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Analysis of the Risks of Using the Blockchain Technology in the Accounting and Audit of a Fuel and Energy Complex Enterprise

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ABSTRACT

Blockchain is a modern, influential technology that is already transforming organizations and their business models in all business processes, including accounting and auditing. The article identifies and analyzes the risks of blockchain application in accounting and audits of fuel and energy companies. Areas of application of blockchain in accounting and auditing of fuel and energy companies have been determined, which include - integration of cryptocurrency into the accounting system of an energy company, creation of smart contracts, certification of renewable energy sources, automation of accounting and document flow, operational management of energy company assets, accounting of accounts consumption of energy and fuel resources. The risks of using blockchain technology in accounting and auditing of fuel and energy companies are systematized, which are grouped according to the following directions: high requirements of blockchain for energy consumption, lack of sufficient knowledge and skills of accountants in working with blockchain, technical, accounting and auditing problems. An example of choosing an economic risk management strategy of an energy company using maximax, Bayes, Laplace, Wald, Savage, Hurwitz criteria has been developed. The results of the research can be useful for accountants, auditors and managers of fuel and energy companies during the implementation and use of blockchain technology in practical activities.

Keywords: Blockchain, Digitalization, Accounting, Audit, Fuel and Energy Complex
JEL Classifications: G4, O1

1. INTRODUCTION

Accounting creates information using standard data processing methods. The way data is processed is determined by the specific information needs of an enterprise's stakeholders. At the same time, information technology such as blockchain embraces the research of scientists, managers, and practitioners from around the world (Teufel et al., 2019; Abreu et al., 2018).

1.1. Problem Statement

It should be emphasized that despite significant progress in recent years, blockchain technology applications for transactions and accounting management are still in their infancy. Little is known about blockchain's role in tracking transactions and its use in areas such as e-commerce, auditing, government services, etc. At the same time, the risks of blockchain technology in the economy, including accounting and auditing, remain poorly understood.

1.2. The Focus of the Study

In addition to the benefits of blockchain technology in reducing transaction times and automating accounting and auditing processes, there are also risks associated with blockchain technology. These risks are related to the specifics of blockchain as information technology and the requirements of the blockchain environment.

1.3. Purpose of the Study and Research Questions

The purpose of the study is to establish and analyze the risks of applying blockchain technology in the accounting and auditing of fuel and energy companies. The research questions are: What are the applications of blockchain in the accounting and auditing of fuel and energy companies? What are the risks of applying blockchain in the accounting and auditing of fuel and energy companies? How can we reduce the impact of blockchain risks in the accounting and auditing of fuel and energy companies?

2. LITERATURE REVIEW

Many scientific papers are devoted to the research of blockchain technology application. In particular, a number of scientists determine the essence and advantages of blockchain application in the energy sphere.

For example, Paliwal et al. (2020) note that Blockchain technology provides a transparent, real-time, auditable accounting ecosystem. This technology can also improve auditing practices and thus reduce trading costs, increase transaction settlement rates, reduce fraud risk, improve transaction verification, and increase monitoring efficiency (Paliwal et al., 2020).

According to Elommal and Manita (2022), blockchain is a decentralized, electronic, replicated, and distributed file in which transactions are recorded using peer-to-peer protocols; it is fast digital communication, huge computing power, and advanced encryption technology. It uses computers that are independent of each other and connected to each other to create a network over the Internet (Britchenko, and Saienko, 2017).

However, according to Cao (2019), the paradigm shift is considered a breakthrough in the energy industry to promote autonomous and decentralized power grid operation while maximizing the use of distributed generation (DG). Blockchain is defined as a revolutionary technology for implementing EI to facilitate reliable autonomous energy delivery. It is also worth highlighting studies that systematize the directions and areas of application of blockchain by fuel and energy companies.

Juszczyk and Shahzad (2022) identify areas of the energy business where blockchains may have the greatest impact, such as energy accounting and legal agreements, anti-counterfeiting, logistics, transparency in tracking energy costs, or creating new markets for energy trading. It is noted that in these areas, blockchain helps automate and facilitate business processes.

Andoni et al. (2019), formally classified blockchain use cases in the energy sector into eight major groups according to their purpose and scope:

1. Metering/billing and security
2. Cryptocurrencies, tokens, and investments
3. Decentralized energy trading
4. Green certificates and carbon trading
5. Electric grid management
6. Internet of Things, smart devices, automation, and asset management
7. Electric mobility
8. General purpose initiatives and consortia.

The next group of scientific papers is devoted to the practical aspects of the application of blockchain in the activities of fuel and energy companies.

In particular, the results of research by Brilliantova and Thurner (2018) indicate that most companies are launching pilot projects, and the application of the technology depends mainly on its functionality and features.

The electricity sector is testing blockchain technology to support the decentralization of energy production. Wang et al. (2020) argue that blockchain can fuel renewable energy and ensure energy sustainability. The scientists also suggest a possible future trend for energy blockchain development. Using smart contracts, according to Miglani et al. (2020) blockchain technology enables automated data exchange, complex energy transactions, demand management and peer-to-peer (P2P) energy trading, etc. Blockchain will play a vital role in the evolution of the IoE market as distributed renewable resources and smart power grids are deployed and used.

As, Bürer et al. (2019), private blockchain networks of energy companies offer party pre-approved data authorization and limited access to the consortium. Private and cooperative blockchains offer an intermediate alternative before the necessary privacy features for business demand can be introduced by public blockchains.

At the same time, there is also an opinion among scientific studies regarding the risks of blockchain applications. For example, Erturk et al. (2019) point to significant risks and problems for smart energy applications based on blockchain, including limited scalability and speed, the requirements for off-chain support. Researchers also emphasize high installation and maintenance costs, high transaction costs, and the need for further practical testing.

Thus, the application of blockchain technology is a relevant area of scientific research in various areas of the economy, including the fuel and energy complex. The attention of scientists is focused on determining the essence of blockchain technology, the directions of its application, identifying the advantages and disadvantages. Taking into account the results of these scientific studies, it is still relevant to find out the risks of applying blockchain technology in the accounting and auditing of fuel and energy companies.

3. METHODOLOGY

3.1. Methods

The study used methods of analysis and synthesis in determining the characteristics of the application of blockchain technology in the accounting and auditing of fuel and energy enterprises. For a detailed study of the risks of applying blockchain technology in the accounting and auditing of fuel and energy enterprises, a monographic method was used. The statistical method was used to select the risk management strategy for the application of blockchain technology in the accounting and auditing of fuel and energy companies.

3.2. Sampling

The study analyzes the case of the Polish energy company PGNiG with the choice of alternatives to the use of blockchain for smart contracts (A_1), certification of renewable energy sources (A_2), and the integration of cryptocurrency for energy payments (A_3).

3.3. Tools and Stages

Maximex, Bayes, Laplace, Wald, Savage, Hurwitz criteria were used to make an economic risk management strategy. The maxima criterion focuses the statistics on favorable conditions of the energy market, i.e., this criterion expresses an optimistic assessment of the situation.

According to Bayes criterion for the optimal strategy is that strategy (net) Ai, which maximizes the average gain or minimizes the average risk r.

Under Laplace's criterion If the probabilities of the states of the energy market conjuncture are plausible, to estimate them we use Laplace's principle of insufficient basis, according to which all states of nature are considered equally probable, i.e.:

$q_1 = q_2 = \ldots = q_n = 1/n.$

$q_i = 1/3.$

According to the Wald criterion for the optimal strategy is taken as a pure strategy, which in the worst conditions guarantees the maximum winnings, i.e.:

$a = \max(\min a_{ij})$

The Wald criterion focuses statistics on unfavorable states of the energy market conditions, i.e., this criterion expresses a pessimistic assessment of the situation.

The Hurwitz criterion is a criterion of pessimism-optimism. As the optimal strategy is taken that strategy, for which the ratio is fulfilled:

$\text{Max}(s_i)$

where si = y min (aij) + (1-y) max (aij)

If y = 1 we get the Wald criterion, if y = 0 we get the optimistic criterion (maximax).

The Hurwitz criterion takes into account the possibility of both worse and better market behavior for the company. The worse the consequences of erroneous decisions, the greater the desire to hedge against mistakes, the closer to 1.

The research procedure includes the following steps:
1. Collection of materials from scientific, periodic, and statistical sources of information in accordance with the specific topic of the study
2. Formulation of peculiarities of application of blockchain technology by scientific interpretation of scientists' positions
3. Finding out the directions of application of blockchain technology in the accounting and auditing of fuel and energy enterprises
4. Systematization of risks of blockchain technology application in accounting and auditing of fuel and energy enterprises
5. Analysis of the risks of applying blockchain technology in the accounting and auditing of fuel and energy enterprises
6. Risk assessment of blockchain technology application in accounting and auditing of fuel and energy enterprises
7. Identification of risk management strategies for the application of blockchain technology in the accounting and auditing of fuel and energy enterprises.

3.4. Data Analysis

To determine the economic risk management strategy for blockchain technology and to create a payment matrix, data on the cost of implementing blockchain technology (millions of dollars) and the profit from each of the defined alternatives (millions of dollars) were used.

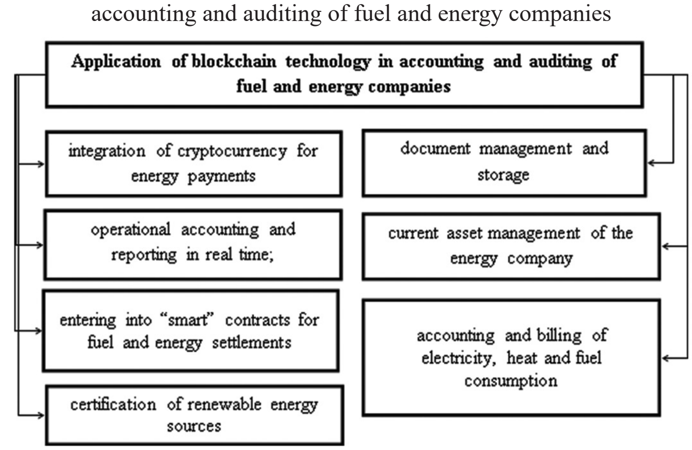
4. RESULTS

We believe that the key areas for the application of blockchain technology in the accounting of fuel and energy companies are as follows (Figure 1).

Based on (Lardo et al., 2022; Abreu et al., 2018; Afanasyev et al., 2019; Gokoglan and Cetin 2022; Bonsón and Bednárová, 2019).

Given that blockchains have a number of advantages, they are not without some disadvantages. Let us systematize the main risks of using blockchains in the accounting and auditing of fuel and energy companies.
1. High energy intensity of the system (the energy consumption of blockchain use is quite high and requires significant costs)
2. Lack of familiarity and standardization
3. Cybersecurity and other technical problems
4. Accounting difficulties (e.g., accountants' unfamiliarity with blockchain technology)
5. Audit practice problems (lack of sufficient evidence of the nature of the transaction, guarantees of transaction

Figure 1: Directions of blockchain technology application in accounting and auditing of fuel and energy companies



Source: Authors' development

classification in the financial statements of the fuel and energy company, the approximate value of transactions, etc.)

6. Technological barriers (significant computing power to verify transactions, huge amount of memory to store the history of transactions).

To determine the economic risk management strategy for the application of blockchain technology in the accounting and auditing of fuel and energy companies should use the criteria of Maximex, Bayes, Laplace, Wald, Savage, Gurwitz. For this purpose, let us consider an example. The Polish energy company PGNiG can apply blockchain to enter into smart contracts (A1), renewable energy certification (A2), and integration of cryptocurrency to pay for energy (A3), while making a profit (million dollars), which can be in one of three states (P1, P2, P3). The elements of the payment matrix characterize the profits made during the i-th activity of the company at the j-th state of demand. The company A‘s game against demand is given by the payment matrix. Let's determine the optimal proportions in the blockchain activities, guaranteeing the maximization of the average profit at any state of demand, considering it to be certain. The problem is reduced to the game model.

10	9	11
15	17	12
10	11	14

Source: Author's calculations

Maximax criterion. Making a payment matrix.

A_i	$П_1$	$П_2$	$П_3$	Max (a_{ij})
A_1	10	9	11	11
A_2	15	17	12	17
A_3	10	11	14	14

Source: Authors' calculations

Choose max = 17 from (11; 17; 14).
Conclusion: Choose strategy n = 2.
Bayes criterion. Determine the value $\sum (a_{ij} p_j)$:
$\sum (a_{1,j}\, p_j) = 10*0.33 + 9*0.33 + 11*0.33 = 9.9$.
$\sum (a_{2,j}\, p_j) = 15*0.33 + 17*0.33 + 12*0.33 = 14.52$.
$\sum (a_{3,j}\, p_j) = 10*0.33 + 11*0.33 + 14*0.33 = 11.55$.

A_i	$П_1$	$П_2$	$П_3$	$\sum (a_{ij} p_j)$
A_1	3.3	2.97	3.63	9.9
A_2	4.95	5.61	3.96	14.52
A_3	3.3	3.63	4.62	11.55
p_j	0.33	0.33	0.33	

Source: Authors' calculations

Choose max = 14.52 from (9.9; 14.52; 11.55).
Conclusion: we choose strategy n = 2.
Laplace criterion. Make a payment matrix.

A_i	$П_1$	$П_2$	$П_3$	$\sum (a_{ij})$
A_1	3.333	3	3.667	10
A_2	5	5.667	4	14.667
A_3	3.333	3.667	4.667	11.667
p_j	0.333	0.333	0.333	

Source: Authors' calculations

Choose max = 14.67 from (10; 14.67; 11.67)
Conclusion: we choose strategy n = 2.
Wald criterion. Make a payment matrix.

A_i	$П_1$	$П_2$	$П_3$	Min (a_{ij})
A_1	10	9	11	9
A_2	15	17	12	12
A_3	10	11	14	10

Source: Authors' calculations

Choose max = 12 from (9; 12; 10).
Conclusion: we choose strategy n = 2.
Savage criterion. We find the risk matrix. The maximum gain in the j-th column $b_j = \max (a_{ij})$ characterizes the favorability of the energy market conditions.
1. Calculate the 1st column of the risk matrix.
$r_{11} = 15-10 = 5$; $r_{21} = 15-15 = 0$; $r_{31} = 15-10 = 5$;
2. Calculate the 2nd column of the risk matrix.
$r_{12} = 17-9 = 8$; $r_{22} = 17-17 = 0$; $r_{32} = 17-11 = 6$;
3. Calculate the 3rd column of the risk matrix.
$r_{13} = 14-11 = 3$; $r_{23} = 14-12 = 2$; $r_{33} = 14-14 = 0$;

A_i	$П_1$	$П_2$	$П_3$
A_1	5	8	3
A_2	0	0	2
A_3	5	6	0

Source: Authors' calculations

The results of calculations are presented in the form of a table.

A_i	$П_1$	$П_2$	$П_3$	Max (a_{ij})
A_1	5	8	3	8
A_2	0	0	2	2
A_3	5	6	0	6

Source: Authors' calculations

Choose the minimal element min = 2 from (8; 2; 6)
Conclusion: We choose strategy n = 2.
Hurwitz criterion. Calculate s_i.
$s_1 = 0.5*9 + (1-0.5)*11 = 10$
$s_2 = 0.5*12 + (1-0.5)*17 = 14.5$
$s_3 = 0.5*10 + (1-0.5)*14 = 12$

A_i	$П_1$	$П_2$	$П_3$	Min (a_{ij})	Max (a_{ij})	y min (a_{ij}) + (1-y) max (a_{ij})
A_1	10	9	11	9	11	10
A_2	15	17	12	12	17	14.5
A_3	10	11	14	10	14	12

Source: Authors' calculations

Choose from (10; 14.5; 12) the maximum element max = 14.5
Conclusion: choose strategy n = 2.

5. DISCUSSION

Given the results of our research, it is worth noting that, for example, setting up and programming smart energy trading contracts takes a very long time in the first stage. A wide range of contractual terms and conditions (including general terms and conditions) must be written into the software code in a legally secure way so that in the case of automated execution, the same contractual goal agreed upon by the parties is always achieved. Then, as Afanasyev et al. (2019), the contract is handled in a simplified way using "if-then" relationships. Once a certain environmental condition (e.g., low energy, risk transfer) is deemed fulfilled, reasonable contracts release appropriate goods or reservations However, Erturk et al. (2019), point out that using smart contracts, blockchain technology can automate individual contracts or entire business relationships. If blockchain is successfully integrated into a company's existing processes, accounting can phase out manual postings and thus make accounting data available in real-time. At the same time, a decentralized blockchain architecture can significantly reduce the likelihood of errors and fraud in companies. And as Bonsón and Bednárová (2019) rightly point out, triple-entry accounting provides better protection against manipulation by introducing a third document into the blockchain. As a consequence, collaboration with auditors could change. If smart contracts were programmed in accordance with the law, auditors could focus on IT and process control, as well as individual offline bookings (Bonsón and Bednárová, 2019). Reservations within the blockchain could be verified in real-time as participants in the network.

A similar view of the technological barriers identified in this study is held by Erturk et al. (2019). Nevertheless, it has the potential to initiate fundamental changes in accounting (Erturk et al., 2019).

See also Bürer et al. (2019), note that blockchain private keys give the user access to their digital assets and protect against unauthorized access or transactions. If a private key has been compromised (e.g., due to fraud or theft), third parties can control the digital assets. For this reason, the secure creation and storage of private keys and their backups are very relevant.

Significant risks include the compromise and loss of confidentiality, availability, or integrity of private keys and their backups. We agree with the view, Abreu et al. (2018), who highlight the risk that unauthorized persons may gain access to private keys and backups. Unauthorized access can authorize transactions and access to digital assets. Or the risk of general inaccessibility or timely inaccessibility of private keys and their backups. Loss of access to private keys and their backups can make access to digital assets impossible (Ahl et al., 2019).

And the risk that private keys or their backups will be altered and therefore no longer readable. If the integrity of private keys and their backups is compromised, it can also make it impossible to access digital assets (Oneshko and Pashchuk, 2021; Miglani et al., 2020).

It is also advisable to pay attention to specific risks arising from the main risks. For example, during the key ceremony (generation of private keys) there is, among other things, the risk that private keys will be viewed and, for example, copied during creation or transportation to the places where private keys and their backups are stored (Buriak and Petchenko, 2021; Lardo et al., 2022). This can be done by engaged or unengaged individuals, for example, gaining access to selected technical components, such as printer memory. Managing private blockchain keys in an energy company and backing them up contains an inherent risk of being lost, stolen, or unreadable. This is also the view of Wang et al. (2020). There is also a risk of fraud if the storage of private keys and backups does not correspond to a clear allocation of responsibilities or if the people in charge of control and security do not follow the necessary security standards (Wang et al., 2020). In addition, private keys and their backups stored in different locations must also be protected from physical exposure.

When initiating and approving digital asset transactions, an inadequately designed control system or an underdeveloped allocation of responsibilities can lead to financial risks (Wang et al., 2020). Note that in the traditional banking world, recovery of financial values is possible in case of error or fraud, but not in the cryptocurrency world. Loss of control over cryptocurrencies may also contain significant risks in terms of financial reporting.

Holding cryptocurrency can have a significant impact on a company and audit. If control of digital assets is lost, assets may have to be written down and additional liabilities recognized on the balance sheet. This can quickly lead to over-indebtedness and necessary restructuring depending on the amount of cryptocurrency lost and the capital situation. That said, if the bank or asset manager reports off-balance sheet cryptocurrencies, losing control of the off-balance sheet cryptocurrencies could result in the client's liabilities being recognized on the balance sheet; assuming the bank or asset manager itself bears the storage risk. Incidentally, for this reason, and because of the increased risk of off-balance sheet cryptocurrencies, the auditor should perform the same audit procedures as for cryptocurrencies that are on-balance sheet. Correctly noted Gokoglan and Cetin (2022), cryptocurrencies that the custodian no longer controls should be excluded from assets in the income statement. Since the custodian usually bears the risk of custody, the customer is liable in these cases. The custodian typically earns a small percentage of the cryptocurrency in custody (Gokoglan and Cetin, 2022).

Therefore, the equity should be expected to be quite low compared to the cryptocurrencies in custody. In the event of a partial loss of cryptocurrencies and without proper loss risk insurance, the custodian could quickly find itself in a situation of over-indebtedness. If the custodian fails to restructure, it also means that customers will have to write off some or all of their cryptocurrencies. Cryptocurrencies that the company no longer controls need to be excluded from assets on the income statement.

The operational use of blockchain has potentially huge implications for the work of accountants, controllers, and auditors. Managers should be aware of this potential change and consider the extent of the impact on existing personnel and process structures. That said, the same view is held by Elommal and Manita. Managers should not underestimate possible problems with acceptance and motivation among employees. Too often IT projects fail because of these obstacles, which could be reduced by, for example, early, clearly notified pilots in the energy industry (Elommal and Manita, 2022).

However, blockchain cannot do everything. Authors Upadhyay et al. (2021), note that some enthusiasts already see the possibility of real-time financial reporting that can be created at any time without trusting the integrity of management or the judgment of an auditor.

To some extent, however, this is not entirely unrealistic. On the one hand, for technical reasons since the success of blockchain is based on error-free programming. But on the other hand, also through the financial reporting system itself. Financial reporting is not just based on standard cases. With complex issues, discretionary decisions still have to be made by people. Therefore, technology will not completely replace accountants and auditors. Special knowledge and the ability to assess complex problems will still have to be applied by people.

6. CONCLUSION

The purpose of the study was to establish and analyze the risks of applying blockchain technology in the accounting and auditing of fuel and energy companies. Based on the results of the study it should be determined that:

1. In the fuel and energy sector, the use of blockchains extends to the conclusion of smart energy trading contracts, the automation of energy and fuel cost accounting, the electronification of document management, the integration of cryptocurrency for settlements with counterparties, etc.
2. Blockchain technology can have a significant impact on the way accounting and auditing are done. However, it needs to be more widely used by business users in situations of daily economic practice. This is likely to contribute to the need for user-friendly solutions, as well as a better understanding of the risks and opportunities the technology offers.
3. Awareness and understanding of the idea of blockchain will be needed by the entire stakeholder group, from management entities to fuel and energy company accountants.
4. As a result of solving the statistical game according to different criteria, the A2 strategy was most often recommended, i.e., with relatively less economic risk at PGNiG would be the use of blockchain technology for renewable energy certification.
5. It is advisable for further research the direction of integration of blockchain technology with modern accounting ERP systems of fuel and energy companies.

REFERENCES

Abreu, P.W., Aparicio, M., Costa, C.J. (2018), Blockchain technology in the auditing environment. In: 2018 13th Iberian Conference on Information Systems and Technologies (CISTI). p1-6.

Afanasyev, V.Y., Lyubimova, N.G., Ukolov, V.F., Shayakhmetov, S.R. (2019), Digitalization of energy manufacture: Infrastructure, supply chain strategy and communication. International Journal of Supply Chain Management, 8(4), 601-609.

Ahl, A., Yarime, M., Tanaka, K., Sagawa, D. (2019), Review of block-chain-based distributed energy: Implications for institutional development. Renewable and Sustainable Energy Reviews, 107, 200-211.

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., Peacock, A. (2019), Block-chain technology in the energy sector: A systematic review of challenges and opportunities. Renewable and Sustainable Energy Reviews, 100, 143-174.

Bonsón, E., Bednárová, M. (2019), Blockchain and its implications for accounting and auditing. Meditari Accountancy Research, 27(5), 725-740.

Brilliantova, V., Thurner, T.W. (2018), Block-chain and the future of energy. Technology in Society, 57, 38-45.

Britchenko, I., Saienko, V. (2017), The perception movement economy of Ukraine to business. Ikonomicheski Izsledvania, 26(4), 163-181.

Bürer, M.J., De Lapparent, M., Pallotta, V., Capezzali, M., Carpita, M. (2019), Use cases for blockchain in the energy industry opportunities of emerging business models and related risks. Computers and Industrial Engineering, 137, 106002.

Buriak, I., Petchenko, M. (2021), Analysis of the dilemmas of building an accounting system for the needs of future economic management. Futurity Economics and Law, 1(1), 17-23.

Cao, Y. (2019), Energy internet block-chain technology. In: The Energy Internet. Netherlands: Elsevier. p45-64.

Elommal, N., Manita, R. (2022), How blockchain innovation could affect the audit profession: A qualitative study. Journal of Innovation Economics, 37(1), 37-63.

Erturk, E., Lopez, D., Yu, W.Y. (2019), Benefits and risks of using blockchain in smart energy: A literature review. Contemporary Management Research, 15(3), 205-225.

Gokoglan, K.G., Cetin, S. (2022), Blockchain technology and its impact on audit activities. PressAcademia, 9, 72-81.

Juszczyk, O., Shahzad, K. (2022), Blockchain technology for renewable energy: Principles, applications and prospects. Energies, 15(13), 4603.

Lardo, A., Corsi, K., Varma, A., Mancini, D. (2022), Exploring blockchain in the accounting domain: A bibliometric analysis. Accounting Auditing and Accountability, 35(9), 204-233.

Miglani, A., Kumar, N., Chamola, V., Zeadally, S. (2020), Blockchain for internet of energy management: Review, solutions, and challenges. Computer Communications, 151, 395-418.

Oneshko, S., Pashchuk, L. (2021), Industry 4.0 and creative economy (globalization challenges of the time). Futurity Economics and Law, 1(4), 4-11.

Paliwal, V., Chandra, S., Sharma, S. (2020), Blockchain technology for sustainable supply chain management: A systematic literature review and a classification framework. Sustainability, 12(18), 7638.

Teufel, B., Sentic, A., Barmet, M. (2019), Blockchain energy: Blockchain in future energy systems. Journal of Electronic Science and Technology, 17(4), 100011.

Upadhyay, A., Mukhuty, S., Kumar, V., Kazancoglu, Y. (2021), Blockchain technology and the circular economy: Implications for sustainability and social responsibility. Journal of Cleaner Production, 293, 126130.

Wang, Q., Zhu, X., Ni, Y., Gu, L., Zhu, H. (2020), Blockchain for the IoT and industrial IoT: A review. Internet of Things, 10, 100081.