Support for Knowledge Management Processes with Blockchain Technology

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Abstract: *Knowledge management facilitates the cycle of knowledge within organization through processes for knowledge capture/creation, storing, sharing and application. Various information technologies are already used to support those processes and their mechanisms, and new ones are continually emerging. The use of blockchain technology is lately suggested in many areas, including knowledge management. This paper aims to identify what are the most discussed benefits of using blockchain technology in knowledge management, considering their features, especially for specific processes. It also explores possible advantages and disadvantages of the use of blockchain technology, on which depends its real adoption in organizations as support for knowledge management processes.*

1. INTRODUCTION

Importance of organizational knowledge is indisputable today for the success of any business organization on a market that is continually changing and is, especially lately, disrupted by various events – diseases (COVID-19), natural disasters (earthquakes), wars (Ukraine), or logistic problems (truck drivers shortage, Suez Canal obstruction). Critical knowledge must be determined and obtained from sources within and without organization, as is accentuated in Quality management systems – Requirements standard, ISO 9001:2015 (Kahler et al., 2016), which was again confirmed in 2021 (International Organization for Standardization, 2015). For this reason, knowledge management should be an integral part of organization management, ensuring that knowledge management processes have the continuous support that they need.

The use of various information technologies to foster knowledge management processes has been investigated by various authors (Becerra-Fernandez & Sabherwal, 2014; Dalkir, 2017; de Carvalho & Ferreira, 2001; Lovrenčić et al., 2017) because it offers many possibilities for improvement of business processes that organization can benefit from and gain competitive advantage. It is not exaggerated to say that knowledge management can benefit from almost any information technology, and therefore this research continues with the emergence of new technologies, including blockchain technology.

The paper is structured as follows. In Chapter 2 is given an overview of knowledge management processes and well known technologies for their support, and in Chapter 3 are described the basics of blockchain technology. Chapter 4 investigates benefits of blockchain use for knowledge management processes, and Chapter 5 advantages and disadvantages of blockchain technology in general. Potential directions for future research are described in Chapter 6, and in chapter 7 the conclusion is given.

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2.   KNOWLEDGE MANAGEMENT PROCESSES AND TECHNOLOGY

The flow of knowledge through organization is enabled by knowledge management processes that are part of knowledge management architecture, which also includes various mechanisms, technologies, systems and supporting infrastructure. There are numerous proposals for names and number of those processes. For example, Wei and Yeganeh (2013) list suggestions from six different papers and Dalkir (2017) gives a review of seven approaches to knowledge management cycle. In general, knowledge management processes can be divided into four phases:

1.   **Knowledge capture/creation:** First phase of knowledge management cycle that is focused on obtaining new or existing knowledge, which resides within or without organization and is necessary for its business.
2.   **Knowledge storing:** The phase in which different methods and technologies are used for processing, codifying and storing knowledge in various formats that are appropriate for sharing and using.
3.   **Knowledge sharing:** Often mentioned as the most important phase, it ensures that knowledge is accessible in an understandable form and at the right time to employees that make decisions and perform actions.
4.   **Knowledge application:** Last phase refers to the application of knowledge in business, whereby the knowledge that is applied can be one's own or someone else's.

Information technology is an integral part of knowledge management since it began to be studied as a scientific discipline. This is depicted in well-known Stankosky's (2005) four pillars of knowledge management: leadership, organization, learning and technology; where information technology such as e-mail, data warehousing, search engines, decision support and management tools are mentioned. During years many „traditional" and also emerging technologies were and are used for support of knowledge management processes, for example databases, content management systems, decision support systems, lessons learned systems, data mining, blogs, big data analytics, machine learning. augmented reality, natural language processing and semantic technologies. For a large number of emerging information technologies, the benefit for supporting knowledge management processes, and thus the organization's operations, is assessed. Blockchain is also one of those technologies.

3.   BLOCKCHAIN TECHNOLOGY

It is considered that work on blockchain began when Haber and Stornetta (1991) described the procedure of secure time-stamping of digital documents, and then gained interest after famous mail and paper from Nakamoto (2008) that proposes a bitcoin as electronic cash with peer-to-peer network and proof-of-work chain. The first implementation of blockchain was in 2009 as the public distributed ledger for bitcoin transactions, meaning that a ledger is distributed over network (Chowdhury et al., 2019).

There are many papers that in detail explain blockchain technology (Belotti et al., 2019; Chatterjee & Chatterjee, 2017; Murray, 2019; Sahani et al., 2020; Yaga et al., 2018), which can be described in the simplest way as a shared distributed database. In the blockchain, content is stored on a decentralized public ledger that ensures tracking of history of all transactions and thus provenance of data, information and knowledge. Encrypted content, distributed ownership and distributed physical structure of the ledger ensure trust and security. Blocks in a ledger are connected into chains, and each block has a block header and block data. Block header contains information about block

number and size, time of creation, previous block hash value, block data hash representation and nonce value, whereas block data are stored transactions and ledger events (Yaga et al., 2018). There is no need for intermediaries and interactions can be trustless and permissionless. For example, blockchain enables use of smart contracts – certain actions (such as transfer of some asset) can be predefined and automatically executed when certain conditions are met, without a third party (Belotti et al., 2019), enabling automation of business workflow. Blockchain can also store non-fungible tokens (NFTs) that are unique and can identify something or someone, thus proving the existence and ownership over any digital asset which is the object of a smart contract (Wang et al., 2021).

On Figure 1 is depicted a simple representation of the process of creation of a new block. The important part of the process after initiation of a blockchain change is that transaction has to be validated by computers on the network with consensus protocols, such as Proof of Work (PoW) or Proof of Stake (PoS) (Sriman et al., 2020). Once verified and added to blockchain, block is immutable, irreversible and resilient. This is why its use is investigated in many domains beyond cryptocurrencies, and one of them is knowledge management.
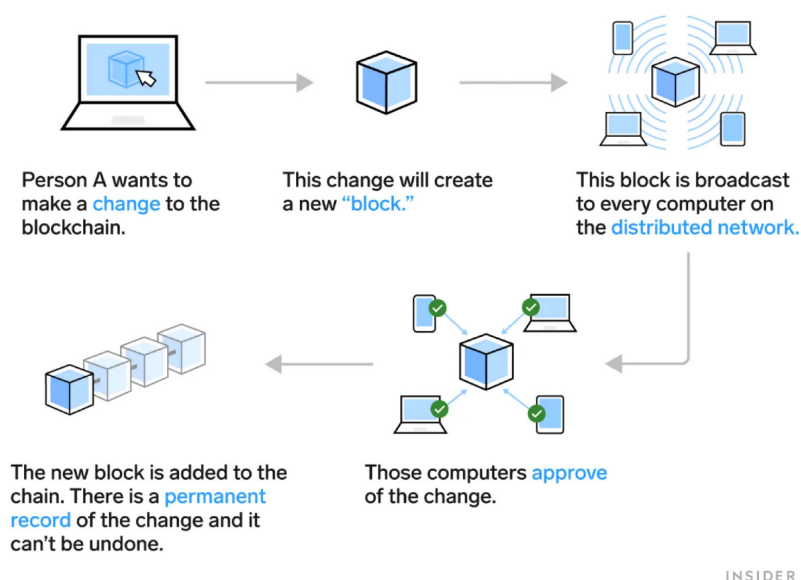

Person A wants to make a change to the blockchain.

This change will create a new "block."

This block is broadcast to every computer on the distributed network.

Those computers approve of the change.

The new block is added to the chain. There is a permanent record of the change and it can't be undone.

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Figure 1. Creation of a Block in a Blockchain
Source: Houston, 2022.

4.   THE USE OF BLOCKCHAIN IN KNOWLEDGE MANAGEMENT PROCESSES

Since knowledge management continuously makes use of new technologies to support its processes, there is also ongoing research and proposals of possible application of blockchain for this purpose. The aim of this research was not only to find scientific papers about the topic but also suggestions and ideas from professional perspective, such as business magazines and professional blogs, so that the scope of the interest and practical use in business organizations can be viewed from different perspectives. For this reason, only Google and Google Scholar were searched with keywords "knowledge management processes", "knowledge creation", "knowledge acquisition", knowledge storing", knowledge storage", "knowledge sharing", "knowledge distribution", "knowledge use" and "knowledge application" combined with "blockchain". Results directly connected to knowledge management processes in business organizations and blockchain features that would improve them were taken into account. For given conditions, only few papers described below and no relevant other sources were found.

Investigation of Scopus citation database papers about general use of blockchain for knowledge management was done by Frozza et. al. (2019) and the authors found nine papers in total and several proposals for blockchain application in all knowledge management processes, naming decentralization, immutability, traceability, anonymity, distrusting, transparency and smart contracts as its important features. Akhavan et al. (2018) argue that blockchain should be used in knowledge management because of various features: for knowledge creation because of collective verification and transparency; for knowledge storage because of transparency, decentralization, immutability and integration; for knowledge sharing because it ensures intellectual property rights; and for knowledge use because of security and access control. Yuman and Goyal (2022) propose model of enterprise knowledge management blockchain technology platform that ensures verification, security and anonymity of knowledge creation and transfer with the use of private keys, using distributed and decentralized knowledge base. Framework for knowledge acquisition system with secure, immutable and irrevocable blockchain-driven decentralized knowledge base is proposed by Majeed & Hong (2018), which will enable secure submission of rules with public and private keys. Decentralization, immutability and establishment of trust are also features that improve processes of knowledge storage and sharing (Adeleke, 2019). Other features that make blockchain technology useful for knowledge sharing are transparency and security (Hu et al., 2018; Philsoophian et al., 2022), as well as security, trust, immutability, distribution and traceability (Pastor et al., 2020).

According to purpose of knowledge management processes, known features of blockchain and analyzed literature, most important benefits of blockchain technology that can be identified for specific processes/phases are:

1. **Knowledge capture/creation:** provenance of captured/created knowledge and trustworthiness of data sources,
2. **Knowledge storing:** distributed, decentralized knowledge storage and decreased possibility of knowledge manipulation,
3. **Knowledge sharing:** no intermediaries in knowledge sharing and facilitated sharing because of decentralized storage,
4. **Knowledge application:** self-execution through smart contracts and automation of business workflow.

5. ADVANTAGES AND DISADVANTAGES OF THE USE OF BLOCKCHAIN

In previous chapter are described many positive perspectives of implementation of blockchain technology. One of most mentioned advantages is security of stored data, information and knowledge, because of use of cryptography, decentralization and need for network consensus for any change in a ledger. The way in which each block is created ensures immutability of stored information, which becomes permanent and uneditable. The whole process brings even more advantages in form of transparency and trustless and permissionless interactions, but also ensures authorship and ownership of created knowledge (NFTs) and proof of knowledge.

When adopting blockchain in knowledge management, organizations should not be aware only of its benefits and advantages, but also of disadvantages in general. Important disadvantages that organizations have to take into consideration before implementation of blockchain technology in knowledge management and for specific knowledge management processes are:

- **Scalability:** The number of transactions per second (TPS) of blockchain technology is still low; according to various sources, Bitcoin has 7-14 TPS and Ethereum 20-35 TPS whereas Visa has 1700 TPS.
- **Cost:** Transaction fees can significantly vary, depending on various factors (Clarke, 2022) as well as mining and service fees.
- **Storage limitations:** Compared to standard data and knowledge bases, the size of Ethereum Blockchain (978 GB) and Bitcoin Blockchain (406 GB) is small, but largely affects the scalability. Up to date size can be checked at https://ycharts.com.
- **Sustainability issues:** Energy consumption depends on consensus method – Bitcoin has estimated energy consumption of 132.42 TWh/year (comparable to Argentina), and Ethereum 0.01 TWh/year (comparable to Gibraltar). Up to date energy consumption estimate and comparison with countries can be checked at https://www.statista.com.
- **Questionable future value:** As with any new technology, organizations may not see future value of use of blockchain when considering other technologies and blockchain advantages versus mentioned disadvantages, as well as possible contrary information in media.

6. FUTURE RESEARCH DIRECTIONS

Blockchain technology is continuously investigated for application in many domains and for various purposes. There is also research interest aimed at knowledge management in general and for specific domains, which was not in the focus of this paper. Surprisingly, there were only several papers that investigated the use of blockchain technology features specifically for knowledge management processes and no other relevant web sources were found. This points out that more thorough research should be made in several citation databases with carefully selected keywords to find out the nature of connection between blockchain and knowledge management that is currently in the main scientific focus.

Research aimed at blockchain features and knowledge management processes mainly took into account possible benefits. But, to enable organizations to make decision about implementing blockchain technology together with other technologies it already uses to support knowledge management processes, a framework that weighs all advantages and disadvantages for specific processes and their mechanisms should be established. The framework should take into account various factors, such as business strategy, importance of specific process and already implemented technologies, as well as extended use of blockchain technology beyond knowledge management.

7. CONCLUSION

Literature search and overview showed that there is ongoing research about blockchain and knowledge management, but mostly not focused on blockchain features and their potential to support knowledge management processes. Since continuous practice and research proves that many technologies can successfully be implemented into knowledge management systems, there is large potential also for blockchain technology. Organizations invest resources into areas that will be profitable, and knowledge management is not an exception. This is why consideration of use of blockchain technology depends on various factors and such investment would probably need justification of broader use. However, with advancement of blockchain technology, main disadvantages have potential to be reduced over time and influence less on profitability issues, making organizations more prone to implement blockchain as a support for knowledge management processes.

References

Adeleke, T. (2019). *Blockchain and Learning Organizations: How the Emerging Technology Impacts Knowledge Sharing* (Publication No. 27672423) [Doctoral dissertation, University of Maryland University College]. ProQuest Dissertations Publishing. https://www.proquest.com/docview/2385767203

Akhavan, P., Philsoophian, M., Rajabion, L., & Namvar, M. (2018). Developing a block-chained knowledge management model (BCKMM): beyond traditional knowledge management. In E. Bolisani, E. Di Maria, & E. Scarso (Eds.). *Proceedings of the 19th European Conference on Knowledge Management* (pp. 17-24). Curran Associates.

Becerra-Fernandez, I., & Sabherwal, R. (2014). *Knowledge management: systems and processes*. New York: Routledge. https://doi.org/10.4324/9781315715117

Belotti, M., Božić, N., Pujolle, G., & Secci, S. (2019). A vademecum on blockchain technologies: When, which, and how. *IEEE Communications Surveys & Tutorials*, 21(4), 3796-3838. https://doi.org/10.1109/COMST.2019.2928178

Chatterjee, R., & Chatterjee, R. (2017). An overview of the emerging technology: Blockchain. In *2017 International Conference on Computational Intelligence and Networks*. (pp. 126-127). Piscataway: IEEE

Chowdhury, M. J. M., Ferdous, S., Biswas, K., Chowdhury, N., Kayes, A. S. M., Alazab, M., & Watters, P. (2017). A Comparative Analysis of Distributed Ledger Technology Platforms. *IEEE Access*, 7, pp. 167930-167943. https://doi.org/10.1109/ACCESS.2019.2953729

Clarke, A. (2022, September 7). How high transaction fees are being tackled in the blockchain ecosystem. *Cointelegraph*. https://cointelegraph.com/news/how-high-transaction-fees-are-being-tackled-in-the-blockchain-ecosystem

Dalkir, K. (2017). *Knowledge Management in Theory and Practice* (Third Edition). Cambridge, MA: The MIT Press

de Carvalho, R. B., & Ferreira, M. A. T. (2001). Using information technology to support knowledge conversion processes. *Information Research*, 7(1). http://www.informationr.net/ir/7-1/paper118.html

Frozza, T., Casella Galli, F., Pinheiro da Lima, E., & Ribeiro da Silva, E. (2019). Implications of Blockchain technology in Knowledge Management: a literature review. In *Third International Symposium on Supply Chain 4.0 : Challenges and Opportunities of Digital Transformation, Intelligent Manufacturing and Supply Chain Management 4.0*. (pp. 92-98). Collaborative Research Network on Supply Chain 4.0. http://supplychain4.org/wp-content/uploads/2018/03/Proceedings-ISSC4-2019.pdf

Haber, S., & Stornetta, W. S. (1991). How to time-stamp a digital document. *Journal of Cryptology*, 3(2), 99-111.

Houston, R. (2022, July 13). Blockchain is a digital database used to store data for crypto transactions and other assets — here's how it works. *Insider*. https://www.businessinsider.com/personal-finance/what-is-blockchain

Hu, S., Hou, L., Chen, G., Weng, J., & Li, J. (2018, November). Reputation-based distributed knowledge sharing system in blockchain. In *Proceedings of the 15th EAI International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services* (pp. 476-481). ACM. https://doi.org/10.1145/3286978.3286981

International Organization for Standardization. (2015). *Quality management systems — Requirements* (ISO Standard No. 9001:2015). https://www.iso.org/standard/62085.html

Kahler, T., Gross, D., Bredehorst, B., & Ulrich, D. (2016). *Organizational Knowledge: DIN EN ISO 9001:2015 interpreted and explained for practical use* (Research Report No.

15.R.004), Pumacy Technologies AG. https://www.pumacy.de/en/publications/studies/report-organizational-knowledge/

Lovrenčić, S., Sekovanić, V., & Jarnjak, A. (2017). Knowledge Management in the Wealth of Information Technology. In V. Potočan, P. Kalinić & A. Vuletić (Eds.), *Economic and Social Development: 26th International Scientific Conference* (pp. 499-507). Varaždin Development and Entrepreneurship Agency

Majeed, U., & Hong, C. S. (2018). Blockchain Driven Knowledge Acquisition Systems: A General Framework. Journal of the Korean Data and Information Science Society, pp. 988-990. https://www.researchgate.net/publication/334519686_Blockchain_Driven_Knowledge_Acquisition_Systems_A_General_Framework

Murray, M. (2019). Tutorial: A descriptive introduction to the blockchain. *Communications of the Association for Information Systems*, 45(1), pp. 464-487. https://doi.org/10.17705/1CAIS.04525

Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. https://bitcoin.org/bitcoin.pdf

Pastor, I. G., Olaso, J. R. O., & Fuente, F. S. (2020). Blockchain as a Trust Building Tool for the Promotion of Knowledge Sharing in Project Management. In J. R: Otegi, N. Toledo & I. Taboada (Eds.) *Research and Education in Project Management* (pp. 44-47), 44. AEIPRO.

Philsoophian, M., Akhavan, P., & Namvar, M. (2022). The mediating role of blockchain technology in improvement of knowledge sharing for supply chain management. *Management Decision*, 60(3), 784-805. https://doi.org/10.1108/MD-08-2020-1122

Sahani, A., Singh, P., & Kumar, A. (2020). Introduction to Blockchain. *Journal of Informatics, Electrical and Electronics Engineering*, 1(1), 1-9. http://doi.org/10.54060/JIEEE/001.01.004

Sriman, B., Ganesh Kumar, S., & Shamili, P. (2020). Blockchain technology: Consensus protocol proof of work and proof of stake. In S. S. Dash, S. Das & B. K. Panigrahi (Eds.), *Intelligent Computing and Applications: Proceedings of ICICA 2019* (pp. 395-406). Springer Singapore. https://doi.org/10.1007/978-981-15-5566-4_34

Stankosky, M. A. (2005). Advances in Knowledge Management: University Research Toward an Academic Discipline. In M. A. Stankosky (Ed.), *Creating the Discipline of Knowledge Management* (pp. 1-14). New York: Routledge

Wang, Q., Li, R., Wang, Q., & Chen, S. (2021). Non-fungible token (NFT): Overview, evaluation, opportunities and challenges (Technical Report). https://arxiv.org/pdf/2105.07447.pdf

Wei, C. C., & Yeganeh, M. (2013). The Influence Of Information Technology On The Knowledge Management Process. *Journal of Knowledge Management Practice*, 14(1). http://www.tlainc.com/articl327.htm

Yaga, d., Mell, P., Roby, N., & Scarfone, K. (October, 2018). *Blockchain Technology Overview* (Report No. 8202), National Institute of Standards and Technology. https://doi.org/10.6028/NIST.IR.8202

Yuman, Y., & Goyal, D. S. (2022). Knowledge Management using IoT-Blockchain Technology: State of the Art. *International Journal of Electrical and Electronics Research (IJEER)*, 10(2), 183-189. https://doi.org/10.37391/IJEER.100223