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BLOCKCHAIN IN DIGITAL ADMINISTRATION AS A STRENGTHENING ELEMENT FOR THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT GOALS

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Abstract

In an era defined by growing sustainability challenges, public administration has a pivotal role in addressing these issues. The convergence of public administration, blockchain technology, and sustainable development initiatives and challenges is at the forefront of smart governance practices. This article explores the intricate interconnections between these domains, shedding light on the transformative potential of blockchain technology in enhancing the transparency, efficiency, and accountability of public administration while promoting, at the same time, main sustainability goals. Through an analysis of scholarly insights and some practical implementations, the article highlights the benefits, challenges and strategic considerations associated with this synergy. It underscores the need for collaborative, cross-sectoral efforts and comprehensive policy frameworks to leverage blockchain's potential for fostering smart governance practices. The crucial questions that should be answered concern how the digitalisation of public information and use of advanced ICT have reshaped the public administration sphere, and how they influence the implementation of the idea of sustainable development. Ultimately, the article emphasises the pivotal role of blockchain – public administration interdependence in shaping a more resilient, accountable, and environmentally conscious model of public management, aligned with the global sustainable development agenda.
Key words: blockchain, public management, ICT, sustainability

Introduction

In recent years the digitalisation of public information has transformed the way governments, organisations, and individuals access, store, and disseminate information. This evolution has been driven by technological advancements, changing societal expectations and creating the need for greater efficiency and transparency in the public sector.[1] By exploring the evolution of digitalisation in the context of public information, examining its historical development, key milestones, as well as its far-reaching implications, it is possible to show its impact and connection to contemporary trends in building a more sustainable society. By referencing pivotal moments and technological advancements, we are able to show a comprehensive understanding of how the digitalisation of public information has reshaped our world and how it influences the implementation of the idea of sustainable development.

> Digital transformation and sustainable development are two of the most important challenges in today's world that seemingly have little in common. As the strongest driving force of the 21st century, digitalisation has been a response to the growing expectations of business, in line with the slogan "faster, higher, further", and it seems to have pushed the demands of sustainable development to the sidelines. However, it is the combination of both aspects that holds the greatest potential. Reorganisation of enterprises and public administration, optimisation of processes and conquering new markets using the opportunities offered by digitalisation are the basis for changing thinking and acting in the spirit of sustainable development.[2]

The purpose of this article is to critically examine the multifaceted implications of integrating blockchain technology within the sphere of public administration, with a particular focus on its transformative impact on sustainable development initiatives. By delving into the intersection of blockchain and public administration, this article seeks to elucidate the various ways in which blockchain applications can foster transparent governance, enhance administrative efficiency and promote environmentally conscious practices. The desk research method was chosen as the appropriate one for this topic, and through a comprehensive analysis of scholarly research with the addition of case studies, the article aims to underscore the pivotal role of blockchain technology as a catalyst for advancing sustainable development goals within the realm of public administration. Furthermore, by examining the role of blockchain in enhancing data transparency, ensuring accountability, and optimising resource allocation, it seeks

[1] I. Mergel, N. Edelmann, N. Haug, *Defining digital transformation: Results from expert interviews*, "Government Information Quarterly" 2019, vol. 36, 101385, p. 1, https://doi.org/10.1016/j.giq.2019.06.002.

[2] proALPHA, *Ekologia w biznesie, czyli o sztuce wyboru. Cyfryzacja drogą do zrównoważonego rozwoju*, Polski Przemysł, 28.11.2022, https://polskiprzemysl.com.pl/it-dla-przemyslu/transformacja-cyfrowa-i-zrownowazony-rozwoj [accessed: 5.10.2023].

to emphasise the crucial contribution of blockchain technology in reshaping administrative processes to align with the principles of sustainable governance. By offering a holistic perspective on the symbiotic relationship between blockchain, public administration, and sustainable development, it endeavours to stimulate discourse and inspire innovative approaches to harnessing blockchain's potential for fostering transparent, efficient, and environmentally conscious governance practices, thereby contributing to the global agenda for sustainable development in the 21st century.

The beginnings of digital transformation in public administration

The roots of digitalisation of public information can be traced back to the late 20th century. In the 1970s and 1980s, governments began to digitise paper-based records and documents for easier storage and retrieval. This transition from physical to digital formats was a significant step towards improving data management. These systems represented a significant departure from traditional paper-based record-keeping methods, offering improved efficiency and accessibility.[3] However, it was a slow and costly process due to limited technology and resources. The advent of the internet and finally the World Wide Web in the late 20th century marked a pivotal moment in the evolution of digitalisation. It provided a platform for governments to share information with the public on a scale never before imagined.[4] Websites like the Library of Congress in the United States and the European Union's portal were early examples of digital repositories of public information. Thanks to the internet we are facing

> the disappearance of the asymmetry in the relationship between the sender and the recipient of the message, […] the producer and consumer of information […], since anyone who meets the technical standards can play both of these roles, often simultaneously. Access to information, therefore, is not subordinate to any restrictions, which is so much easier because information is such a good that, unlike material ones, can almost never be impoverished or exhausted.[5]

As the internet continued to expand, governments across the world initiated e-government projects to enhance the delivery of public services. These initiatives aimed to streamline administrative processes, improve citizen engagement,

[3] D.C.G. Brown, S. Toze, *Information governance in digitized public administration*, "Canadian Public Administration" 2017, vol. 60, no. 4, pp. 582–583.

[4] P. Dunleavy, H. Margetts, S. Bastow, J. Tinkler, *New public management is dead–long live digital-era governance*, "Journal of Public Administration Research and Theory" 2006, vol. 16, issue 3, p. 478.

[5] M. Majorek, J. Wojniak, *The Public Information Bulletin as an example of public information digitalisation in Poland*, [in:] *The Polish Media System 1989–2011*, ed. K. Pokorna-Ignatowicz, Krakow Society for Education–AFM Publishing House, Krakow 2012, p. 182–183.

and increase the accessibility of government information. The open data movement gained momentum in the early 21st century, with governments publishing datasets in machine-readable formats for public use. As digitalisation progressed, the concept of open data gained prominence. Governments worldwide started embracing open data initiatives, releasing vast amounts of public information for public use. These initiatives aimed to promote transparency, accountability, and innovation. Notable examples include Data.gov in the United States and Data.gov.uk in the United Kingdom. One example here could be that legislature defined the concept of public information in the text of the Polish Act on access to public information issued in 2001, showing an objective list in article 6, which defined what information should be totally accessible. The act states that public information shall mean all data obtained for public affairs in any form, including that obtained through direct expression of the members of the public authorities, public entities and persons entitled (or obliged) to represent the body, the personnel providing the service.[6] Moreover, open data has enabled the public, researchers and businesses to harness public information for various purposes, from developing new applications to conducting data-driven research. The digitalisation of public information has led to the rise of e-government and digital governance. Governments have developed not only platforms for disseminating public information, but also various online tools, public services delivery, and communication. Services like e-tax filing, access to online documents, and voting registration have become commonplace. These digital tools streamline government operations and enhance citizen participation, although they are no longer able to meet the requirements of both citizens and the rapidly changing technological reality.

The transition from e-administration to digital governance

In the early literature on the subject[7], we can find an inconsistent understanding of the term e-administration or e-governance. For the purposes of our considerations in this section, due to a number of interdisciplinary connotations, it will be worth following the approach promoted by Richard Heeks. He used to treat the concept of e-governance in broader categories, which means not limiting it only to the analysis of applications and government websites. Indeed, the term should be

[6] Ustawa z dnia 6 września 2001 r. o dostępie do informacji publicznej, Dz.U. 2001 nr 112 poz. 1198 [Journal of Laws of the Republic of Poland 2001 no. 112 item 1198].

[7] See D.M. West, *E-Government and the Transformation of Service Delivery and Citizen Attitudes*, "Public Administration Review" 2004, vol. 64, no. 1, pp. 15–27; R. Heeks, *Implementing and Managing eGovernment: An International Text*, Sage Publications, London 2006, https://books.google.pl/books?id=hRzAnMulatUC&lr=&source=gbs_navlinks_s [accessed: 7.10.2023]; M.J. Moon, *The Evolution of E-Government among Municipalities: Rhetoric or Reality?*, "Public Administration Review" 2002, vol. 62, issue 4, pp. 424–433.

considered as the totality of tools, computers, networks and all information and communication tools used in the public sector.[8]

E-governance refers to the application of Information and Communication Technology (ICT) for providing government services, and exchange of information and communication between the government and the four major stakeholders of a nation, namely, citizens, businesses, employees, and other government organisations. Thanks to this, citizens of a given country have the opportunity to increase participation in the services offered by state institutions, and also have a simplified way of co-decision-making. E-governance also enhances the effectiveness of government services for all participants of socio-political life. Easier access for citizens to all information and greater transparency in administration has a positive impact on the reduction of corruption and the position of citizens. E-administration brings a very noticeable change in the form of reduced formalities and bureaucracy. It is intended to ensure better management and help validate government actions. An undoubted benefit is also reduced consumption of office supplies and other resources, including human resources. Significant limitations of office work and the use of electronic media speed up the provision of services, which leads to increased awareness of government policy among citizens.[9]

It is worth pointing out that the framework of e-administration is based on information and communication technologies, which comprehensively create good management practices for the further development of the public services sector. They can be divided into three basic groups. First of all, there is computerisation, i.e. supporting current, manual practices. An example would be supporting and promoting existing decision-making practices and their implementation. Secondly, there is process automation, i.e. the gradual replacement of current, traditional data processing practices. The third area in which the concept of e-administration arises will be transformation, i.e. rejecting or transforming old practices and replacing them with new ones using the tools of new information and communication technologies. Then a completely new approach civic administration in a broad sense emerges. In this context, ICT can provide cheaper and more efficient services.[10]

Several factors have driven the transition from e-governance to digital governance. First of all, it is worth mentioning innovative technological advancements, for instance the rapid growth of digital technologies, including artificial intelligence, blockchain, and the Internet of Things. These elements have expanded the possibilities for government services and operations and, as a result, have led to increased expectations of citizens. They now expect convenient, personalised,

[8] R. Heeks, *op. cit.*, p. 2.

[9] R. Setiya, S. Pandey, A.K. Singh, D.K. Sharma, *Citizen e-governance using blockchain*, [in:] *Blockchain for Smart Cities*, eds. S. Krishnan, V.E. Balas, E.G. Julie, Y.H. Robinson, R. Kumar, Elsevier, Amsterdam 2021, pp. 120–121.

[10] *Ibidem*, p. 121.

and efficient services similar to those offered by the private sector, driving governments to adapt.

Moreover, the ongoing phenomenon of globalisation cannot be ignored either, as in an interconnected world, governments need to cooperate and exchange information efficiently, not only inside the system, but also outside, so digital governance facilitates international collaboration. The transition to more advanced systems was also a response to the increased demand for security and privacy concerns: as cyber threats evolve, governments have had to prioritise security and privacy, necessitating more comprehensive approaches.

These causes of evolution are only some of many attempts to explain the transformation of e-government that can be found in the literature on the subject.[11] However, all known approaches have at least a few common features, such as progresses in stages, from simpler forms to more sophisticated and advanced ones. According to these assumptions, we will always be dealing with a certain gap that needs to be filled, in this case the public administration sector is too inflexible, highly bureaucratic, and does not meet citizens' expectations and the rapidly changing technological reality.[12]

E-governance, with all its limitations, was an indispensable step to creating more advanced information management structures in public administration. As previously indicated, it primarily focused on automating existing government functions and enhancing efficiency, but e-governance, while a significant leap forward, was still primarily a one-way interaction, with governments providing information and services online. As Darrell M. West points out, traditional structures will be characterised by a high degree of hierarchy, focused on delivery rather than exchange. One-way communication was no longer efficient, so it was necessary to shift the emphasis to creating processes with a high degree of interactivity and accessibility. This type of access to government services allows citizens to seek information at their own discretion, and the interactive aspects of e-government enable both citizens and officials to quickly exchange information. Thanks to two-way interaction, we are dealing with not only public services improvement and availability, but also with a response to the needs of citizens in the long run, which translates into increased social trust in authorities and public institutions.[13]

A simple examination of these assumptions clearly indicates that we are dealing with a greater focus on the individual, i.e. the citizen. Therefore, a citizen becomes more of a client than a supplicant, because it is his or her needs that are

[11] E. Barcevičius, G. Cibaitė, C. Codagnone, V. Gineikytė, L. Klimavičiūtė, G. Liva, L. Matulevič, G. Misuraca, I. Vanini, *Exploring Digital Government transformation in the EU. Analysis of the state of the art and review of literature*, ed. G. Misuraca, Publications Office of the European Union, Luxembourg 2019, pp. 42–45.

[12] *Ibidem*, p. 43.

[13] D.M. West, *op. cit.*, p. 16.

noticed, and not only the state's procedures. Digital governance places citizens at the centre of government services and policymaking. It aims to provide personalised and responsive services, fostering active citizen engagement.[14]

The previously mentioned exchange of information between the citizen and the administration, which replaced one-sided transmission, is the starting point for the development of an important feature of digital governance, namely interoperability. In principle, "interoperability is the ability of [individuals, institutions and – M.M] organisations to interact with each other across data, systems and processes, to achieve common goals." Thanks to this type of approach, we gain the opportunity to share "information and knowledge through business processes, by means of the exchange of data between ICT systems."[15] Digital governance promotes seamless data exchange between different government agencies and jurisdictions, ensuring cohesive service delivery.[16]

However, this process is burdened with a number of problems that make it difficult to fully implement the theoretical assumptions. In the technical area, we are dealing with a lack of compatibility between information technologies, as well as the use of different data models and standards. Apart from purely technical issues, there are a number of other factors, including organisational and administrative fragmentation, legal aspects, and lack of cooperation between public institutions at various levels.[17]

One of the more serious challenges for digital governance is an assumption that is also supposed to distinguish the new formula from the current e-government, namely inclusivity. A starting point could be the creation of supporting policies which work to expand internet and ICT infrastructure to less developed areas, including sustained government intervention to address gaps in service, and actions intended to reform the Internet services market in order to reduce the costs of access to the medium. The main goal is to bridge the digital divide by making digital services accessible to all citizens, regardless of natural differences and divisions resulting from demography and place of residence, their technological literacy or access to resources.[18] Lack of access, equipment or skills are the

[14] S. Hovik, G.A. Giannoumis, *Linkages Between Citizen Participation, Digital Technology, and Urban Development*, [in:] *Citizen Participation in the Information Society*, eds. S. Hovik, G.A. Giannoumis, K. Reichborn-Kjennerud, J.M. Ruano, I. McShane, S. Legard, Palgrave Macmillan, Cham 2022, p. 4, https://doi.org/10.1007/978-3-030-99940-7_1.

[15] B. Kruger, *Interoperability – the key enabler of e-government*, European Commission, 1.04.2022, https://joinup.ec.europa.eu/collection/digital-skills-public-sector/solution/interoperable-europe-academy/news/interoperability-key-enabler-e-government [accessed: 13.10.2023].

[16] *Ibidem*.

[17] A. Campmas, N. Iacob, F. Simonelli, *How can interoperability stimulate the use of digital public services? An analysis of national interoperability frameworks and e-Government in the European Union*, "Data & Policy" 2022, vol. 4, e19-3.

[18] J. Wojniak, *Od podziału do nierówności – nowy wymiar cyfrowego wykluczenia*, "Aequalitas" 2013, vol. 2, no. 1, p. 2.

most frequently cited elements that have had a direct impact on the failure of various projects in the field of implementing public e-services.[19] One of the solutions being implemented is to promote digital literacy training and the provision of free programmes to help generate an equitable number of online services.[20]

The last important elements included in the concept of e-government are data-driven implications and security issues. These refer to the use of data analytics, digital technologies, and automation to improve the efficiency, transparency, and effectiveness of administrative processes within an organisation or government. In general, this approach involves the collection, analysis, and utilisation of data to make informed decisions, optimise operations, and deliver better services to citizens or customers. However, while leveraging data in digital administration can bring numerous benefits, it must be done in a way that ensures the security and privacy of the data being handled. By analysing data, administrators can identify trends, patterns, and areas for improvement, leading to more effective and efficient decision-making processes. Moreover, data security involves protecting digital data from unauthorised access, corruption, or theft throughout its lifecycle. In digital administration, securing sensitive data is crucial to maintaining the trust of citizens or customers.[21] This requires the implementation of robust security measures, such as encryption, access controls, and regular security audits, to prevent data breaches and unauthorised access. Data security refers to the protection of personal information and the right of individuals to control how their data is collected, used, and shared. In the context of e-administration, respecting data privacy involves adhering to data protection laws and regulations, obtaining consent for data collection, and ensuring that data is only used for the purposes for which it was collected.

Digital administration and sustainability – interconnections

Digital governance, finance, and sustainable development are intricately linked, and their interconnections are becoming increasingly apparent in the modern world. It is therefore necessary to consider what direct implications these connections have in the context of individual solutions developed both in the area of digital administration and sustainability.

As previously indicated, digital governance facilitates big data collection, analysis, and dissemination, and in the context of sustainability it allows

[19] I. Dhaoui, *E-government for sustainable development: Evidence from MENA countries*, "Journal of the Knowledge Economy" 2022, vol. 13, issue 3, pp. 2076–2077.

[20] N. Tiku, *A world without digital inclusivity: What it means to securitize technology, "*The Journal of Intelligence, Conflict, and Warfare" 2021, vol. 4, no. 1, p. 168.

[21] M. Alqahtani, R. Braun, *Examining the Impact of Technical Controls*, *Accountability and Monitoring towards Cyber Security Compliance in E-government Organisations*, Research Square" 2021, https://doi.org/10.21203/rs.3.rs-196216/v1.

policymakers to make informed decisions about particular sustainable development goals. Utilising big data analytics and digital platforms, governments can assess the impact of their policies on various aspects of sustainable development, such as environmental conservation, social equity, and economic growth.[22] This can be seen as a means to achieve the United Nations Sustainable Development Goals (SDGs) effectively.[23]

Another aspect may be increasing the availability and expanding the group of recipients of financial transfer technologies. Digital finance plays a crucial role in promoting financial inclusion, especially in developing countries. Through mobile banking, digital wallets, and other financial technologies, underserved populations gain access to banking services, loans, and insurance, empowering them to participate in economic activities.[24] This fosters economic growth, reduces poverty, and contributes to sustainable development by ensuring that marginalised communities have the means to improve their livelihoods. Besides, digital governance mechanisms ensure transparency and accountability in financial transactions. By leveraging technologies like blockchain, governments can create secure, transparent and immutable ledgers that track financial transactions in real time. This helps prevent corruption, financial fraud, and illicit activities, thereby fostering an environment more conducive to sustainable economic development and investment.

Undoubtedly, one of the main goals of the development of digital administration is to strive for greater availability of various services for the community. Digital governance supports e-governance initiatives that enhance the delivery of public services. Through online portals and digital platforms, citizens can access essential services such as healthcare, education, and social welfare more efficiently. Co-creation initiatives in public services are also becoming more and more visible. Thanks to the constructive exchange of knowledge, experiences and ideas between sectors, the improvement of overall social well-being is observed. This undoubtedly contributes to the attainment of sustainable development objectives, particularly those related to quality education, good health, and well-being.[25] In the context of the improvement of life and the

[22] M.N.I. Sarker, M. Wu, M.A. Hossin, *Smart governance through bigdata: Digital transformation of public agencies*, [in:] *2018 international conference on artificial intelligence and big data (ICAIBD)*, IEEE, Chengdu 2018, pp. 64–66.

[23] United Nations, *Transforming our goals. The 2030 agenda for sustainable development*, https://sdgs.un.org/goals [accessed: 12.10.2023].

[24] E. Ajambo, *Fintech and digital finance for financial inclusion*, with contributions from: A.S. Virdee, J. Palacin Lucio, M. Sanchez Cantillo, N. Obikili, S.A. Davies, W. Ngwabe, United Nations, https://www.un.org/sites/un2.un.org/files/fintech4_14_march_2023.pdf [accessed: 14.10.2023].

[25] N. Edelmann, S. Virkar, *The Impact of Sustainability on Co-Creation of Digital Public Services*, "Administrative Sciences" 2023, vol. 13, no. 2, 43, p. 2, https://www.mdpi.com/2076-3387/13/2/43 [accessed: 13.10.2023].

general well-being of society, digital governance can promote the adoption of green technologies and the development of a digital infrastructure.[26] By incentivising the use of renewable energy sources, smart grid systems, and sustainable manufacturing practices, governments can reduce the environmental impact of digital technologies. This fosters environmentally sustainable development and contributes to the achievement of climate action goals outlined in the SDGs.[27]

And finally, as digital governance and finance rely heavily on technology, ensuring robust cybersecurity measures is essential. Protecting digital infrastructure and financial systems from cyber threats is crucial for maintaining economic stability and promoting sustainable development. A secure digital environment fosters trust among investors, businesses, and consumers, thereby stimulating economic growth and supporting long-term sustainable development goals.[28]

Blockchain as a catalyst for sustainable public administration

Blockchain, understood in the simplest way,

> is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. An asset can be tangible (a house, car, cash, land) or intangible (intellectual property, patents, copyrights, branding). Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and cutting costs for all involved.[29]

Built on the principles of transparency, decentralisation, and immutability, blockchain offers a secure and efficient means of record-keeping and data management. It can also significantly enhance the efficiency, transparency, and accountability of public administration processes, but one of the key advantages lies in its ability to create an immutable ledger, ensuring not only the transparency but also integrity of public records.[30] This feature can be particularly beneficial in areas such as voting systems, property registration, and supply chain management, where data security and accuracy are paramount.

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[26] R. Verdecchia, P. Lago, C. de Vries, *The future of sustainable digital infrastructures: A landscape of solutions, adoption factors, impediments, open problems, and scenarios*, "Sustainable Computing: Informatics and Systems" 2022, vol. 35, 100767, p. 2.

[27] United Nations, *op. cit.*

[28] M.E. Milakovich, *Digital governance: New technologies for improving public service and participation*, 2nd ed., Routledge, New York 2022, pp.118–120.

[29] IBM, *What is blockchain?*, https://www.ibm.com/topics/blockchain [accessed: 16.10.2023].

[30] D. Allessie, M. Sobolewski, L. Vaccari, *Blockchain for digital government. An assessment of pioneering implementations in public services*, ed. F. Pignatelli, Publications Office of the European Union, Luxembourg 2019, pp. 11–12, https://www.mafr.fr/media/assets/publications/blockchain-for-digital-government-2019.pdf [accessed: 16.10.2023].

Additionally, the decentralised nature of blockchain can help streamline bureaucratic processes by reducing the need for intermediaries, thus minimising the potential for corruption and fraud.[31] By providing a secure and transparent platform for managing transactions and sensitive data, blockchain technology can foster greater trust between governments and citizens, leading to increased public confidence in the administrative machinery.[32]

The application of blockchain technology in public administration can serve as a catalyst for sustainable development initiatives. By enabling transparent and trustworthy record-keeping, blockchain can facilitate the monitoring and implementation of sustainability-focused policies and programmes. It offers a decentralised platform that enhances data integrity, promoting accountability in environmental governance and resource management. Furthermore, through the implementation of smart contracts and decentralised applications, blockchain can streamline administrative processes, leading to optimised resource allocation and reduced environmental impact.

The use of blockchain in public administration can also foster citizen engagement and participation in sustainable initiatives. By providing transparent access to information and decision-making processes, blockchain empowers citizens to increased participation.[33] They may actively contribute to environmental conservation efforts and hold governing bodies accountable for sustainable policy implementation. This increased transparency can strengthen the public's trust in governmental efforts toward sustainability and encourage collective action for a more environmentally conscious society.

The integration of blockchain technology into public administration for sustainable development apparently is not without challenges. One key hurdle is the need for interoperability between various blockchain platforms and existing administrative systems.[34] Overcoming this challenge requires the development of standardised protocols and frameworks that enable seamless integration and data exchange, fostering collaboration between different administrative entities and ensuring the compatibility of sustainability-focused initiatives.

Moreover, ensuring the energy efficiency and sustainability of blockchain infrastructure itself is crucial. As blockchain operations can be energy-intensive, the deployment of energy-efficient consensus mechanisms and the utilisation of renewable energy sources are essential for mitigating the environmental

[31] *Ibidem*, p. 29.

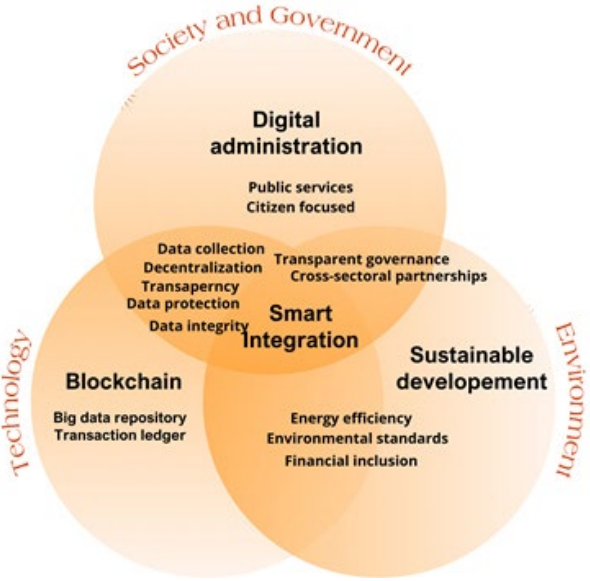
[32] S. Myeong, Y. Jung, *Administrative reforms in the fourth industrial revolution: the case of blockchain use*, "Sustainability" 2019, vol. 11, no. 14, 3971, pp. 6–7.

[33] F.L. Benítez-Martínez, M.V. Hurtado-Torres, E. Romero-Frías, *A neural blockchain for a tokenizable e-Participation model*, "Neurocomputing" 2021, vol. 423, pp. 704–705.

[34] S. Kurpjuweit, C.G. Schmidt, M. Klöckner, S.M. Wagner, *Blockchain in additive manufacturing and its impact on supply chains*, "Journal of Business Logistics" 2021, vol. 42, issue 1, p. 55.

impact of blockchain technology.[35] Governments must prioritise the adoption of sustainable practices in blockchain implementation, thereby aligning technological advancements with broader sustainability objectives.

Figure 1. Interconnection and smart integration of blockchain, public administration, and sustainabe development.



Source: Own study.

Several countries have made significant strides in integrating blockchain technology into public administration to promote sustainability by creating smart integration of technology, contemporary government management systems and sustainable development (see Figure 1). For instance, Bhutan's integration of blockchain into its carbon-neutral initiatives has enabled the transparent monitoring and trading of carbon credits, incentivising sustainable practices and fostering environmental conservation.[36] Moreover, the integration of blockchain technology into carbon footprint reduction strategies carries multifaceted implications for environmental governance and sustainable development. By promoting transparent and auditable carbon accounting mechanisms, blockchain fosters greater

[35] J. Sedlmeir, H.U. Buhl, G. Fridgen, R. Keller, *The energy consumption of blockchain technology: Beyond myth*, "Business & Information Systems Engineering" 2020, vol. 62, issue 6, pp. 603–604.

[36] See G.T. Vives, S. Tashi, J. Singay, *Of dragons, data and clouds: Bhutan's journey into carbon markets, technology, and a resilient future*, World Bank Blogs, 19.10.2023, https://blogs.worldbank.org/climatechange/dragons-data-and-clouds-bhutans-journey-carbon-markets-technology-and-resilient [accessed: 20.10.2023].

trust among stakeholders, enabling more effective collaboration and knowledge sharing in the pursuit of carbon neutrality.[37] Similarly, Singapore's utilisation of blockchain for digital identity management has streamlined administrative processes, enhanced data security, and facilitated the seamless delivery of sustainable public services, contributing to the nation's commitment to building a smart and sustainable city-state. Additionally, Sweden has leveraged blockchain technology to enhance transparency and traceability in its supply chains, particularly in the food and forestry sectors.[38] By implementing blockchain-based solutions, this country has improved supply chain efficiency, minimised waste, and promoted sustainable production practices, thus advancing the country's commitment to sustainable resource management and environmental conservation.

Conclusion

The transition from e-governance to digital governance represents a profound shift in the way governments operate and interact with citizens. It encompasses a citizen-centric, data-driven, and interconnected approach to governance. While it presents numerous opportunities for improving government services and operations, addressing cybersecurity, data privacy, and digital inclusion challenges is crucial. This transition is not a destination but an ongoing journey, and a clear example of this process is the possibilities, advantages and disadvantages of using blockchain technology that have been analysed here.

The implementation of blockchain technology in public administration holds immense potential for promoting sustainable development and fostering transparent governance practices by creating smart integration processes and practices. By leveraging blockchain's inherent capabilities, governments can enhance data integrity, promote citizen engagement, and streamline administrative processes, all while aligning with sustainability goals. While the integration of blockchain technology into sustainable digital administration presents unprecedented opportunities, it is not without its challenges. One of the key obstacles lies in the establishment of regulatory frameworks that accommodate the complexities of blockchain-based transactions, while upholding environmental standards and data privacy regulations. Furthermore, ensuring the inclusivity and accessibility of blockchain-powered services remains a crucial consideration, as equitable

[37] M. Wang, B. Wang, A. Abareshi, *Blockchain technology and its role in enhancing supply chain integration capability and reducing carbon emission: A conceptual framework*, "Sustainability" 2020, vol. 12, no. 24, 10550, pp. 4–6, https://www.mdpi.com/2071-1050/12/24/10550 [accessed: 20.10.2023].

[38] M. Hultgren, F. Pajala, *Blockchain technology in construction industry: Transparency and traceability in supply chain*, Master of Science thesis, supervisor: T. Karrbom Gustavsson, Royal Institute of Technology, Department of Real Estate and Construction Management, Stockholm 2018, p. 14.

access to digital infrastructure is paramount in fostering sustainable development and bridging the digital divide.

Amid these challenges, there exist significant opportunities for collaborative partnerships between governments, private enterprises and civil society organisations to develop inclusive and sustainable blockchain solutions. By fostering cross-sectoral collaborations, governments can harness the collective expertise and resources of diverse stakeholders to co-create sustainable digital administration frameworks that prioritise environmental stewardship, social equity, and technological innovation. So despite the obstacles and challenges mentioned previously, with strategic planning, collaboration, and a commitment to energy efficiency, the integration of blockchain into public administration can serve as a catalyst for fostering a more sustainable and transparent governance framework that prioritises the well-being of both present and future generations.

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