Study of Blockchain Technology in Some Selected Fields

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ABSTRACT: *Digital technology has produced the Blockchain systems which is expected to improve the system performance. But still, there are impediments in registering progress. We need to assess the extent to which the digital system requires the consequences of blockchain technology for attaining progress. In this work we studied the requirements to achieve the success in the blockchain technology with the introduction of some measures. We did a brief review of a few areas such as Finance, Business and Marketing, Energy Systems, Food Industry, Healthcare Systems, Science and Education, Engineering and Construction, Environment, Technology, and Crimes to determine the influence of Blockchain technology.*

Keywords: Blockchain, Digital Evolution, Technology Metrics

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1. Introduction

It is controversial to write about digital evolution, and all the factors include looking at, analyzing, and predicting the future they will create. Developing technology brings many benefits to human society. However, analyzing their effectiveness and importance is the most vital part of development. Blockchain (BC), among all well-developed technologies, has the most substantial potential to drive society to be more innovative and more developed and eventually make the idea of digital evolution come true. IT IS UNDENIABLE that BC technology already affects businesses, structures, and organizations and has revolutionized their ways of thinking, planning, and managing. The BC validates the consensus of autonomous systems, but it is not a replacement for database systems. Keeping records of accord in BCs is the explicit purpose of BCs. However, keeping more public records on BCs is likely not desirable. In particular, it can be time-consuming and costly to download entire BCs. Blocking space is also limited and expensive, and records are not alterable (Bradford and Benites, 2020).

2. BC technology

2.1. According to IBM[1], BC is a shared ledger that manages the process of recording financial payments and tracking every type of asset in every business. This fact provides a situation to trade every valuable asset virtually and reduce expenses while improving profitability. Furthermore, as a result, BC has evolved into the ideal ledger for delivering information in a transparent, immutable manner that can be accessed only by network members with permission. Everything can be tracked in the BC network, including orders, payments, productions, etc. Because members share a single view of the truth, all details of a transaction from end to end can be seen, giving greater confidence and new efficiencies and opportunities.

2.2. Technical Definition of BC
According to National Archives and Records Administration[1], The BC network, or distributed ledger, replicates and stores transactional data created by each party or node. Conflicts or inaccuracies within the database are automatically resolved with predefined A distributed ledger comprises four primary characteristics:

- Peer-to-peer networks operate
- Decentralised record keeping
- Trust-based transactions
- Tamper resistance

The network consists of nodes, each containing all the transactions within the ledger. The transactions or, on occasion, their proofs use BC. These essential parts constitute a BC. The BC is similar to a database but also helps with transaction data. The block lists recorded transactions; the chain is transactions recorded with a hash that links preceding blocks with new blocks. A soup is an algorithm that takes a variable string of data and generates a fixed-length value.

2.3. BC Components
A BC comprises three main parts. A block collects transactions recorded over a specific period as the first component. A series of blocks that reach their full-size link together via a hash code create chains. Finally, every node contains a complete record of all transactions on the BC network.

2.4. Types of BC
Three types of blocks fit them for every single project. These three types are as follows:

Public: Large distributed BCs are available for anyone to participate and are generally open-sourced, with the code maintained by a broad community. For example, Bitcoin, one of the most commonly known BC networks, is a public BC.

Permissioned: it is an extensive, distributed BC network with established roles that individuals can fill when using the BC. For example, a group of banks may share sensitive cash reserve information through the BC.

Private: Often, a smaller BC is tightly controlled and is established between trusted entities that wish to share sensitive information. For example, an organization could use an internal BC to certify documents for its use.

2.5. BC Smart Contracts
According to the National Archives and Records Administration, an intelligent contract appears when contracts are translated into the BC software. They are a series of statements that the agreement will run automatically when their requirements are met. They are stored on the BC and executed autonomously by triggering an event.

2.6. BC Technology's Importance
Since BC technology provides a single source of truth for recorded transactions without centralized authority, it helps the digital world by using this technology. As a result of executing smart contracts on the BC, transparency, security, and efficiency will increase and create a unique, trustable platform for applications on the Internet (National Strategy on Blockchain Towards Enabling Trusted Digital Platforms, 2021). Transparency and processing speed will increase due to BC's tracking of every asset,

while costs will decrease.

Every BC entering the marketplace must be able to meet the requirements to qualify. BC offers distribution, encryption, immutability, tokenization, and decentralization (Wilkie and Smith, 2021). According to the mentioned factors, BC brings numerous benefits to businesses and society.

3. Digital Evolution

The incorporation of digital technology into businesses sometimes causes fundamental changes in business operations and value delivery to customers, a process known as "digital evolution" (Miæiæ, 2017).

Gartner defines Digital evolution as a concept that refers to any improvement in IT modernisation, digitalisation, and innovative digital models. In public sector organisations, this term refers to putting services online or legacy modernisation, which is digitalisation rather than digital business transformation.

The most important characteristic of digital evolution is that it brings added value to businesses or organisations. In other words, digital evolution affects various levels of any society. From a production perspective, it automates business operations and improves efficiencies, namely cost reduction and productivity. Digital evolution, similarly, creates new opportunities for businesses and entrepreneurs. Meanwhile, public services can be improved by developing healthcare and education systems, as well as interactions between social members and governments. Social communication and personal relationships are another side of a society that digital evolution affects. On the other hand, cybercrime, vanishing companies, and workforce disruption are the downsides of digital evolution (Katz, 2017).

3.1. Digital Evolution in Smart Societies

Customers' experiences and behaviours have changed drastically due to the appearance of digital evolution and new business models that effortlessly communicate with firms and other consumers and pass through rapidly increasing numbers of touchpoints in their customer journey, many of which are digital (Verhoef *et al.*, 2021). The importance of digital evolution is defined by the organisation's growth in innovative methods, dealing with market conditions, and managing future obstacles (Wren, 2020). According to Eurocities[1] , during the past two decades, digital evolution has altered our daily routine lives significantly, door-step delivery for goods and services or doing official tasks of a workplace at home, namely holding meetings during a pandemic. In other words, we are living through an intense digital evolution of our society, in which the integration of different digital technologies, such as artificial intelligence (AI), sensor networks, 3D printing, and others, with digital data, are changing every aspect of our daily lives ("Science for Policy Handbook", 2020).

Overall, for three main reasons, digital evolution is needed:

First of all, numerous technologies have strengthened and resulted in e-commerce development due to the global worldwide web adoption.

Consumer behaviour is changing as a response to the digital revolution

As mentioned above, by developing technologies, daily routine activities are influenced magnificently, from personal ones to allotted tasks at work or workspace. Doing every single task through computer devices and the Internet is the key factor in leading smart societies. Developing these infrastructures as well as other factors, namely applications, will eventually bring humanity to smarter societies.

3.2. Digital Evolution Metrics

The progress of digital evolution is an integral part of this journey. There is no doubt that constant measurement leads to finding

[1]eurocities.eu. 2020. The Digital Services Act Making digital opportunities work for people and the public good. Available at https://eurocities.eu/wp-content/uploads/2020/09/Eurocities-Policy-Paper-on-the-Digital-Services-Act.pdf. Accessed 21 December 2021.

the bottlenecks, issues, best practices, and other vital ones, modifying the process to achieve exultation. Learning and tuning business models are critical to achieving and measuring the effectiveness of digital evolution performance. Key Performance Indicators (KPIs) are essential to achieving and measuring the effectiveness of digital evolution performance and facilitating learning and tuning business models. Even though they are vital, they vary due to various phases of digital evolution (Verhoef et al., 2021).

Metric means "using or related to the metric system of weights and measures"[1]. A metric is a tool to measure something (in this case, progress and evaluate a project). The most critical factors in assessing digital evolution project performance management are: firstly, the knowledge of measuring the value proposition created by the transformation; secondly, whether firms can manage what they measure (Ahmad et al., 2020).

The vast majority of companies have already adopted this technology. However, many businesses need to prepare themselves to upgrade their services, systems, and structures accordingly. In addition, digital evolution deals with deploying all these technologies closely. However, plenty of companies today boast about undergoing digital change, but what they usually mean is digitization (Wren, 2020)

Digitalization will convert data to digital from analog ones, but digital evolution has a broader concept. Digital evolution is a collection of all new technologies, making the most of them and providing an opportunity to change products, processes, and businesses to create value for both companies and customers. Despite the importance of BC technology and the existing practical experience in deploying it in trades, academic forums pay little attention to this new technology and the developments it brings to society (Verhoef et al., 2021).

Constant measuring is another crucial factor in leading digital evolution. This measuring should take place on two sides. Firstly, all employees and generally the whole company, and secondly, customers. The necessity of measuring is to make sure both aspects improve over time and determine how they are equipped and change their attitudes towards digital evolution. Surveys, interviews, or other measurements to achieve this goal are common.

Information technologies (IT) are considered critical assets in the public sector. It is essential to design, execute, and maintain IT assets practically and effectively. IT investment has increased at all three federal, state, and local levels in recent years, and this trend is expected to continue (Desouza, 2015).

In this article, the author identifies BC as a pioneering technology for creating intelligent societies due to digital evolution. One of the most critical issues in the modern world is providing a practical solution based on the latest-tested technologies to meticulously manage produced records (all records loge and audited via a wide range of personal and social applications, business applications). In developing societies, the number of produced records has increased magnificently. Governments are trying to find a solution to manage them to lead to humanity being more intelligent, where everything is done automatically and keeps the data transparent and safe.

Despite the importance of BC technology in achieving digital evolution, the indicators of evaluation of achievement and success i-n implementation are not yet clear. Therefore, measuring the extent to which societies achieve digital development requires identifying the potential and effects of BC as an essential factor in attaining digital evolution. This research tries to facilitate the introduction of necessary metrics and indicators by determining the impact of blockchain. The findings are based on recent research.

4. Methodology

The generation of the diagram in this study involved three stages (**Figure 1**). The first stage included a literature search to clarify various viewpoints on BC. The review of published papers began by searching one of the remarkable databases, Emerald. Searched articles had three main keywords: "digital society," "digital evolution," and "blockchain." The findings were also limited to those in the recent four years (2016-2021). In the second stage, the results were organized and classified into ten topics, including Finance, Business and Marketing, Energy Systems, Food Industry, Healthcare Systems, Science and Education, Engineering and Construction, Environment, Technology, and Crimes. Finally, the categorized findings were shown by drawing a diagram that can help scientists define the metrics in implementing BC.

5. Findings

5.1. Finance: BC is a distributed ledger technology designed to save and verify transaction data. Even if there was no actual storage of ownership on the assets, the tasks of financial institutions were determined by the ledger of records. Banks manage each customer's balance, approve and record deposits and withdrawals, while the central bank keeps track of each bank's balance and handles inter-bank transfers. The existing financial institution system was designed to establish a Trusted 3rd Service Provider, and then the trust in the organization is secured (Probst *et al.*, 2016).

Because BC does not require a middleman, the effect of lower fees and management costs can be seen, and because the data is shared, it is challenging to manipulate arbitrarily (Oh and Shong, 2017). Because many institutions are involved in the transaction, the international remittance service, for which customers must pay a high fee, is recognized as the field where BC technology is most valuable, as it allows individuals to transact without the use of an intermediary (Davidson, De Filippi, and Potts 2016). Instead of storing the ledger with transaction details on a central server, BC distributes it over a peer-to-peer network (a group of computers is linked together with equal permissions and responsibilities for processing data), allowing participants to record and manage transactions collaboratively, reducing management costs and decreasing the risk of hacking (Probst *et al.*, 2016).

The design of BC technology in the accounting framework is organized around three scalable levels: the first is a technological infrastructure based on a distributed database with peer-to-peer storage; second, increasing control levels are ensured through permissions and validation; and third, the system provides the integration of business and security applications (Centobelli *et al.*, 2021). This system is deployed using a private network of nodes that validate transactions (Centobelli *et al.*, 2021).

Based on the principal-agent theory, inventory pledge financing (IPF) risks are divided into collateral, warehousing, and liquidity risks. IoT (Internet of Things) can improve traditional banks' ability to obtain information, and blockchain can promote credible information transformation, allowing banks to get knowledge from collateral. In addition, the new architecture's e-platform increases banks' involvement in the supply chain and creates a fair network to reduce warehousing risks. Smart contracts and collaborative mechanisms maintain process and outcome control while reducing liquidity concerns (Liu, Zhang, *et al.*, 2021).

5.2. Business and Marketing: BC technology can significantly affect business strategy to be implemented into specific operations (Turhan and Akman, 2021). Firms seeking to access international markets for investors, customers, employees, and suppliers may find that BC technologies provide competitive advantages (Laplume, 2018).

Keeping records consistent between multiple entities, maintaining auditable information trails, efficiently settling and tracking exchanges of value, and authenticating user identity are all problems that BCs can solve (George *et al.*, 2019). BC has the potential to create democracies of access, trust, and agency in an era of decreased confidence, particularly in the digital, globalized marketplace. With its ability to connect market participants with society, this system can potentially bridge two opposing populations' viewpoints, allowing for contested market development (Carrasco and Romi, 2021).

For most of the sampling period, the returns of blockchain-based technology companies' indices and the price returns of cryptocurrencies are positively correlated. Furthermore, for more than 93 percent of sampling days, the return price of newly invented and more advanced cryptocurrencies with unique characteristics, such as Monero, Ripple, Dash, Stellar, and Peercoin, is positively correlated with the return of stock indices of blockchain-based technology companies (Ghaemi Asl *et al.*, 2021). The social capital theory has emerged as a useful but optional lens for examining BC implementation in supply chains. Intuitions emphasized the importance of managers' sensemaking in discussing technology adoption. Relational capital has emerged as a necessary but insufficient condition for BC adoption in supply chains. Furthermore, a link has been established between competitive opportunities at the firm level and the decision to use BC technology. The ability to act as "Tertius Gaudens" [1] or "Tertius Iungens[2]" information brokers in supply networks should have a significant impact on companies' willingness to adopt BC solutions (Galati, 2021).

BC technology is a solution for disintermediation, traceability, and transparency in the luxury goods sector, highlighting the challenges that luxury firms' supply networks face. The knowledge gap, the diversity of third parties participating in the production process, and the inclination toward short-term returns on investment are all challenges that luxury businesses confront when integrating this technology into their ecosystem (de Boissieu *et al.*, 2021).

BC technology allows for trust and traceability by starting with a real-world use case. Through three main elements: system architecture, data recovery, and communication, the developed conceptual framework enables unpacking the mechanism by which BC facilitates trust and explicates how information flows in a blockchain-based system versus a traditional one in a real-world business application scenario (Yacoub and Castillo, 2021).

Firms must share their valuable know-how assets with individuals or other enterprises outside of their organizational bounds, making sharing knowledge with business partners problematic. When companies share their know-how with suppliers or business partners, they encounter issues with privacy and ownership since supply chain management (SCM) deals with a variety of stakeholders. BC technology can help supply chains improve their knowledge sharing (KS) procedures. Transparency and security, two properties of BC technology, have the most impact on mediating knowledge exchange implications on supply chain performance. When BC technology is used for knowledge exchange, speed improves dramatically among SCM performance measures (philsoophian *et al.*, 2021).

5.3. Energy Systems: Today, power trading systems use centralized processes that are complex and vulnerable to price tampering and hacking. BC technology, which has recently been highlighted for its decentralized and unmodifiable nature, has the potential to improve this power trading process. The solution could be to implement a system that uses BC technology to solve the problem of power trading (Oh *et al.*, 2017).

A lack of information flow throughout the supply chain is the root cause of high cost and time inefficiencies in oil and gas infrastructure development. According to the new BC system design, cost inefficiencies are reduced by 12.4 percent, and operation lead times are reduced by 36.5 percent, making it an economically viable solution (Amiri Ara *et al.*, 2021).

5.4. Industry: BC allows different players in the food industry, such as farmers, food suppliers, and investors, to share information, allowing for a more efficient decision-making process with traceable details about goods. The intentions in the food industry are positively influenced by perceived efficiency, transparency, standardization, platform development, and traceability factors et al., 2021). Although the BC technology is still in its infancy, its application in the food industry must be examined from various perspectives, including organizational policy, adoption strategies, and potential technological innovations that could improve business processes.

Perishable food supply chains (PFSCs) are characterized by poor economic sustainability and rising food quality and safety concerns. Because PFSC products are perishable and have a short shelf life, sustainability management is critical. To cope with the impacts of pandemics, PFSCs need to be more responsive, flexible, efficient, and collaborative, using BC capabilities such as immutability, transparency, visibility, and traceability (Kayikci *et al.*, 2021)

5.5. Healthcare Systems: Although the COVID-19 pandemic negatively impacts both treatment and control firms, the effect is less damaging for treatment firms than for control enterprises, suggesting the function of blockchain-enabled supply chains in moderating the negative impact of the pandemic (Xiong *et al.*, 2021).

Vaccine safety is a big concern worldwide. Building a vaccine traceability service platform based on BC technology is ideal for this global challenge. When the proportion of revenue sharing meets specific parameters, a revenue-sharing contract can be used to organize the vaccine supply chain. The vaccine supply chain benefits more from the fixed fee scenario than the proportional charge scenario. The use of BC technology in the vaccination supply chain boosts total profit, consumer surplus, and societal welfare. As a result, the vaccine supply chain's operating efficiency is improved (Liu, Tan, *et al.*, 2021).

5.6. Science and Education: With the use of a blockchain-based application, digital registration could improve the efficiency of student enrollment (Chen *et al.*, 2021).

The shared data in the open data context could come from various transformation procedures and sources, exposing the risk of non-authentic data. Furthermore, each data set has unique qualities shared under multiple licenses, implying that updated data may have distinct characteristics and policies. A practical and scalable option is a blockchain-based provenance preservation system that keeps track of data changes and controls their features within an open data platform (Dang and Duong, 2021).

5.7. Engineering and Construction: BC can profoundly disrupt the workflow, trust, and procurement environments in the architecture, engineering, and construction (AEC) industry in the digital age (Xu *et al.*, 2021).

BC can solve the challenges of midstream liquefied natural gas (LNG). Excessive paperwork, process repeatability and communication, overwhelming paperwork, and communication hiccups. In terms of real-time monitoring, transparency and paperwork reduction, and time and cost savings, stakeholders can use the methodology to quantify the impact of BC on their operations individually and the supply chain collectively (Lyridis *et al.*, 2021).

5.8. Environment: Rapid technological advancements, shifting customer needs, built-in obsolescence, the inclusion of more non-repairable parts, shorter product life spans, and other factors have resulted in record levels of e-waste generation. The new blockchain-based e-waste management system addresses the disadvantages highlighted above (Sahoo *et al.*, 2021).
Green supply chain practices are being influenced by BC technology to promote pro-environmental settings in the supply chains of manufacturing companies. BC has had a good impact on green supply chain operations, as evidenced by the literature (Mubarik *et al.*, 2021).

5.9. Technology: Because of BC's unique characteristics, the literature demonstrates the importance of BC to ensure Internet of things (IoT) security. Numerous current threats can be addressed more effectively with BC than conventional mechanisms (El-Masri and Hussain, 2021).

Modern customization, personalization, and multi-restrictive working scenarios have affected Small and Medium Enterprises (SMEs) manufacturing operations. In the new normal, manufacturing SMEs can be disrupted by digitalization. The industrial Internet of Things (IIoT), Internet of things, cyber-physical systems, and big data analytics are all part of modern digitalization. Modernizing design and manufacturing through digitalization can improve product quality and timeliness. Using IoT technologies makes manufacturing processes more efficient and traceable in real-time. Enabling BC technologies can mitigate top effect group challenges like data security and technology reliability. Blockchain-enabled IIoT technologies will be highly beneficial for Indian SMEs (Kumar *et al.*, 2021).

Today, games are customized and designed in a large volume with specific goals and based on the audience; the gaming industry has grown exponentially in recent years to reach audiences worldwide, according to Grandviewresearch[1]. For users' behavioral intention to use blockchain-based games, trust, perceived usefulness, enjoyment, and ease of use are important determinants (Gao and Li, 2021).

5.10. Crimes: The most crucial factor to consider when designing BC systems is the desired level of upstream/downstream counterfeiting protection that a brand owner intends to provide to customers via BC. Variables are essential in the feeding and reading processes design, and they can be changed to achieve the desired level of counterfeiting protection *(*Danese (*et al.*, 2021).

The potential and Implemented influences of BC on achieving digital evolution are categorized in Figure 1.

6. Discussion and Conclusion

Despite the importance of BC technology in attaining digital progress, there are still no clear measures of achievement and implementation success. As a result, determining the extent to which societies achieve digital evolution necessitates determining the possibilities and consequences of BC as a critical factor in attaining digital growth. By identifying the effects of blockchain, this study aimed to simplify the implementation of needed measures and indicators.

Researchers, practitioners, and governments can benefit from this research, which is based on a review of recent research and presentation of the influence of BC on achieving digital evolution in ten topics, including Finance, Business and Marketing, Energy Systems, Food Industry, Healthcare Systems, Science and Education, Engineering and Construction, Environment, Technology, and Crimes. With the introduction of new concepts, researchers should continue to investigate BC applications, their diffusion, adoption, and the outcomes of such processes. In addition, in some areas, the adoption of BC technology is not considered and needs a close look to determine the advantages. The hope is that this research will help researchers, practitioners, and governments make informed decisions that will better serve their society and organizations when allocating budgets, time, and other limited resources in the context of this emerging technology.

[1] Video Game Market Size, Share | Industry Report, 2020-2027. (2020). Available at: www.grandviewresearch.com/industry-analysis/video-game-market, Accessed 24 December 2021.

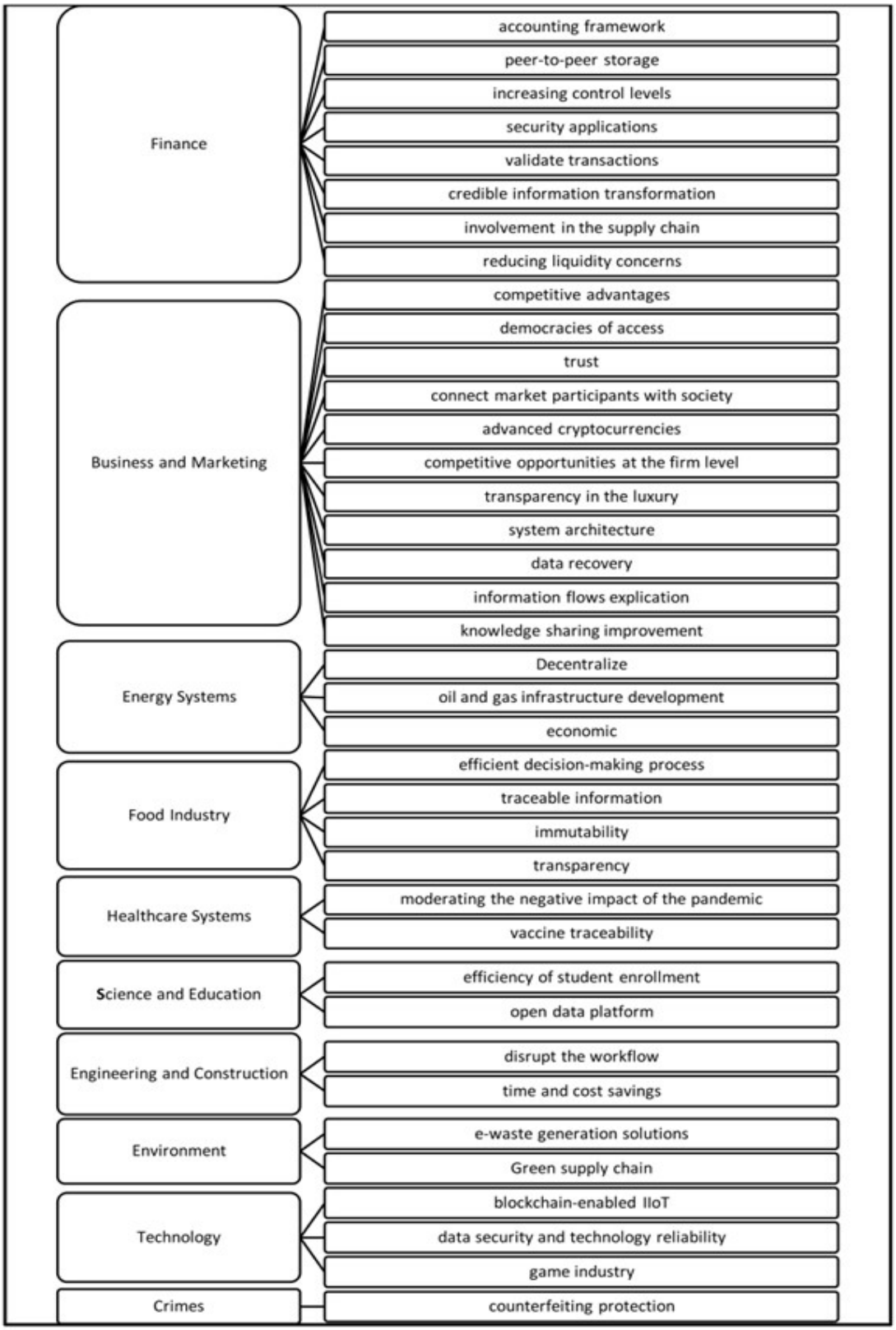

Figure 1. Influence of block chain on digital evolution according to the literature

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References

[1] Ahmad, A., Turki Alshurideh, M., al Kurdi, B. and Aburayya, A. (n.d.). Digital Transformation Metrics: A Conceptual View Machine Learning View Project A Conceptual Framework for Implementing TQM in the Primary Healthcare Centers and Examining Its Impact on Patient Satisfaction View Project, available at: https://www.researchgate.net/publication/353527038.

[2] Amiri Ara, R., Paardenkooper, K. and van Duin, R. (2021). A new blockchain system design to improve the supply chain of engineering, procurement and construction (EPC) companies – a case study in the oil and gas sector, *Journal of Engineering, Design and Technology, Emerald Group Holdings Ltd.*, available at: https://doi.org/10.1108/JEDT-01-2021-0047/FULL/XML.

[3] De Boissieu, E., Kondrateva, G., Baudier, P. and Ammi, C. (2021). The use of blockchain in the luxury industry: supply chains and the traceability of goods, *Journal of Enterprise Information Management, Emerald Group Holdings Ltd.*, 34 (5) 1318–1338.

[4] Bradford, P.G. and Benites, R.M. (2020). A Framework to Evaluate Blockchain Use-Cases, The Definitive Guide to Blockchain for Accounting and Business: Understanding the Revolutionary Technology, Emerald Publishing Limited, 107–126.

[5] Carrasco, H. and Romi, A.M. (2021). Toward an omniopticon: the potential of blockchain technology toward influencing vulnerable populations in contested markets, Accounting, Auditing and Accountability Journal, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/AAAJ-08-2020-4732/FULL/XML.

[6] Centobelli, P., Cerchione, R., del Vecchio, P., Oropallo, E. and Secundo, G. (2021), Blockchain technology design in accounting: Game changer to tackle fraud or technological fairy tale?, Accounting, Auditing & Accountability Journal, Emerald Publishing Limited, Vol. ahead-of-print No. ahead-of-print, available at: https://doi.org/10.1108/AAAJ-10-2020-4994.

[7] Chen, W., Bohloul, S.M., Ma, Y. and Li, L. (2021), A blockchain-based information management system for academic institutions: a case study of international students' workflow, Information Discovery and Delivery, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/IDD-01-2021-0010/FULL/XML.

[8] Danese, P., Mocellin, R. and Romano, P. (2021), Designing blockchain systems to prevent counterfeiting in wine supply chains: a multiple-case study, *International Journal of Operations and Production Management*, Emerald Group Holdings Ltd., 41 (13) 1–33.

[9] Dang, T.K. and Duong, T.A. (2021), An effective and elastic blockchain-based provenance preserving solution for the open data, *International Journal of Web Information Systems,* Emerald Group Holdings Ltd., 17 (5) 480–515.

[10] Davidson, S., de Filippi, P. and Potts, J. (2016), Economics of Blockchain, *SSRN Electronic Journal*, Elsevier BV, available at: https://doi.org/10.2139/SSRN.2744751.

[11] Dehghani, M., Popova, A. and Gheitanchi, S. (2021), Factors impacting digital transformations of the food industry by adoption of blockchain technology, *Journal of Business and Industrial Marketing*, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/JBIM-12-2020-0540/FULL/XML.

[12] Desouza, K.C. (n.d.). Using Technology Series Creating a Balanced Portfolio of Information Technology Metrics, available at: (accessed 27 December 2021).

[13] El-Masri, M., Hussain, E.M.A. (2021). Blockchain as a mean to secure Internet of Things ecosystems – a systematic literature review, *Journal of Enterprise Information Management*, Emerald Group Holdings Ltd., 34 (5) 1371–1405.

[14] Galati, F. (2021). Blockchain adoption in supply networks: a social capital perspective, Supply Chain Management, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/SCM-12-2019-0448/FULL/PDF.

[15] Gao, S. and Li, Y. (2021). An empirical study on the adoption of blockchain-based games from users' perspectives, Electronic Library, Emerald Group Holdings Ltd., 39 (4) 596–614.

[16] George, R. P., Peterson, B.L., Yaros, O., Beam, D.L., Dibbell, J.M. and Moore, R.C. (2019), Blockchain for business, *Journal of Investment Compliance*, Emerald Publishing Limited, 20 (1) 17–21..

[17] Ghaemi Asl, M., Rashidi, M.M. and Hosseini Ebrahim Abad, S.A. (2021). Emerging digital economy companies and leading cryptocurrencies: insights from blockchain-based technology companies, *Journal of Enterprise Information Management, Emerald Group Holdings Ltd*., 34 (5) 1506–1550.

[18] Katz, R.L. (2017), SOCIAL AND ECONOMIC IMPACT OF DIGITAL TRANSFORMATION ON THE ECONOMY, available at: https://www.itu.int/en/ITU-D/Conferences/GSR/Documents/GSR2017/Soc_Eco_impact_Digital_transformation_finalGSR.pdf (accessed 30 December 2021).

[19] Kayikci, Y., Durak Usar, D. and Aylak, B.L. (2021). Using blockchain technology to drive operational excellence in perishable food supply chains during outbreaks, *The International Journal of Logistics Management*, Emerald Publishing Limited, Vol. ahead-of-print No. ahead-of-print, available at: https://doi.org/10.1108/IJLM-01-2021-0027.

[20] Kumar, R., Sindhwani, R. and Singh, P.L. (2021). IIoT implementation challenges: analysis and mitigation by blockchain, Journal of Global Operations and Strategic Sourcing, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/JGOSS-08-2021-0056/FULL/XML.

[21] Laplume, A. (2018). Blockchain ventures and international business, Progress in International Business Research, Emerald Group Publishing Ltd., Volume 13, 141–157.

[22] Liu, L., Zhang, J.Z., He, W. and Li, W. (2021). Mitigating information asymmetry in inventory pledge financing through the Internet of things and blockchain, *Journal of Enterprise Information Management*, Emerald Group Holdings Ltd., 34 (5) 1429–1451.

[23] Liu, R., Tan, C., Zhao, C. (2021). Pricing and coordination of vaccine supply chain based on blockchain technology, *Internet Research*, Emerald Group Holdings Ltd., 31 (6) 2096–2119.

[24] Lyridis, D. V., Andreadis, G.O., Papaleonidas, C., Tsiampa, V. (2021). A BPM-based framework for the impact assessment of blockchain to the midstream LNG supply chain, Maritime Business Review, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/MABR-03-2021-0023/FULL/PDF.

[25] Micic, L. (2017). Digital Transformation and Its Influence on GDP, ECONOMICS, Walter de Gruyter GmbH, Vol. 5 No. 2, 135–147.

[26] Mubarik, M., Raja Mohd Rasi, R.Z., Mubarak, M.F., Ashraf, R. (2021). Impact of blockchain technology on green supply chain practices: evidence from emerging economy, Management of Environmental Quality: *An International Journal*, Emerald Group Holdings Ltd., 32 (5) 1023–1039.

[27] Obstfeld, D., Baker, W., Cohen, M., Ventresca, M., Lacey, R., Morrill, C., Swaminathan, A., et al. (n.d.). Social Networks, the Tertius Iungens Orientation, and Involvement in Innovation 1 OF THE AUTHOR 1 I want to thank, available at: (accessed 30 December 2021).

[28] Oh, J. and Shong, I. (2017). A case study on business model innovations using Blockchain: focusing on financial institutions, *Asia Pacific Journal of Innovation and Entrepreneurship*, Emerald Publishing Limited, 11 (3) 335–344.

[29] Oh, S.-C., Kim, M.-S., Park, Y., Roh, G.-T. and Lee, C.-W. (2017). Implementation of blockchain-based energy trading system, *Asia Pacific Journal of Innovation and Entrepreneurship*, Emerald Publishing Limited, 11 (3) 322–334.

[30] Philsoophian, M., Akhavan, P., Namvar, M. (2021). The mediating role of blockchain technology in improvement of knowledge sharing for supply chain management, Management Decision, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/MD-08-2020-1122/FULL/XML.

[31] Probst, L., Frideres, L., Cambier, B., Martinez-Diaz, C. and Luxembourg, P. (2016). Blockchain applications & services. Case study 68, Business Innovation Observatory, European Union, available at: https://ec.europa.eu/growth/system/files/2017-07/68_blockchains_0.pdf (accessed 15 December 2021).

[32] Sahoo, S., Mukherjee, A. and Halder, R. (2021). A unified blockchain-based platform for global e-waste management, *International Journal of Web Information Systems*, Emerald Group Holdings Ltd., 17 (5) 449–479.

[33] Science for Policy Handbook. (2020). Science for Policy Handbook, Elsevier, available at: https://doi.org/10.1016/C2018-0-03963-8.

[34] Turhan, C., Akman, I. (2021). Exploring sectoral diversity in the timing of organizational blockchain adoption, Information Technology and People, Emerald Group Holdings Ltd., available at:https://doi.org/10.1108/ITP-05-2020-0330/FULL/XML.

[35] Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N. and Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda, *Journal of Business Research, Elsevier*, Volume122, 889–901.

[36] Wilkie, A., Smith, S.S. (2021). Blockchain: Speed, Efficiency, Decreased Costs, and Technical Challenges, The Emerald Handbook of Blockchain for Business, Emerald Publishing Limited, 157–170.

[37] Wren, H. (2020). What is digital transformation? Definition, Examples, Main Areas, Zendesk, 1 December, available at: https://www.zendesk.com/blog/digital-transformation/ (accessed 27 December 2021).

[38] Wren, H. (2020b). What is digital transformation? Definition, Examples, Main Areas, Zendesk, 1 December, available at: https://www.zendesk.com/blog/digital-transformation/ (accessed 27 December 2021).

[39] Xiong, Y., Lam, H.K.S., Kumar, A., Ngai, E.W.T., Xiu, C., Wang, X. (2021), The mitigating role of blockchain-enabled supply chains during the COVID-19 pandemic, *International Journal of Operations and Production Management, Emerald Group* Holdings Ltd., 41 (9) 1495–1521.

[40] Xu, Y., Chong, H.Y., Chi, M. (2021). Modelling the blockchain adoption barriers in the AEC industry, Engineering, Construction and Architectural Management, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/ECAM-04-2021-0335/FULL/XML.

[41] Yacoub, G., Castillo, M. (2021). Blockchain in your grocery basket: trust and traceability as a strategy, *Journal of Business Strategy*, Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/JBS-02-2021-0032/FULL/XML.