TECHNOLOGICAL AND ENERGY TRANSITION CONCERNING THE EUROPEAN UNION: PERSPECTIVES FROM NORTH MACEDONIA AND TURKEY

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Abstract: This study investigates the technological and energy transitions in North Macedonia and Turkey, focusing on their alignment with European Union (EU) standards and policies. Even though being at different stages of their EU relationships—North Macedonia as a candidate country and Turkey as a negotiating partner—both nations share common objectives in harmonizing their digital and energy infrastructures with EU requirements.
North Macedonia's efforts highlight the development of its digital infrastructure to meet the EU's digitalization goals, while Turkey's initiatives concentrate on energy transition projects associated with the EU Green Deal framework, prioritizing sustainability and clean energy.
The research uses a comparative qualitative methodology, analyzing policy documents, strategic frameworks, and case studies from both countries in order to conduct and to gain insights into national priorities, challenges, and synergies in adapting to EU norms.
The results tell that both countries have made significant progress but face distinct challenges. North Macedonia benefits from EU technical assistance and structured integration guidelines, which have accelerated its digital transformation. On the other side, Turkey's energy transition platforms advanced projects but is delayed by political and economic factors affecting its relationship with the EU.
This work highlights the vital role of regional cooperation in supporting both nations' efforts to align with EU standards. In addition, merging digital transformation with energy transition presents valuable opportunities to promote sustainable economic growth and enhance environmental resilience in the long term. These advancements not only address immediate policy objectives but also lay the groundwork for future cross-border partnerships. By leveraging shared experiences, both countries can accelerate progress and ensure a smoother transition in critical sectors.
The study identifies overlapping challenges, such as financing transitions and ensuring institutional capacity, while also highlighting opportunities for mutual learning and regional collaboration.
This analysis underscores the important role of EU policies in driving innovation and sustainability in both member and candidate states.
It concludes that effective integration strategies can strengthen national development paths and promote long-term regional stability.
Keywords: Technological Transition, Energy Transition, European Union, Digital Transformation, Sustainability and Innovation

1. INTRODUCTION

Technological and energy transitions have become critical priorities in line with the European Union's (EU) sustainable development goals. In particular, digitalization and energy transformation are addressed as interconnected processes within the framework of the European Green Deal (Commision, 2020). While digitalization supports economic growth and social development, energy transition aims to ensure environmental sustainability and energy security (Delegation of the European Union, 2023). In this respect, the EU must make significant progress in areas such as technological developments and energy contribution. It should trigger the use of different renewable energy sources for energy transformation and gradually reduce the dependence on coal. In this context, the positive effects of digitalization on development should not be forgotten. With the increase in the use of digital technology, energy consumption can be controlled and more energy can be used. In addition, digitalization can increase resource use and environmental efficiency. When these studies are realized, it will be possible for the EU to achieve its sustainable development goals. On the other way, coordination and information sharing between EU member states will be important. In this process, the EU's leadership role and its continuation as an exemplary country will be important for the future. As a result of all these, a sustainable future can be built on a universal scale and the impact of environmental problems can be reduced (Sipahi, 2010). Despite their different positions in their relations with the EU, North Macedonia and Turkey have similar goals in technological and energy transformation. As an EU candidate country, North Macedonia has accelerated its investments in digital infrastructure and aligned its energy policies with EU standards. In this context, North Macedonia is pleased to cooperate with Turkey in the areas of technological development and energy transformation, which are of great importance. At the same time,

Turkey is making progress in technological innovation and energy efficiency in line with its goal of EU membership. Therefore, the similar goals between North Macedonia and Turkey create a stronger cooperation and partnership in the relations of the two countries with the EU. The development of technological infrastructure and the harmonization of energy policies are critical for North Macedonia and Turkey to achieve sustainable development and competitive advantage. In this respect, the joint efforts of the two countries offer an important opportunity to increase regional growth and stability (Risteska & Taşkıran, 2023). Turkey has continued to be a negotiating partner and focused on a sustainable clean energy sector within the framework of harmonization with the European Union (Bajic, Damjanovic, & Pastrovic, 2024). It has made significant progress in energy efficiency by implementing the necessary policies to strengthen the transition to renewable energy. In addition, it has taken the necessary steps and made significant investments in terms of digital economy. Both countries are moving forward with sure steps with the goal of both technological progress and sustainable clean environment (Emeksiz & Fındık, 2021).

North Macedonia's digitalization journey has accelerated with the EU's technical support and financing opportunities. For example, the €2.1 billion investment package provided by the EU to the Balkan countries has played an important role in the development of digital infrastructure (Commission, European Commission launched an additional €2.1 billion investment package for the Western Balkans under the Economic and Investment Plan, 2023). Thanks to this investment, the country's digital sector has grown, technological innovations have accelerated, and citizens' access to digital services has increased. North Macedonia's successful digitalization process is progressing sustainably thanks to the cooperation with the EU and the resources provided. In the future, it is expected that North Macedonia's digital infrastructure will be further strengthened and the digital economy will grow rapidly. In this process, the EU's technical support and financing opportunities will continue to guide North Macedonia. By working together, it will be possible to fully utilize North Macedonia's digitalization potential and shape the country's digital future. Turkey, on the other hand, focuses on renewable energy projects in line with the European Green Deal, but political and economic factors constitute a decisive obstacle to this process. Although North Macedonia and Turkey have taken important steps in digitalization and energy transition, economic and political challenges limit the effectiveness of these processes. Factors such as lack of resources, policy alignment problems and technical infrastructure deficiencies, especially in cooperation with the EU, make it difficult to achieve sustainable development goals. This study aims to analyze the causes and solutions to these problems.

2. MATERIALS AND METHODS

This research was conducted within the framework of a comparative analysis, adopting a qualitative methodology. The main data sources within the scope of the research included official EU reports and academic studies.

The digitalization and energy transition processes of North Macedonia and Turkey were evaluated from the perspective of compliance with EU standards. The progress in the EU candidacy process for North Macedonia and the developments in energy projects for Turkey were examined. The sources used in the study reveal in detail the difficulties encountered and the successes achieved by both countries in their relations with the EU (OECD, 2022) (Commission, 2023).

Economic data, digital technology adaptation, and business activities in the Balkans were compiled from reports published by the State Statistical Offices of the respective countries. Additionally, the 2022 Digital Economy and Society Index (DESI) served as a significant data source. The DESI report offered secondary data that enabled a quantitative evaluation of digitalization levels across various dimensions, including connectivity, human resources, internet usage, digital technology adoption, and public digital services. An extensive review of the literature was undertaken to analyze the effects of digitalization on economic growth and to establish a theoretical foundation. This review guided the conceptual foundation of the study and enabled the contextualization of findings within broader academic discussions. To assess the ability of businesses in the Balkans to share information electronically, data on digital communication tools, platforms for data sharing, and online collaboration applications were examined. Furthermore, the extent to which businesses utilize social media platforms was assessed through their frequency of use and the role these platforms play in marketing, communication, and customer relationship management. The methods by which businesses in the region adopt and use advanced digital technologies such as data analytics and automation are among the main data sources for this research. An assessment of corporate initiatives has also been conducted to investigate how businesses integrate digital solutions for environmental sustainability and e-commerce (Tintor, ve diğerleri, 2022).

The methodology section of the paper analyzes the current state of Turkey's energy sector and examines how its relations with the European Union have developed in this context. Işık emphasizes the necessity of strengthening the regulatory framework, alongside gas and oil strategies, to ensure Turkey's energy security. In this regard, elements such as investment opportunities in the energy sector, participation of EU companies, and technology transfer are

highlighted as playing a crucial role in Turkey's energy transition (Işık, 2004). The goal of this work is to offer a thorough understanding of the current status of digital technology integration in North Macedonia and Turkey by utilizing both quantitative and qualitative approaches, while also contributing to wider discussions on digitalization and economic development in these two nations.

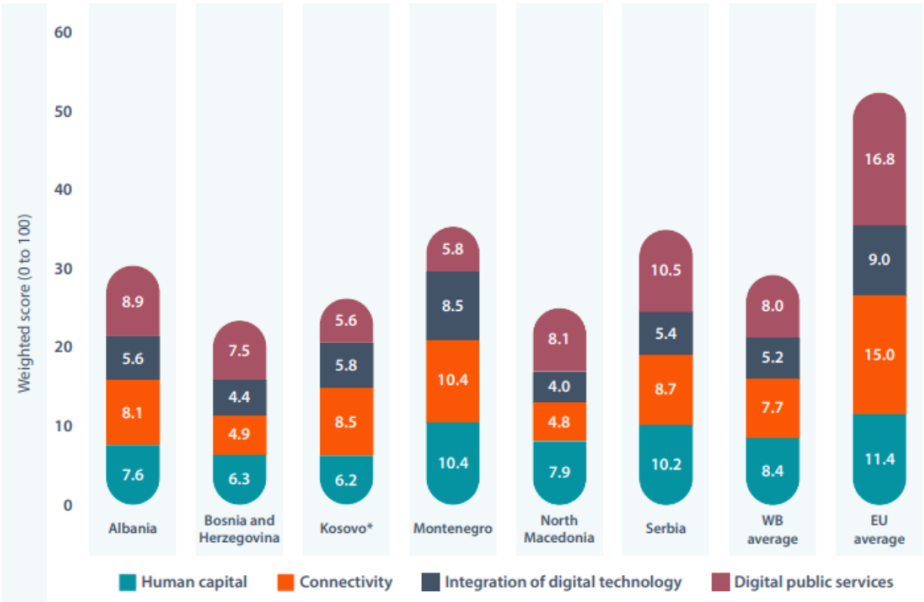
3.RESULTS

Merging digital and physical infrastructure assets leads to the creation of cyber-physical systems, commonly known as "smart" infrastructure. These systems utilize computer-driven technologies and tools to connect various utilities, infrastructure components, and public services, enabling the collection of real-time data. This data supports asset managers in enhancing the efficiency of infrastructure and service management, resulting in cost savings, reduced downtime, environmental benefits, and improved service quality, delivery, and accessibility. Upgrading infrastructure through digital means can achieve better social, environmental, and economic results, while also promoting transparency and accountability, making digital transformation a fundamental aspect of sustainable infrastructure solutions. The EBRD's Energy Sector Strategy highlights digital transformation as a key driver of the energy transition. For example, digitalisation aids in the growth and integration of variable renewable energy sources by reducing costs, enhancing forecasting capabilities, enabling demand-side management, and introducing novel strategies for system management. These efforts contribute to the establishment of efficient, modernized, and electrified energy systems through focused investments in energy sector digitalisation (Mirbabaeva, 2023).

The Digital Transformation of North Macedonia

This work findings emphasize the advancements and obstacles encountered by businesses in the region in adopting digital technologies. Although certain countries have made notable progress, narrowing the divide between the Western Balkans and EU standards, as well as cultivating a more competitive digital landscape, demands continuous efforts, strong policy frameworks, and strategic investments. North Macedonia has received technical and financial support from the EU to develop its digital infrastructure. The e-government applications developed in the country are advancing in line with the EU's digitalization goals. The €2.1 billion investment package provided by the EU to the Western Balkan countries has been a key factor in accelerating digital transformation (Union, 2023).

Figure 1. WB DESI 2022 Dimensions



Source: WB DESI Calculations, EU DESI 2022 (EU average)

Progress in Turkey's Energy Transition

Turkey has made important progress in its energy transition by focusing on renewable energy projects, and the increase in solar and wind energy capacity, specially, indicate Turkey's efforts to align with EU standards in its energy transformation. However, Governance challenges and economic difficulties remain key factors that slow down this process. On the other hand, since 2016, the adoption of digital technologies has accelerated in Turkey,

leading to the establishment of cloud-based digital power plants. Although some important companies in the energy sector in Turkey are using digital technologies such as "big data, artificial intelligence and IoT", the level of development of these technologies has not yet reached a sufficient level. With the increasing use of renewable energy, data collection and analysis through sensors are becoming increasingly important. Many hardware providers in Turkey offer products to collect accurate and continuous data. However, the biggest challenge is to use this data in a way that will produce more value and to perform predictions and automated actions. With the development of energy management systems, innovative business models are expected to become widespread in Turkey (Acar, ve diğerleri, 2022).

Common opportunities and Challenges

Both countries benefit from EU technical guidance and financing opportunities. However, national policies need to be aligned for sustainable implementation of energy and digital infrastructure projects (OECD, Energy Policies in Southeast Europe, 2018). The process of integration with the European Union presents a complex set of dynamics, especially for the Western Balkans. In this context, the study conducted by examines the effects of differentiated integration in the regional context. The authors emphasize that the Western Balkan countries are treated differently by the European Union during the integration process and how this situation affects the integration process between the countries. In particular, Macedonia's name dispute with Greece and ethnic tensions with Bulgaria are among the important obstacles to this process (Blaga & Brie, 2013). Eva Teqja's article "The Different 'Speeds' of Countries in the WB toward EU Evaluations of Recent Developments" comprehensively examines the opportunities and challenges of the Western Balkan countries' integration process into the European Union (EU). The author uses comparative methods, surveys and official reports from European institutions to understand the dynamics of this process. The main idea of the article is to examine the positions of the Western Balkan countries, especially Macedonia and Turkey, in the EU accession process and the obstacles they face in this process. Teqja states that the granting of official EU membership candidate status to Albania by the 28 EU member states is a recognition of the country's recent reforms. This situation emphasizes that other candidate countries, such as Macedonia and Turkey, should also implement similar reforms. The study reveals that Albania's accession process requires more efforts in areas such as combating corruption, public administration and judicial reforms, as well as factors such as geographical stability. In this context, the challenges faced by Turkey and Macedonia in their EU harmonization process are directly related to the need to implement similar reforms. Teqja emphasizes that candidate countries need to prove that the laws they have adopted operate effectively, and states that this is an important factor affecting the speed of the EU integration process (Teqja, 2014). Finally, Đukanović, examines the contribution of Macedonia's relations with its neighbors to the Euro-Atlantic integration process, providing important findings on how the improvements in these relations, along with the progress brought by the Prespa Agreement, could accelerate the country's EU accession process (Dukanovic, 2019).

4. CONCLUSSIONS

This work focuses on how the challenges faced by North Macedonia and Turkey in their EU alignment process can be overcome through potential collaborations. The literature, has shown that the integration of digital technologies with renewable energy systems not only ensures environmental sustainability but also promotes economic growth. If Turkey and North Macedonia collaborate and follow a joint roadmap in critical areas such as digitalization and energy transition, it is evident that both countries can achieve greater regional benefits and maximize their mutual gains. This work, discusses how the efforts of both countries in digitalization and energy transformation can play a guiding role in their alignment with the European Union. The collaboration between Turkey and North Macedonia in their EU alignment processes will not only help them achieve environmental sustainability goals but also enable them to take on an important leadership role in the fields of digitalization and energy transition.

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