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DIGITAL TOOLS FOR SUPPORTING GREEN ECONOMIC DEVELOPMENT

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Abstract: The transition toward a green economy requires innovative approaches that integrate economic growth with environmental sustainability. Digital tools play an increasingly important role in supporting this transition by enabling more efficient resource management, reducing environmental impacts, and fostering sustainable business models. This paper explores the role of digital technologies – such as big data analytics, artificial intelligence, the Internet of Things, and digital platforms – in promoting green economic development. The study analyzes how these tools contribute to energy efficiency, emission reduction, circular economy practices, and sustainable decision-making in both the public and private sectors. Furthermore, the paper identifies key challenges related to digitalization, including technological gaps, high implementation costs, data security issues, and the digital divide. Based on the analysis, the paper highlights best practices and provides recommendations for policymakers and stakeholders on how to effectively leverage digital tools to support sustainable and inclusive green economic growth.

Keywords: Digitalization, Green economy, Sustainable development, Digital tools, Environmental sustainability and Smart technologies

INTRODUCTION

The growing pressure of climate change, environmental degradation, and resource depletion has intensified the need for a transition toward a green economy that balances economic growth with environmental sustainability. Governments, businesses, and international organizations increasingly recognize that traditional economic models are no longer sufficient to address contemporary environmental challenges. In this context, green economic development has emerged as a strategic priority aimed at reducing environmental risks while promoting social inclusion and long-term economic resilience.

At the same time, rapid advancements in digital technologies have fundamentally transformed economic and social systems. Digital tools such as big data analytics, artificial intelligence, the Internet of Things, cloud computing, and digital platforms have created new opportunities for improving efficiency, transparency, and innovation across sectors. (Saadia, D. 2021) When applied to sustainability goals, these technologies can significantly enhance resource management, optimize energy consumption, support low-carbon production processes, and enable evidence-based decision-making.

Despite their potential, the integration of digital tools into green economic development faces several challenges. These include technological and infrastructural gaps, high implementation costs, lack of digital skills, data security concerns, and unequal access to digital solutions. Moreover, the environmental footprint of digital technologies themselves raises important questions about their long-term sustainability.

The aim of this paper is to examine the role of digital tools in supporting green economic development by analyzing their applications, benefits, and limitations. The paper also seeks to identify key challenges associated with digitalization in the green economy and to propose policy and strategic recommendations for effectively leveraging digital technologies (Liu, Y., Dong, F., Yu, J., & Liu, A., 2024) to foster sustainable and inclusive economic growth. By providing an integrated overview of digitalization and sustainability, this study contributes to the ongoing academic and policy-oriented debate on the future of the green economy.

LITERATURE REVIEW

The concept of the green economy has been widely discussed in the academic literature as a framework that integrates economic development with environmental protection and social well-being. Research emphasizes that green economic development seeks to decouple economic growth from environmental degradation through efficient resource use, reduced emissions, and the promotion of sustainable produ-

ction and consumption patterns. Within this framework, technological innovation is frequently identified as a key enabler of sustainable economic transformation.

Digitalization has emerged as one of the most influential drivers of contemporary economic change. Existing literature highlights the role of digital tools in enhancing productivity, transparency, and innovation across various sectors. In the context of the green economy, (Joksimović, M., 2025) digital technologies are increasingly recognized for their potential to improve environmental performance and support sustainability-oriented decision-making. (Umair, M., Gulzar, F., & Ur Rahman, S., 2025) Studies underline that digital tools enable real-time data collection, monitoring, and analysis, which are essential for optimizing resource use and reducing environmental impacts.

A significant body of research focuses on the application of digital tools in energy systems, where smart grids, digital monitoring platforms, and data analytics contribute to improved energy efficiency and the integration of renewable energy sources. (Joksimović, M., 2025) Similarly, the literature points to the importance of digital solutions in industrial processes, where automation and digital control systems support cleaner production, waste reduction, and circular economy practices. In agriculture, digital tools such as precision farming technologies are identified as crucial for minimizing resource inputs while maintaining productivity. (SS, V. C., Hareendran, A., & Albaaji, G. F., 2024) Another important research stream addresses the role of digital platforms and information systems in supporting sustainable governance and policy implementation. Digital tools facilitate transparency, (Joksimović, M. & Stoimenov, S., 2024) stakeholder engagement, and evidence-based policymaking by providing access to relevant environmental and economic data. They also support the development of new green business models by enabling collaboration, innovation, and market access for sustainable products and services.

Despite the recognized benefits, the literature also identifies several challenges associated with the use of digital tools in green economic development. (Söderholm, P., 2020) (Hung, N. T., 2023) Commonly discussed issues include high investment costs, technological complexity, lack of digital skills, and uneven access to digital infrastructure. Furthermore, concerns are raised about data security, privacy, and the environmental footprint of digital technologies themselves, which may offset some of their sustainability benefits if not properly managed. (Chen, Z., & Xing, R., 2025).

Overall, the existing literature suggests that digital tools have substantial potential to support green economic development, but their effectiveness depends on appropriate policy frameworks, institutional support, and capacity building. The reviewed studies emphasize the need for an integrated approach that aligns digitalization strategies with sustainability objectives in order to achieve long-term and inclusive green economic growth.

METHODOLOGY

This study employs a qualitative research approach supplemented by descriptive analysis to examine the role of digital tools in supporting green economic development. The research focuses on identifying the key digital technologies applied in sustainable economic practices, their benefits, limitations, and the challenges associated with their implementation. The methodology is structured in three main steps: data collection, data processing, and descriptive analysis.

Information was gathered from multiple secondary sources, including academic publications, industry reports, policy documents, and relevant statistical data on digitalization and green economy initiatives. The selection criteria prioritized studies and reports that addressed practical applications of digital tools in energy management, industrial processes, agriculture, and governance related to sustainability. Both global and regional examples were considered to provide a comprehensive overview.

Collected data were organized according to the type of digital technology, sector of application, and observed outcomes in terms of environmental and economic performance. Key trends, recurring themes, and common challenges were identified to provide a structured basis for analysis.

Descriptive analysis was used to summarize and interpret the collected data. This included quantitative summaries of the prevalence of specific digital tools across sectors, as well as qualitative assessments of their effectiveness in promoting sustainable practices. Tables, charts, and conceptual models were employed to visualize trends and patterns, making it easier to compare the performance and impact of various digital solutions. The descriptive approach allowed the study to provide a clear and accessible overview of the current state of digitalization in the green economy, highlighting both opportunities and constraints.

By combining qualitative assessment with descriptive analysis, this methodology enables a comprehensive understanding of how digital tools contribute to green economic development, and it provides a basis for identifying best practices and policy recommendations for effective digital integration in sustainability initiatives.

RESULTS

The descriptive analysis of collected data highlights the current applications, benefits, and challenges of digital tools in green economic development. The findings are presented in two tables: the first summarizes the types of digital tools used across different sectors, and the second highlights the perceived benefits and challenges associated with these tools.

Table 1 presents the application of digital tools across different sectors of the green economy. In the energy sector, smart grids are the most widely used, ena-

bling energy management, load balancing, and the integration of renewable sources, while IoT sensors are moderately applied and are used for real-time monitoring of energy consumption. In the industrial sector, automation and robotics are moderately implemented, supporting cleaner production and waste reduction, along with big data analytics, which facilitates process optimization and emission tracking. The agricultural sector shows a high adoption of precision farming technologies, such as IoT devices and drones, which contribute to efficient use of water and fertilizers, while AI-based crop management systems are less common but provide predictive analysis and yield optimization. In the governance and policy sector, digital platforms are moderately used to support policy implementation and stakeholder engagement, while cloud-based data systems are less frequently applied, providing centralized environmental monitoring and reporting. The table clearly shows that the adoption of digital tools is most widespread in energy and agriculture, while industry and governance have moderate use, with tools tailored to the specific sustainability needs of each sector.

Table 1. Digital Tools Applied in Green Economy Sectors

Sector	Digital Tool/Technology	Frequency of Use*	Key Applications
Energy	Smart Grids	High	Energy management, load balancing, renewable integration
Energy	IoT Sensors	Medium	Real-time monitoring of energy consumption
Industry	Automation & Robotics	Medium	Cleaner production, waste reduction
Industry	Big Data Analytics	Medium	Process optimization, emission tracking
Agriculture	Precision Farming (IoT, Drones)	High	Efficient water use, fertilizer management
Agriculture	AI-based Crop Management	Low	Predictive analysis, yield optimization
Governance	Digital Platforms	Medium	Policy implementation, stakeholder engagement
Governance	Cloud-based Data Systems	Low	Environmental monitoring, reporting

*Frequency of use is based on reviewed studies and reports: High = widely implemented, Medium = moderately implemented, Low = limited implementation.

Source: Authors' own elaboration based on available data

The analysis of digital tools applied in various sectors of the green economy shows a clear pattern of adoption and sector-specific applications. In the **energy sector**, smart grids represent the most widely used technology, playing a crucial role in energy management, load balancing, and the integration of renewable sources. IoT

sensors are moderately applied in this sector, primarily to monitor energy consumption in real time, allowing for better efficiency and reduced environmental impact.

In **industrial settings**, automation and robotics, as well as big data analytics, are moderately implemented. Automation and robotics support cleaner production processes and contribute to waste reduction, while big data analytics facilitates process optimization and the monitoring of emissions, helping industries align with sustainability goals.

The **agriculture sector** demonstrates a high adoption of precision farming technologies, such as IoT devices and drones, which enable efficient use of water and fertilizers. AI-based crop management, though less commonly implemented, offers predictive insights that can optimize crop yields and support data-driven decision-making in agricultural practices.

Finally, in **governance and public administration**, digital platforms are moderately used to enhance policy implementation and foster stakeholder engagement, improving transparency and participation. Cloud-based data systems, while less frequently applied, serve important functions in environmental monitoring and reporting, providing centralized access to critical data for informed decision-making.

Overall, the table highlights that adoption of digital tools is most widespread in energy and agriculture, while industrial and governance sectors show moderate use. The applications of these technologies are closely tied to sector-specific sustainability needs, ranging from efficiency improvements and waste reduction to enhanced monitoring and participatory governance.

Table 2. Benefits and Challenges of Digital Tools in Green Economic Development

Digital Tool/ Technology	Key Benefits	Main Challenges
Smart Grids	Improved energy efficiency, renewable integration	High implementation cost, technical complexity
IoT Sensors	Real-time data monitoring, resource optimization	Data security, limited infrastructure
Automation & Robotics	Waste reduction, cleaner production	High investment cost, skill requirements
Big Data Analytics	Process optimization, emission tracking	Data privacy, technical expertise needed
Precision Farming	Efficient resource use, increased yields	High technology cost, training requirements
AI-based Crop Management	Predictive decision-making, productivity gains	Limited adoption, data availability issues
Digital Platforms	Transparent governance, stakeholder engagement	Digital divide, cybersecurity risks
Cloud-based Data Systems	Centralized environmental monitoring	Dependence on internet access, security issues

Source: Authors' own elaboration based on available data

Table 2 presents the key benefits and challenges of using digital tools in green economic development. Smart grids contribute to improved energy efficiency and the integration of renewable sources, but their implementation is costly and technically complex. IoT sensors enable real-time data monitoring and resource optimization, yet face challenges related to data security and limited infrastructure. Automation and robotics help reduce waste and support cleaner production, but require high investments and specialized skills. Big data analytics contributes to process optimization and emission tracking, while demanding technical expertise and raising data privacy concerns. In agriculture, precision farming allows for efficient resource use and increased yields, but involves high technology costs and requires training. AI-based crop management supports predictive decision-making and productivity gains, though its adoption is still limited and dependent on data availability. Digital platforms in governance and policy enable transparent decision-making and stakeholder engagement, while facing challenges such as the digital divide and cybersecurity risks. Cloud-based data systems allow for centralized environmental monitoring and reporting, but rely on internet access and data security.

The tables indicate that digital tools are increasingly applied across multiple sectors of the green economy, with energy and agriculture showing the highest levels of adoption. While benefits such as efficiency improvement, resource optimization, and transparency are widely reported, challenges like high implementation costs, lack of skills, and security concerns remain significant barriers. These findings highlight the need for targeted policies and capacity-building initiatives to maximize the potential of digitalization in supporting green economic development.

CONCLUSION

This study has examined the role of digital tools in supporting green economic development across multiple sectors, including energy, industry, agriculture, and governance. The analysis shows that digital technologies such as smart grids, IoT sensors, automation, robotics, big data analytics, precision farming, AI-based crop management, digital platforms, and cloud-based data systems are increasingly applied to improve efficiency, reduce environmental impacts, and enable evidence-based decision-making.

The results indicate that adoption is most widespread in the energy and agricultural sectors, where smart grids, precision farming, and IoT devices play a key role in optimizing resource use and integrating renewable energy. Industrial and governance sectors show moderate use of digital tools, with a focus on cleaner production, emission tracking, and transparent policy implementation. The descriptive analysis also highlights the main benefits, including improved resource efficiency, productivity gains, and enhanced stakeholder engagement, as well as persistent challenges

such as high implementation costs, technical complexity, data security issues, and uneven access to technology.

Overall, the findings suggest that digitalization holds substantial potential to accelerate the transition to a green economy, but its effectiveness depends on adequate policy support, capacity building, and technological infrastructure. Policymakers, industry leaders, and stakeholders should prioritize strategic investments in digital tools, promote skill development, and address barriers to adoption to fully leverage the sustainability benefits of digitalization. Future research could focus on empirical studies measuring the direct environmental and economic impacts of specific digital technologies, as well as exploring innovative solutions to overcome implementation challenges in diverse regional contexts.

REFERENCES

1. Chen, Z., & Xing, R. (2025). Digital economy, green innovation and high-quality economic development. *International Review of Economics & Finance*, 99, 104029.
2. Hung, N. T. (2023). Green investment, financial development, digitalization and economic sustainability in Vietnam: Evidence from a quantile-on-quantile regression and wavelet coherence. *Technological Forecasting and Social Change*, 186, 122185.
3. Joksimović, M. (2025). Catalyst for sustainable development and digital transformation: Roundtable on the green economy. *REVIZOR Journal of Organization Management, Finance, and Auditing*, 28(2), 110.
4. Joksimović, M. (2025). The green transformation of the banking sector: challenges and opportunities for sustainable finance. *ECOLOGICA*, 32(119).
5. Joksimović, M., & Stoimenov, S. (2024). The importance of green bonds for the development of the green economy. *BizInfo Blace*, 15(1), 107–111.
6. Liu, Y., Dong, F., Yu, J., & Liu, A. (2024). Examining the impact of digital economy on environmental sustainability in China: Insights into carbon emissions and green growth. *Journal of the Knowledge Economy*, 15(4), 18044–18080.
7. Saadia, D. (2021). Integration of cloud computing, big data, artificial intelligence, and internet of things: Review and open research issues. *International Journal of Web-Based Learning and Teaching Technologies (IJWLTT)*, 16(1), 10–17.
8. SS, V. C., Hareendran, A., & Albaaji, G. F. (2024). Precision farming for sustainability: An agricultural intelligence model. *Computers and Electronics in Agriculture*, 226, 109386.
9. Söderholm, P. (2020). The green economy transition: the challenges of technological change for sustainability. *Sustainable Earth*, 3(1), 6.
10. Umair, M., Gulzar, F., & Ur Rahman, S. (2025). Digital green governance and ESG outcomes: how executive digital orientation drives sustainable transformation in China's mining enterprises. *Mineral Economics*, 1–15.