tokens available to its users on centralized exchanges, like VinDax and

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28   Some centralized exchanges require companies to pay a monthly listing fee to get their tokens listed. Otherwise, the tokens could get delisted. This information is based on the author's experience dealing with centralized exchanges.

29   Xia, P. et al. (2021). 'Trade or Trick? Detecting and Characterizing Scam Tokens on Uniswap Decentralized Exchange', p. 39:5. Available at: https://0-search-ebscohost-com.biblioteca-ils.tec. mx/login.aspx?direct=true&db=edsarx&AN=edsarx.2109.00229&lang=es&site=eds-live&scope=site (last accessed 19 February 2023).

30   LinkBridge (2023). 'LinkBridge'. Available at: https://linkbridge.app/ (last accessed 17 February 2023).

31   LinkBridge (2023). 'LinkBridge dAPP'. Available at: https://dapp.linkbridge.app/ (last accessed 17 February 2023).

32   The token is based on both the Ethereum and Binance Smart Chain blockchains. See Etherscan.io (2023) [Online]. Available at: https://etherscan.io/token/0xaefda5c5dd0d1c607523f3e0ef3ea3 e4ec8c2c64 (last accessed 17 February 2023) and Bscscan.com (2023) [Online]. Available at: https:// bscscan.com/token/0xaefda5c5dd0d1c607523f3e0ef3ea3e4ec8c2c64 (last accessed 17 February 2023).

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Tokpie.[33] Later, the company realized that DEXs could help it expand its target market and reach prospects that are DEXs-based, so it decided to also take advantage of the many benefits of DEXs and listed its token on both Uniswap and PancakeSwap.[34] Now, LinkBridge users can buy and sell their LNKB tokens on both CEXs and DEXs. LinkBridge is a simple example reflecting how companies, between now and in the future, will start appreciating the power of DEXs.

With a daily trading volume of billions of dollars, Uniswap has developed into one of the biggest DEXs in the world, illustrating the rising need for DEX solutions in the crypto economy. Using a DEX may offer a safer, more private and more easily available substitute for centralized exchanges, thus fostering greater entrepreneurialism and innovation inside the established financial system.

According to Brolley and Zoican,[35] DEXs allow high-frequency traders to access real-time speed as needed, while CEXs provide excess capacity to accommodate 'trading micro-bursts'.[36] DEXs eliminate the negative externality of maintaining idle capacity, which is a problem for CEXs.

Stablecoins, DEXs and cross-border payments are some examples reflecting the transformative power of blockchain technology in the financial sector. The financial sector is at a key moment of disruption generated by digital transformation with new technologies, among which blockchain stands out. There are great opportunities for financial institutions to apply this tool, some of which are already implemented around the world. Being a pioneer in technology will make it possible to transform uncertainty, caused by digital disruption, into an advantage within the financial sector.

III Healthcare

According to the analysis report by 'Global Blockchain in Healthcare Market Analysis Report' (2022), from US$0.93 billion in 2021 to US$1.23 billion in 2022, the worldwide blockchain market in healthcare is predicted to develop at a compound annual growth rate (CAGR) of 31.6%. The healthcare blockchain industry is expected to increase at a CAGR of 38.1% by 2026, reaching US$4.46 billion. The two primary types of blockchain in healthcare are permission blockchains and permission-less blockchains. Permissioned blockchains, also known as private blockchains, require prior approval and may only be accessed by those who have been allowed access. They provide excellent flexibility, access constraints, increased scalability, dependability and more efficient performance.[37]

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33   Vindax (2023). 'Basic Exchange', *Vindax*. Available at: https://vindax.com/exchange-base. html?symbol=LNKB_BTC (last accessed 19 February 2023); Tokpie (2023). 'LNKB/ETH Market – Buy, Sell LinkBridge Tokens', *Tokpie* [Online]. Available at: https://tokpie.com/view_exchange/ LNKB-ETH/ (last accessed 16 February 2023).

34   Information is available to the author since he is the cofounder and COO of LinkBridge.

35   Brolley, M. and Zoican, M. (2023). 'On-Demand Fast Trading on Decentralized Exchanges', *Finance Research Letters*, 51. doi:10.1016/j.frl.2022.103350.

36   'Trading micro-bursts' refers to the sudden spikes in trading activity that occur in financial markets, especially because of high-frequency trading strategies.

37   'Global Blockchain in Healthcare Market Analysis Report 2022: A $4.46 Billion Market in 2026 – Growing Adoption of Blockchain as a Service (BaaS) Propels Growth' (2022). Available at: https:// www.prnewswire.com/news-releases/global-blockchain-in-healthcare-market-analysis-report-2022-

The secure exchange of medical records is one application of blockchain technology in the medical sector. In traditional healthcare systems, medical records are frequently stored in multiple systems, making it difficult for healthcare professionals to access and exchange patient information. Healthcare professionals may perform poorly or make mistakes if they cannot access accurate and up-to-date patient medical history records.[38]

Using blockchain technology, a safe and decentralized network for sharing medical data and records may be made. Patients would be in charge of their medical information and may authorize access for healthcare professionals. This would enable medical professionals to have a thorough and current understanding of a patient's medical history, enabling them to make better judgments and enhance patient outcomes.[39]

Figure 6 answers the question of whether healthcare organizations must implement blockchain technology, which still reflects the need for certain organizations to do so.

One of the most talked-about blockchain applications in healthcare is Electronic Health Records (HER) interoperability and healthcare big data interchange. The Office of the National Coordinator for Health Information Technology (ONC) launched the Blockchain Challenge in 2016, offering thousands of dollars in cash awards to authors of white papers that investigated blockchain's potential utility for tackling EHR privacy, security and scalability concerns. Several of the applications focused on building a trusting atmosphere for clinical decision-making, and 15 winners were picked. Clinical decision-making is strongly reliant on care coordination performance and the capacity to link data to patients across the care continuum. The authors of one of the winning papers submitted by Beth Israel Deaconess Medical Center claimed that EHRs were not intended for multi-institutional, lifelong medical record management. Instead, they proposed MedRec.[40] MedRec, a decentralized system that enables patients and healthcare professionals to securely exchange and access medical information, is one example of a blockchain-based medical record platform. MedRec offers a safe and transparent method of exchanging medical data while still maintaining patient privacy by utilizing blockchain technology.[41]

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a-4-46-billion-market-in-2026---growing-adoption-of-blockchain-as-a-service-baas-propels-growth-301673233.html (last accessed 19 February 2023).

38   Hussien, H.M. et al. (2019). 'A Systematic Review for Enabling of Develop a Blockchain Technology in Healthcare Application: Taxonomy, Substantially Analysis, Motivations, Challenges, Recommendations and Future Direction', *Journal of Medical Systems*, 43(10), pp. 1-35, 3. doi:10.1007/s10916-019-1445-8.

39   *Ibid.*

40   Kennedy, S. (2022). '3 Use Cases for Blockchain in Healthcare', *IT Health Analytics*, 20 May. Available at: https://healthitanalytics.com/features/3-use-cases-for-blockchain-in-healthcare (last accessed 17 February 2023).

41   *Ibid.*

Figure 6   *Evaluating the Use of Blockchain Technology in a Healthcare System*[42]
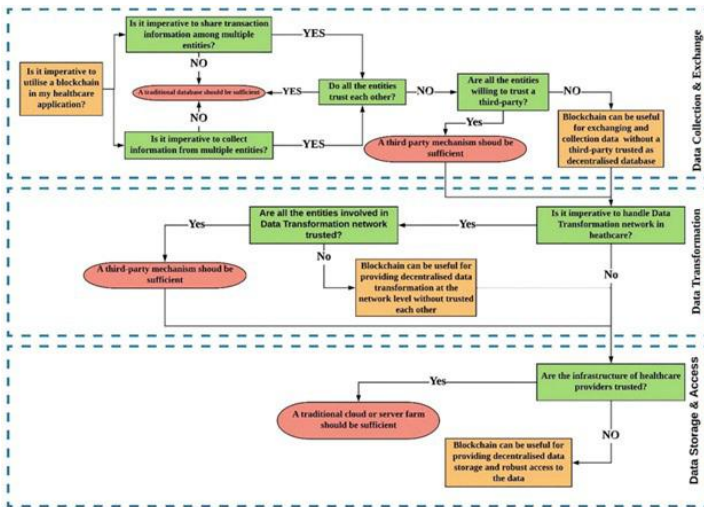
MedRec provides patients with access to their medical history across multiple providers by aggregating data pointers (references to medical records stored elsewhere) into 'patient-provider relationships' on the Ethereum blockchain. These contract data structures are stored on the blockchain and link references to various medical records with ownership and viewing rights, as well as the location of retrieval. In this way, an immutable record of the data lifecycle is created, allowing for later verification. In the Smart Contract, MedRec provides a cryptographic hash of the record to create a baseline of the original information, providing a check against content tampering. The raw medical record is never stored on the blockchain but is securely stored in the provider's current data storage infrastructure. MedRec's customizable user interface promotes examining, sharing and uploading new records. MedRec abstracts away blockchain technology to concentrate on usability for the medical record use case. A notification mechanism is built within the interface to notify users when a new record is posted on their behalf or shared with them.[43]

Maybe the most striking example of a blockchain-powered medical data-sharing network is Medicalchain. Using blockchain technology, Medicalchain securely maintains patient health data. Medicalchain maintains a single version of the original medical data, which is regarded as medical truth. This medical reality is recorded in a blockchain ledger, and participating healthcare companies can request medical data. What makes Medicalchain interesting is the use of both Ethereum

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42   Adapted from Hussien, H.M. et al. (2019). 'A Systematic Review for Enabling of Develop a Blockchain Technology in Healthcare Application: Taxonomy, Substantially Analysis, Motivations, Challenges, Recommendations and Future Direction', Journal of Medical Systems, 43(10), pp. 15. doi:10.1007/s10916-019-1445-8.

43   Ekblaw, A. and Azaria, A. (2016). 'MedRec: Medical Data Management on the Blockchain', *Viral Communications* [Preprint]. Available at: https://viral.media.mit.edu/pub/medrec.

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and Hyperledger Fabric. Although the utilization of a dual blockchain structure is not novel, Medicalchain's solution intelligently executes the needs and use cases required from both blockchains.

The initial blockchain layer, built with Hyperledger Fabric, manages health data access (with permission). The second blockchain, which is powered by an Ethereum ERC20 token, acts as the foundation for all Medicalchain platform apps and services (permission-free). The figure below depicts how objects are stored on the Medicalchain blockchain. A basic hashing algorithm is used to aid the secure storing of Medicalchain information. The hashes genuinely validate the data, and they must exactly match to meet the user's request.[44]

Figure 7   Medicalchain DataFigure[45]
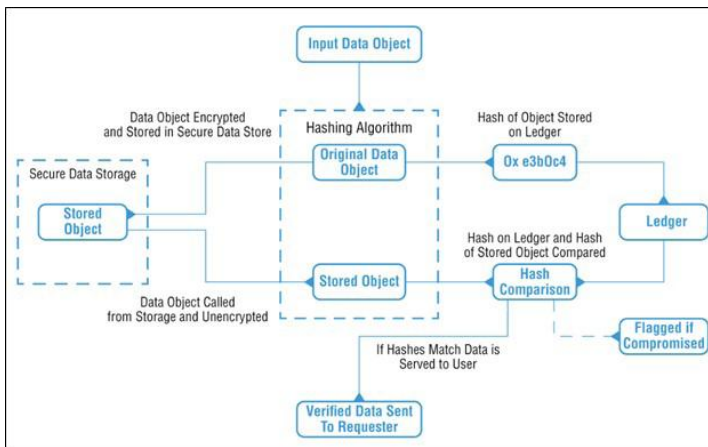
Blockchain technology has the potential to improve the care standards of patients, reduce medical errors and lead to overall medical efficiency. As long as open and safe healthcare solutions are desired, it is anticipated that the development and implementation of industry 4.0 solutions and expansion in this industry will continue.

IV Legal
Blockchain technology has been transforming many sectors, including the legal one. Blockchain technology is applied to a wide range of legal applications since it is safe, transparent and decentralized. From streamlining contract management to increasing supply chain transparency, blockchain technology offers transformative

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44 Holbrook, J. (2020). '8.5 Healthcare Use Cases', in Architecting Enterprise Blockchain Solutions, *John Wiley & Sons*. Available at: https://www.wiley.com/en-us/Architecting+Enterprise+Blockchai n+Solutions-p-9781119557739 (last accessed 20 February 2023).

45 Adapted from Holbrook, J. [2020]. '8.5 Healthcare Use Cases', in *Architecting Enterprise Blockchain Solutions*, John Wiley & Sons. Available at: https://0-search-ebscohost-com.biblioteca-ils.tec.mx/ login.aspx?direct=true&db=edsknv&AN=edsknv.kt012576N4&lang=es&site=eds-live&scope=site (last accessed 20 February 2023).

solutions to long-standing challenges in the legal industry. This has led to blockchain technology being applied to a wide variety of use cases, each with unique benefits for legal departments. Examples of blockchain technology applications in the legal sector demonstrate how this revolutionary technology can alter the way legal organizations work, from securely storing contracts on the blockchain to expediting the identity verification process. The following are a few instances of how blockchain technology is being utilized to transform the legal sector.

Six of Canada's top legal firms have joined together in an innovative pilot project to develop a complex 'smart contract' on the Ethereum blockchain. The project intends to investigate the possible benefits of smart contracts in the legal context to better understand how law firms may best serve their customers by utilizing new technologies. Participants included Bennett Jones LLP, Blake Cassels & Graydon LLP, Davies Ward Phillips & Vineberg LLP, Fasken Martineau Dumoulin LLP, Norton Rose Fulbright LLP and Stikeman Elliott LLP. The law firms collaborated for six months with GenesisB, a forward-thinking blockchain consulting organization, to develop a unique 'smart' legal template on the Ethereum blockchain utilizing the OpenLaw platform.[46] Smart contract technology was utilized by law firms to encode multiple clauses in a merger and acquisition escrow agreement. The negotiated agreement automates concerns like indemnity claims, working capital payouts and disputes by utilizing a pseudo-stable currency. Participating attorneys acquired hands-on experience with the process of drafting, testing and implementing a complex blockchain-based legal agreement through this exercise. This gave crucial insights not just into scenarios where smart contracts might save customers money but also into the industry's preparedness for blockchain technology and the ecosystem reforms required to reap its benefits. According to Aaron Wright, cofounder of OpenLaw, despite the fact this initiative is still in its early phases, efforts like this demonstrate the potential of smart contract technology. Aaron also emphasized that law firms and organizations may utilize OpenLaw to expedite contract automation while preparing for the use of smart contracts as usage grows.[47]

The Accord Project is a platform built on the blockchain that attempts to standardize and simplify the formation and administration of smart legal contracts. The platform uses blockchain technology to securely store and manage contracts, lowering the risk of fraud and tampering while making it easier for companies and

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46 OpenLaw is a blockchain-based legal contract creation and execution system. It allows parties to automate the creation and upkeep of legal contracts, handle signatures and transfer legally binding Blockchain-based assets. Third parties can integrate the OpenLaw protocol into their systems and create blockchain-based apps by utilizing public and private APIs. See OpenLaw (2023). *OpenLaw*. Available at: https://www.openlaw.io/ (last accessed 20 February 2023).

47 Norton Rose Fulbright (2019). 'Norton Rose Fulbright Collaborates with Five Leading Law Firms on Blockchain-Based Smart Contract Project', May 2019. Available at: https://www.nortonrosefulbright.com/en/news/d63310ac/norton-rose-fulbright-collaborates-with-five-leading-law-firms-on-blockchain (last accessed 8 February 2023).

attorneys to access and handle contracts.[48] The Accord Project makes sure that contracts are safeguarded from manipulation by safely keeping them on the blockchain and offers access to a secure and transparent record of contracts for attorneys and enterprises.[49] The Accord Project also seeks to boost the effectiveness of the contract management process by standardizing the contract generation and administration process and making it simpler for businesses and attorneys to manage contracts.[50]

An Accord Project template ties legal text to computer code. It is composed of three elements: '1. Template Text: the natural language of the template, 2. Template Model: the data model that backs the template, acting as a bridge between the text and the logic and 3. Template Logic: the executable business logic for the template'.[51]

Figure 8   *Accord Project templates*[52]
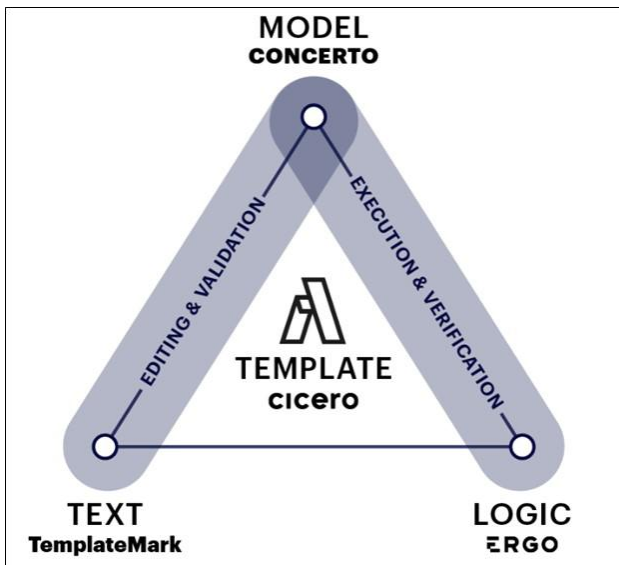
The three components (text-model-logic) can also be viewed as a logical development from machine-readable legal text to machine-executable code. When these three

48   PR Newswire (2018). 'Accord Project Announces New Members in Major International Law Firms Ashurst, DLA Piper, Fasken, Orrick and Simmons & Simmons', *PR Newswire US*, 27 March. Available at: https://0-search-ebscohost-com.biblioteca-ils.tec.mx/login.aspx?direct=true&db=bwh&AN=2 01803270821PR.NEWS.USPR.NY49892&lang=es&site=eds-live&scope=site (last accessed 20 February 2023).
49   Michaelson, P.L. and Jeskie, S.A. (2021). 'A Guidebook to Arbitrating Disputes Involving Blockchains and Smart Agreements', *Alternatives to the High Cost of Litigation* (1549-4373), 39(4), pp. 57-69, 64. doi:10.1002/alt.21887.
50   Accord Project (2023). *Home*. Available at: https://accordproject.org/ (last accessed 9 February 2023).
51   Accord Project (2023). *Accord Project Template Library*. Available at: https://docs.accordproject.org/docs/accordproject-template.html (last accessed 8 February 2023).
52   Adapted from Accord Project (https://docs.accordproject.org/docs/accordproject-template.html).

components are combined, templates may be updated, reviewed and run on any computing platform (on one's computer, on a cloud platform, on the blockchain, etc.). This use case illustrates how blockchain technology may be applied to the legal industry to boost the effectiveness and security of contract administration.

The decentralized network Kleros makes use of blockchain technology to speed up and transparently resolve disputes.[53] By combining game theory and smart contracts, the platform provides a secure and impartial method for conflict resolution that can be used for arbitration among other applications, eliminating reliance on traditional arbitration systems, which can be time-consuming and costly. Using blockchain technology, Kleros has developed a secure and open platform for swift, equitable and effective dispute resolution. Kleros has the potential to change the way disputes are handled in the legal industry by improving the efficiency and fairness of dispute resolution.[54] This use case shows how blockchain technology can be used to improve the efficiency and fairness of legal dispute resolution.

Decentralization of legal proceedings and the utilization of electronic communication among all parties involved in judicial operations are becoming more vital for efficient compliance with the law. Based on the use cases mentioned, one could expect many more blockchain implementations in the legal industry to transpire in the future.

V   Voting

The management of safe and transparent elections is an existent use case for blockchain technology in voting. Election officials may use a blockchain-based platform to securely retain information on voters and the voting process, eliminate fraud threats and assure the integrity and openness of election outcomes. A blockchain voting platform, for example, may integrate smart contracts to automate voting and verify that every vote is appropriately counted. To authenticate voter identification and prevent fraud, digital signatures and other decentralized authentication mechanisms can be included in the platform. Furthermore, the platform may give a visible and verifiable record of the voting process, allowing election authorities and the public to readily check the results' correctness.[55]

During the 2018 midterm elections, West Virginia in the United States undertook a trial study for a blockchain-based mobile voting network for military members overseas. The Ethereum blockchain was used to build the platform, which allowed qualified voters to safely cast their ballots using a smartphone or tablet. The pilot was declared successful and was the first time blockchain technology was used in a federal election. According to state authorities, over 140 West Virginians residing abroad in 29 nations voted in an unprecedented pilot effort that involved voting remotely by mobile device. The statewide pilot, which covered 24 of West

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53   Kleros (2023). 'The Justice Protocol'. Available at: https://kleros.io/ (last accessed 20 February 2023).
54   Dylag, M. and Smith, H. (2023). 'From Cryptocurrencies to Cryptocourts: Blockchain and the Financialization of Dispute Resolution Platforms', *Information, Communication & Society*, 26(2), pp. 372-387, 373. doi:10.1080/1369118X.2021.1942958.
55   Jun Huang et al. (2022). 'The Application of the Blockchain Technology in Voting Systems: A Review', *ACM Computing Surveys*, 54(3), pp. 1-28, 3. doi:10.1145/3439725.

Virginia's 55 counties, used smartphones, facial recognition and blockchain technology 'to create a large-scale and secure way for service members, Peace Corps volunteers and other Americans living abroad to vote in the midterm elections'. Before they may vote, voters must first register using the app by presenting a photo of their driver's licence or other photo ID. The program then requests that voters provide a brief video of themselves. The video is compared to the photo ID by facial recognition technology on the voter's iPhone or Android smartphone, and the personal information on the ID is linked to West Virginia's voter registration database. Upon the completion of the verification procedure, voters can make their selections and validate their ballots using fingerprint or face recognition. According to Michael Queen, deputy chief of staff to West Virginia Secretary of State Mac Warner, voters from Albania, Botswana, Egypt, Mexico and Japan, among other nations, have already cast ballots. According to Queen, Warner's son, who is in the military and stationed overseas, has also participated in the pilot experiment. 'It's already received really well,' Queen said. 'We're quite happy with the turnout'.[56] Yet, election officials who are apprehensive about conducting the democratic process over the internet have criticized the usage of blockchain technology. On the other hand, Warner and Voatz (the company behind West Virginia's blockchain-encrypted ballots for overseas voters) mentioned that other states have expressed interest in using the technology and have both defended the software as safe. Furthermore, the latter stated that blockchain voting might spread beyond West Virginia.[57]

The 2019 Swiss online voting pilot program is another real-world application of blockchain technology in voting. The Swiss canton of Zug launched the pilot in collaboration with Swiss Post and local software businesses to test the viability of blockchain-based online voting. The Ethereum blockchain-based technology allows eligible voters to vote safely and anonymously using a web browser. Blockchain technology was used to ensure the transparency and security of the voting process since each vote was recorded as a unique transaction on the blockchain and the results could be reviewed in real time. Zug has started providing digital ID cards to its residents since the winter of 2017. The modest consultative vote used the city's eID system. People were allowed to vote via their cell phones by downloading the app and registering themselves there. In contrast to previous e-voting systems, Zug's voting process was dispersed over several computers using blockchain, rather than a single central server. Nearly all participants considered voting online simple. In their survey, only three persons indicated differently. 'The premiere was a

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56   Fung, B. (2018). 'West Virginians Abroad in 29 Countries Have Voted by Mobile Device, in the Biggest Blockchain-Based Voting Test Ever', *The Washington Post*, 6 November. Available at: www. washingtonpost.com/technology/2018/11/06/west-virginians-countries-have-voted-by-mobile-device-biggest-blockchain-based-voting-test-ever/ (last accessed 22 February 2023).
57   Freed, B. (2019). 'Blockchain Voting Could Grow beyond West Virginia', *Statescoop*, 8 February 2019. Available at: https://statescoop.com/blockchain-voting-could-grow-beyond-west-virginia/ (last accessed 20 February 2023).

success,' said Dieter Müller, head of communications for the city of Zug to the Swiss News Agency.[58]

Even though there are security concerns when it comes to the implementation of electronic voting mechanisms, with further research and development the security concerns may be tackled in the future, considering that the mentioned voting use cases still highlight how blockchain technology may be utilized to increase election security, transparency and accuracy. A blockchain-based voting platform can assist to decrease the risk of fraud and maintain the authenticity of election results by securely storing information about voters and the voting process on the blockchain and employing decentralized authentication methods and smart contracts.

C   Challenges

Although blockchain technology confronts hurdles and has yet to realize its full potential, it has garnered acceptance in many industries and is being welcomed by the public. Among the difficulties are:

1   Scalability: The majority of blockchain networks now suffer from scalability, limiting their capacity to handle huge volumes of transactions. This is especially problematic for public blockchain networks like Bitcoin and Ethereum, which can get overcrowded during peak usage periods.
2   Regulations: Many jurisdictions presently have no clear regulations regarding blockchain technology. As a result, many businesses and people are unclear about how to lawfully implement blockchain technology. Many businesses may be cautious to utilize blockchain technology until a clear legal framework has been established.
3   Interoperability: Various blockchain networks are currently incompatible with one another. As a result, independent systems cannot communicate or share data. The issue of interoperability must be resolved if blockchain technology is to reach its full potential.
4   Security is an issue facing any decentralized system, including blockchain. Blockchain is decentralized. Therefore, there is no single authority to supervise security, making it more vulnerable to attacks. Carrying out a 51% attack against the most popular cryptocurrencies can be too expensive due to the computing power it requires and the cost of achieving it, which led to cybercriminals in 2018 carrying out attacks of this type aimed at lesser-known cryptocurrencies that require less computing power, managing to steal up to US$18 million.[59] News broke of the first 51% attack affecting one of the top 20

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58   SWI (2018). 'Switzerland's First Municipal Blockchain Vote Hailed a Success', *SWI*, 2 July 2018. Available at: www.swissinfo.ch/eng/business/crypto-valley-_-switzerland-s-first-municipal-blockchain-vote-hailed-a-success/44230928 (last accessed 19 February 2023).
59   Group-IB (2018). 'Group-IB Presents Cybercrime Trends 2018 Report Urging the Market to Hunt for Threats', *Group-IB*. Available at: www.group-ib.com/media-center/press-releases/hi-tech-crime-trends-2018/ (last accessed 19 February 2023).

most popular cryptocurrencies, the attack on Ethereum Classic.[60] This type of attack will continue to take place in the future, so continuous research and development in the sector are required to solve security problems and preserve the integrity of blockchain systems.

5 Usability: Understanding and using blockchain technology might be difficult for certain non-technologists. As a result, further research and development are required to generate technological implementations that are simple to use.

D   Overcoming the Challenges

Is it possible to overcome the challenges, discussed above, facing blockchain technology?

There are certain solutions and real implementations of them, giving hope that blockchain technology could reach its full potential one day. Below are illustrations of those solutions and real hopeful examples:

1 Scalability: Scaling blockchain networks so that they can handle massive volumes of data and transactions at lightning speed is crucial. This can be accomplished by developing shared and second-layer solutions that will speed up and improve efficiency. Serenity is an upgrade to Ethereum's blockchain that increases scalability. Transactions can now be completed more quickly and effectively thanks to this improvement.[61]

2 Regulations: The development of clear and comprehensive regulatory frameworks that offer users direction and protection while fostering innovation and growth is needed for blockchain users. Regulators must analyse the specific qualities of blockchain technology to reconcile the demand for openness and accountability with the requirement for security and privacy. The Malta Digital Innovation Authority (MDIA) is a government-backed institution in Malta that strives to decrease legislative hurdles to the use of blockchain technology and to support its development and adoption. Showcase this technology.[62]

3 Interoperability: The creation of standards and protocols that enable smooth communication between various blockchain systems and older centralized systems could ensure that blockchain technology can be linked into current systems, making adoption easier for enterprises. The Interledger Protocol (ILP) is an open standard that connects several payment networks and ledgers, enabling smooth transactions across many platforms.[63]

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60 Cryptopedia Staff (2022) 'What Was the DAO?' *Gemini*. Available at: www.gemini.com/cryptopedia/the-dao-hack-makerdao (last accessed 16 February 2023).

61 Herrera, P. (2023). 'Ethereum, a Promising Future', *El Financiero*, 11 January. Available at: www.elfinanciero.com.mx/opinion/paola-herrera/2023/01/10/ethereum-futuro-prometedor/ (last accessed 16 February 2023).

62 Cachia, F. (2019). 'The Malta Digital Innovation Authority: Bringing Sanity to the Blockchain Island Frenzy?', *Chambers and Partners*, 25 January. Available at: https://chambers.com/articles/the-malta-digital-innovation-authority-bringing-sanity-to-the-blockchain-island-frenzy (last accessed 16 February 2023).

63 Interledger. 'An Open and Inclusive Payments Network that Puts Humanity First'. Available at: https://interledger.org/ (last accessed 17 February 2023).

4   Security: Adopting robust security protocols and encryption technologies that may assure the safety of sensitive data on the blockchain are possible answers to the difficulty of security in blockchain technology. To defend a blockchain against unwanted access, manipulation and data breaches, sophisticated techniques such as multiparty computing, homomorphic encryption and secure multiparty computation can be used. Another possibility is to create decentralized authentication and identity management systems in which individuals own their data and choose who gets access to it. Formal verification, which allows smart contracts and other blockchain applications to be formally shown to be safe and error-free before implementation, is another approach. These are some ways for improving blockchain security. The Chainlink network offers a decentralized oracle solution that enables smart contracts to safely access real-world data and events, lowering the risk of blockchain hacks and assaults.[64]

5   Usability: Improving individual and organizational education and knowledge of the benefits and hazards of blockchain technology. This will aid in increasing confidence and adoption while decreasing the danger of misinformation and misunderstanding. The Stellar network provides an accessible and user-friendly platform for individuals and companies to perform rapid and secure cross-border transactions, making blockchain technology more accessible to users.[65] Furthermore, the University of Tecnológico de Monterrey, the No. 1 University in Mexico, offers blockchain courses to both students and professors in different majors. The Center of Digital Evolution of EGADE Business School, a private business school affiliated with the University of Tecnológico de Monterrey, works with leading Mexican and international companies and offers them blockchain consultations.[66]

E   The Future

Blockchain technology has the potential to disrupt various sectors shortly through inventive new applications. The following are some potential future applications:

1   Management of decentralized identities: A decentralized identity management system that lets users manage and protect their data is expected to be made available. Blockchain-based platforms that allow for the safe and transparent storage and management of personal information, including passport data, may emerge in the future. Everyone will be able to store, protect and have full control over their digitized passport, VISA, migration records system and even additional documents such as vaccination cards. This must allow traceability, immutability, security and the dynamic use of information. This solution is

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64   Chainlink. Available at: https://chain.link/ (last accessed 17 February 2023).
65   Stellar Development Foundation. Available at: https://www.stellar.org/ (last accessed 17 February 2023).
66   The author is a full-time professor teaching Blockchain for Business as a subject for students at the University of Tecnológico de Monterrey and is the Blockchain Leader of EGADE Business School Center of Digital Evolution. See EGADE Business School Center of Digital Evolution (2023). Available at: https://egade.tec.mx/sites/default/files/ced/nosotros.html (last accessed 16 February 2023).

based on the Blockchain and Smart Contracts to provide travellers and governmental entities with migration data in a decentralized, immutable, traceable and secure way.

2   Autonomous supply chains and predictive maintenance: As previously mentioned, the use of blockchain technology across various supply chain solutions has been taking place and is reflected in platforms like TradeLens, lowering the dangers of fraud, counterfeiting and other sorts of misbehaviour, thereby increasing trust and confidence in the supply chains. With AI, IoT and blockchain technology integrated into a supply chain, one could expect the birth of autonomous supply chains in the future. These supply chains would function using smart contracts that eliminate the need for middlemen, like intermediaries or third-party logistics companies. Paying suppliers and tracking goods and optimization processes would be automated using blockchain technology and AI, leading to the existence of cost-efficient, secure, faster and transparent supply chains. Also, with the implementation of blockchain technology, IoT and machine learning predictive maintenance would take place and, hence, companies would be able to forecast when maintenance is required, avoiding costly downtime. Businesses involved in manufacturing, retail and transportation would highly benefit from these supply chains.

3   Smart cities: In the future, blockchain would be implemented within smart cities. In the Daimaruyu district, Japan, there are 106 skyscrapers, 4,300 offices, 40,000 restaurants, 90,000 shops, 13 railway, metro stations and 16 major companies that have their headquarters there. The technological infrastructure of this labyrinth of buildings and transport allows sharing the of economic information that comes from the buildings owned by Mitsubishi, from the IoT sensors located in the buses, from the shops regarding the availability of products, from restaurants regarding the availability of free tables or hotels regarding the number of rooms available. Everything is connected. Different companies have participated in the Daimaruyu smart city project. Because blockchain is a kind of virtual database that allows data to be shared in a secure system, companies can share information without losing control over it. The open-source technology used, expressly projected by the Linux Foundation, is a Blockchain Hyperledger Fabric, based on specific rules that establish who can approve the entry of members into the blockchain and authorize transactions. For its part, Fujitsu has created Virtuora DX software, a cloud service that allows participants to share data and smart contracts.[67]

4   Decentralized social media: In the future, more decentralized social media would exist. Users would earn cryptocurrencies for the content they create while maintaining total control over their data and online identity. This has the

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67   Fujitsu Limited (2018). 'Fujitsu Forum 2018 Customer Case Study' [PDF file]. Available at: https://sp.ts.fujitsu.com/dmsp/Publications/public/Blockchain_Customer_Case_Study_Mitsubishi_Real_Estate.pdf (last accessed 16 February 2023); Pictet Asset Management (2018). 'The Blockchain at the Service of Smart Cities' [online], *Pictet Asset Management Blog*. Available at: https://am.pictet/es/blog/articulos/innovacion/el-blockchain-al-servicio-de-las-ciudades-inteligentes (last accessed17 February 2023).

potential to improve online community privacy and safety. Steemit is a blockchain-based social networking and blogging platform. It is an example of decentralized social media. Users may earn STEEM, a cryptocurrency, by producing and curating content.[68] Steemit's innovative fusion of social media and blockchain technology has fostered a dynamic environment where user engagement and content preferences continuously evolve. This platform serves as a small-scale representation of broader digital trends, encompassing shifts in technology, user behaviour, and digital communication. As such, Steemit exemplifies the potential of blockchain technology to cultivate vibrant, active online communities that significantly influence discussions on digital activism and the impact of technology on societal progress and social transformation.

5 In recent years, the use of public blockchain data for advanced data mining and scraping has emerged as a burgeoning field of interest across multiple sectors, including academia, government, and industry. Platforms like FMTO.COM exemplify this trend by aggregating and structuring bulk data from various public blockchains into accessible CSV formats for comprehensive analysis. This methodological innovation opens new avenues for in-depth research, enabling stakeholders to uncover patterns and insights that were previously obscured in the complex layers of transactional data. As this practice grows, it promises to significantly enhance the capabilities of researchers and professionals in harnessing blockchain data for predictive analytics, policy-making, and strategic business applications, potentially catalyzing major advancements in how digital information is utilized for societal benefit.

6 Decentralized energy trading: Blockchain technology can disrupt the energy sector. Smart contracts are programmed to self-execute under specific conditions without the need for centralized verification. For example, if A receives X kWh, then B automatically receives Y monetary units as payment, thus reducing the exchange periods. The costs of peer-to-peer transactions – energy trade between equals – will also decrease, allowing small electricity producers to sell their excess (with tokens or virtual currencies) to the participants in the network of their choice. Thanks to this, competition and efficiency of the network would increase, which would cause prices to fall. Smart contracts would allow the timing of a specific transaction to be predefined. Thus, energy flows would be easier to manage as there is a better balance between electricity supply and demand.

7 Blockchain-based education: In various aspects, blockchain technology has the potential to revolutionize the education industry. The usage of blockchain for safe and verified student data, transcripts and degrees is one potential. This might reduce the need for several physical copies of information while also making it easier for students to communicate their credentials with future employers or other institutions. Furthermore, blockchain might be used to manage continuing education units and professional development hours safely and transparently, allowing professionals to readily show their continued

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68 'Steemit'. Available at: https://steemit.com/ (last accessed 16 February 2023). https://mostla.tec.mx/titulos-blockchain/index.html

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education and professional advancement. Additionally, blockchain might be used to encrypt and make online tests and evaluations tamper-proof, bringing a new degree of confidence to online education. The University of Tecnológico de Monterrey records the students' credentials on the blockchain using Blockcerts, the open standard for blockchain credentials.[69]

8   Blockchain and the law: Blockchain technology can profoundly change how legal contracts and agreements are produced and implemented in the legal profession. Legal contracts are now kept in centralized databases, which are vulnerable to manipulation and error. In contrast, legal contracts may be securely kept on a decentralized ledger utilizing blockchain technology, boosting transparency, security and efficiency in the legal process. Blockchain technology could be used in the future to automate judicial proceedings, which would accelerate and increase the efficiency of legal operations. For example, terms of legal agreements could be self-enforced without the need for a lawyer or court with the use of smart contracts. By providing a tamper-proof, open and impartial record of the legal process, blockchain technology can also be utilized to expedite dispute resolution. Both increased trust in the judicial system and more effective conflict resolution may result from this.

F   Conclusion

Blockchain is more than just bitcoin and cryptocurrencies. It is not a tool that was created for speculation, but rather for decentralization, financial independence, freedom, anonymity and more. Blockchain has been transforming several industries. Yet, there are certain challenges facing blockchain technology. With a multifaceted strategy that includes improved collaboration among industry players, sustained investment in R&D and the establishment of comprehensive regulatory frameworks, these challenges may be solved and blockchain would reach its full potential. Blockchain has a promising future, with intriguing new applications such as decentralized autonomous supply chains, digital passports and self-sovereign identity management systems on the horizon. Whether it is speeding financial transactions, increasing transparency and efficiency in supply chain management or protecting personal information, the possibilities for what blockchain technology may do are only limited by our imaginations.

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69   Mostla (2023). 'Electronic Titles in Blockchain' [online]. Available at: https://mostla.tec.mx/titulos-blockchain/index.html (last accessed 20 February 2023).