DOI: https://doi.org/10.46793/6461-101.458S
Review Article

DIGITAL TRANSFORMATION IN THE CONTEXT OF THE GREEN ECONOMY: THE PERSPECTIVE OF SERBIA

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Apstract: Digital transformation and the green economy represent two interrelated processes that are increasingly shaping sustainable development worldwide. Digital technologies such as Information and Communication Technologies (ICTs), Artificial Intelligence (AI), the Internet of Things (IoT), big data, and automation enable more efficient resource use, improved decision-making, and the creation of innovative services, while the green economy provides a strategic framework focused on environmental sustainability and reduced ecological impact. This paper analyzes the current state and potential of linking digital transformation and the green economy in Serbia, a country undergoing the process of European integration. The study examines strategic frameworks, sectoral developments, and selected case studies in energy, agriculture, transport, and industry. Particular attention is paid to smart meters in the energy sector, precision agriculture and digital platforms in farming, smart city solutions in transport, and Industry 4.0 applications in manufacturing. The findings indicate that digital technologies can significantly contribute to Serbia's green transition by improving energy efficiency, reducing emissions, and supporting sustainable resource management. However, the paper also identifies key challenges, including financial constraints, regulatory barriers, skills shortages, and regional disparities in digital infrastructure. The study concludes that stronger public–private partnerships, regulatory alignment with the European Union, targeted investments, and education are essential for accelerating Serbia's digital-green transition and positioning the country as a regional leader in sustainable development.

Key words: *digital transformation, green economy, sustainable development, Serbia, Artificial Intelligence (AI), Internet of Things (IoT), smart cities, energy efficiency, precision agriculture.*

INTRODUCTION

Digital transformation and the green economy today represent two key processes shaping the direction of global development. Digital transformation involves the widespread application of information and communication technologies (ICT), artificial intelligence (AI), the Internet of Things (IoT), big data, and automation with the aim of improving business processes, enabling more efficient decision-making, and creating new services and products (Brennen & Kreiss, 2016). The green economy, on the other hand, focuses on sustainable growth and development based on reducing negative environmental impacts, optimizing resource use, and promoting the circular economy (UNEP, 2011).

For Serbia, which is in the process of European integration, linking these two concepts is of particular importance. The European Green Deal (European Commission, 2019) sets ambitious goals for reducing carbon dioxide emissions and transitioning to renewable energy sources, while the EU Digital Agenda promotes accelerated digitalization across all sectors of society. As an EU candidate country, Serbia must align its policies with these trends. In this sense, digital transformation can be a key driver of the green economy, while the green economy provides a strategic framework for the responsible application of digital technologies.

This paper analyzes the current state and potential of Serbia in the fields of digital transformation and the green economy, presents examples of good practice, identifies challenges, and offers recommendations for further improvement.

Digital Transformation in Serbia

Over the past decade, Serbia has made significant progress in digital transformation. A key institutional driver of these activities is the Office for IT and eGovernment, which since 2017 has developed platforms such as the eGovernment Portal, eHealth, eInvoicing, and eAgrar. These systems contribute to transparency, reduced bureaucracy, and increased availability of services for citizens and businesses (Government of the Republic of Serbia, 2019).

Among strategic documents, the Strategy for the Development of Artificial Intelligence 2020–2025 is particularly noteworthy, as it lays the foundations for the application of AI in healthcare, education, agriculture, and public administration. In addition, the Digital Skills Development Strategy 2020–2024 has been adopted, emphasizing the importance of education and training for the digital transition of the workforce.

The private sector also plays an important role. Companies such as Telekom Srbija and Telenor invest in 5G networks and IoT solutions, while software companies and startups in Belgrade, Novi Sad, and Niš develop solutions for Industry 4.0, fintech, and smart cities. According to a World Economic Forum report, Serbia is among the countries in the region that are progressing most rapidly in digital innovation (WEF, 2021).

The Green Economy in Serbia

The concept of the green economy in Serbia is largely shaped by obligations arising from the process of European integration. The European Green Deal and EU regulations in the fields of energy, climate change, and environmental protection require significant investments and reforms from Serbia.

Energy is a key sector. Serbia still relies heavily on lignite, which accounts for more than 60% of electricity production. However, in recent years investments have increased in renewable energy sources, primarily wind farms and solar power plants. The adoption of the Climate Change Act (2021) and the preparation of the National Energy and Climate Plan (NECP) demonstrate efforts toward a transition to a greener model (Ministry of Mining and Energy, 2022).

Agriculture represents an important part of Serbia's economy, but it is also a significant source of greenhouse gas emissions. The transition to precision agriculture, supported by digital tools and sensors, can significantly reduce resource consumption and increase yields.

Transport is another problematic area. Serbia's vehicle fleet is old, with a large number of vehicles emitting polluting gases. Projects such as the electrification of public transport in Belgrade and Novi Sad represent initial steps toward a more sustainable system.

The Link Between Digital Transformation and the Green Economy

Digital technologies provide powerful tools for accelerating the green transition. Through the use of IoT sensors, energy consumption can be optimized, while big data analytics helps predict and reduce emissions. Artificial intelligence can improve recycling and circular economy processes, and blockchain enables transparent tracking of product carbon footprints (Ahmad et al., 2021).

For Serbia, connecting these two processes is particularly important. For example, the implementation of smart meters in EPS not only increases the efficiency of the power system but also enables better energy consumption management by end users. In agriculture, digital solutions help optimize irrigation, reducing water and pesticide consumption.

Case Studies from Serbia

Energy Sector – EPS and Smart Meters

The energy sector is the most significant in Serbia's green transition. Elektroprivreda Srbije (EPS) still produces most of its electricity from lignite, which poses a major challenge in the context of European decarbonization goals (European Commission,

2021). However, in recent years projects combining digital technologies and green policies have been launched.

EPS has begun implementing smart meters as part of the modernization of the energy system. This technology enables real-time consumption monitoring, reduction of grid losses, and improved capacity planning. In this way, it contributes both to the digital transformation of EPS and to green goals through reduced unnecessary energy consumption (EPS, 2022).

Smart meters represent a key EPS project within the digitalization of the distribution system. They enable two-way communication between consumers and distributors, facilitating consumption monitoring and reducing technical and commercial losses. By 2023, approximately 250,000 smart meters had been installed, with plans to increase this number to several million by 2030 (EPS, 2022). This project is significant not only from an energy efficiency perspective but also in terms of integrating renewable energy sources into the grid.

Digitalization of renewable energy sources is another important aspect. Wind turbines and solar power plants built in the past decade are equipped with remote management and monitoring systems. These systems enable accurate production forecasting and grid integration, reducing the risk of destabilizing the energy system.

At the level of public buildings, energy efficiency projects are being implemented that include the installation of sensors, smart thermostats, and LED lighting. The Ministry of Energy, in cooperation with the European Bank for Reconstruction and Development (EBRD), finances these projects through green credit lines, encouraging the combination of digital technologies and sustainable solutions (EBRD, 2022).

Agriculture – Precision Agriculture

Agriculture is a sector with enormous potential for applying digital technologies to support the green economy. Serbia has more than 3.4 million hectares of arable land, and agriculture accounts for approximately 6–7% of GDP. However, traditional production models are often inefficient and resource-intensive (FAO, 2021).

Precision agriculture is gaining increasing importance. In Vojvodina, projects have been launched that use drones for crop monitoring and field mapping. The company Agremo has developed software that uses artificial intelligence to analyze satellite and drone imagery, enabling farmers to monitor plant health, estimate yields, and optimize fertilizer and pesticide use (Agremo, 2021).

In addition, the eAgrar project, launched by the Office for IT and eGovernment in 2023, enables farmers to register land, apply for subsidies, and manage documentation via digital platforms. This system links digital transformation with green economy goals by enabling more precise and transparent planning of agricultural production (Ministry of Agriculture, 2023).

One of the challenges is irrigation, particularly in regions exposed to climate change. The implementation of smart soil moisture sensors helps optimize water consumption. Pilot projects conducted in the South Bačka District have shown that water

consumption can be reduced by up to 30%, significantly improving the sustainability of agricultural production (FAO, 2021).

Transport – Smart Cities

Transport in Serbia is one of the largest polluters, with a significant share of CO_2 emissions. The transition to sustainable transport modes also implies the digitalization of traffic management.

Smart traffic in Belgrade includes the installation of intelligent traffic lights and sensors that monitor vehicle flow in real time. The system enables traffic signals to be adjusted according to street congestion, reducing traffic jams and harmful emissions. In 2022, Belgrade introduced its first electric buses, marking the beginning of a transition toward cleaner public transport (City of Belgrade, 2022).

Novi Sad has developed mobile applications that integrate cycling and public transport, promoting intermodal transport. The NSmart project includes digital tickets, GPS bus tracking, and real-time route planning. These initiatives directly contribute to emission reductions and the promotion of green mobility (City of Novi Sad, 2022).

At the national level, railway infrastructure modernization is supported by European Investment Bank (EIB) loans. Digital train control systems, signaling, and ticket sales are part of a process aimed at increasing the use of rail transport as a more environmentally friendly mode of transportation.

Industry – Digitalization and Energy Efficiency

The industrial sector in Serbia is undergoing modernization and the adoption of Industry 4.0 principles, with particular emphasis on combining digital technologies with energy efficiency and circular economy goals.

ZF Serbia in Pančevo operates as a "smart factory," using IoT systems and robotics to monitor production and energy consumption. Digital solutions enable precise measurement and reduction of energy losses.

The company Brose in Novi Sad applies digital tools to reduce production waste and improve recycling. In the food industry, companies such as Imlek are introducing digital systems for waste control, packaging recycling, and more efficient resource management.

Within the circular economy concept, startups are emerging that use digital platforms to optimize waste management. An example is a platform that connects industrial producers and recyclers for the exchange of by-products and secondary raw materials, directly supporting sustainable development through the digital economy.

Challenges and Barriers

Despite positive examples, Serbia faces several challenges in integrating digital transformation and the green economy:

1. **Financial challenges** – lack of investment and access to favorable financing for green projects.
2. **Regulatory barriers** – insufficient alignment of domestic legislation with EU standards.
3. **Skills shortage** – lack of adequately trained professionals combining digital and green technologies.
4. **Digital divide** – disparities between urban and rural areas in digital infrastructure.
5. **Awareness and culture** – insufficient awareness among citizens and businesses of the benefits of the digital-green transition.

Recommendations for Serbia

To harness the potential of digital transformation in the service of the green economy, Serbia should undertake the following steps:

- **Investment in digital and green infrastructure** – development of 5G networks, smart grids, and renewable energy sources.
- **Support for the startup ecosystem** – encouraging innovative solutions that combine digital and environmental components.
- **Education and training** – introducing interdisciplinary programs linking digital technologies and sustainable development.
- **Regulatory alignment with the EU** – accelerated adoption of regulations enabling the green transition.
- **Public–private partnerships** – connecting universities, research centers, and industry to develop practical solutions.

CONCLUSION

Digital transformation and the green economy are complementary processes that together can shape a sustainable future for Serbia. While digital technologies enable more efficient resource use and the development of innovative solutions, the green economy provides the framework within which these technologies should be responsibly applied.

Case studies show that Serbia has significant potential to link digital transformation and the green economy across various sectors. Energy through smart meters and renewable energy sources, agriculture through precision farming and eAgrar, transport through smart cities and electrification, and industry through Industry 4.0 and the circular economy – all clearly demonstrate that digital technologies can become key tools in achieving sustainable development.

However, the scope and speed of implementation still depend on the availability of investment, regulatory support, and workforce education. This highlights the need

to strengthen public–private partnerships, further align with European policies, and foster innovation through the startup ecosystem.

Despite significant challenges, Serbia has the potential – through strategic policies, investments, and education – to become a regional leader in the digital-green transition. By combining national resources with European support, the country can achieve substantial benefits for the economy, the environment, and its citizens.

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