Print ISSN: 0353-7919 **TEME** ONLINE FIRST Online ISSN: 1820-7804

Original research paper https://doi.org/10.22190/TEME241205015D
Received: December 5, 2024 UDC
Revised: January, 29, 2025
Accepted: May 7, 2025

DIGITAL DEVELOPMENT'S IMPACT ON THE ECONOMIC AND SOCIAL PERFORMANCE OF SELECTED EUROPEAN COUNTRIES

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Abstract

This paper investigates the impact of digital development on the economic and social performance of sixteen European countries using Microsoft's Digital Future Index from 2021. Through ANOVA tests and correlation analysis, we examined the relationships between digital inputs, and the economic and social outputs of the digitisation process in these countries. The results reveal a significant positive correlation between the achieved level of digital development, and the improvement in the economic and social performance of the analysed economies. The key message for policymakers is that increased investment in digitisation can accelerate economic growth and enhance social inclusion within this group of European countries.

Key words: Digital Development, Economic Performance, Social Performance, Microsoft's Digital Future Index, Correlation Analysis.

УТИЦАЈ ДИГИТАЛНОГ РАЗВОЈА НА ЕКОНОМСКЕ И ДРУШТВЕНЕ ПЕРФОРМАНСЕ ОДАБРАНИХ ЕВРОПСКИХ ЗЕМАЉА

Апстракт

Овај рад истражује утицај дигиталног развоја на економске и друштвене перформансе шеснаест европских земаља користећи Мајкрософтов Индекс дигиталне будућности из 2021. године. Путем АНОВА тестова и корелационе анализе

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истражују се односи између дигиталних улаза и економских и друштвених резултата дигитализације у овим земљама. Резултати откривају значајну позитивну корелацију између достигнутог нивоа дигиталног развоја и побољшања економских и друштвених перформанси анализираних националних економија. Кључна порука за креаторе политика је да повећана улагања у дигитализацију могу убрзати економски раст и побољшати социјалну укљученост у посматраној групи европских земаља.

Кључне речи: дигитални развој, економске перформансе, друштвене перформансе, Мајкрософтов Индекс дигиталне будућности, корелациона анализа.

INTRODUCTORY REMARKS

The digital economy represents the application of digital capabilities to processes, products, and assets with the aim of improving efficiency, increasing value for customers, managing risk, and discovering new development opportunities (Herold et al., 2021). For advanced societies, life becomes almost unimaginable without the presence of digital technologies (Fitzgerald et al., 2014).

The widespread application of digital technologies has become an indispensable part of everyday life, as well as efforts for change and the successful positioning of states, organizations, and individuals at both the global and local levels. Today, the success of certain countries is attributed to extensive digitalization processes, which provide societies with various opportunities for accelerated development (Wladawsky-Berger, 2023).

The concept of the digital economy was introduced to the broader public in the 1990s, with an initial focus on internet adoption. The impact of the Internet on economic and social life was a subject of consideration, but from today's perspective, it can be said that its significance was underestimated in the years that followed (Shi & Wei, 2024). The definition of the digital economy has been continuously evolving and expanding since then. Although some contours are emerging, it remains challenging to predict when a universally accepted definition will emerge. This difficulty can partly be attributed to the rapid development and changing nature of information and communication technologies (Chiemeke & Imafidor, 2020).

The annual reports of the Digital Economy and Society Index (DESI), which the European Commission has used since 2014 to monitor progress in the digitization of member states, and Microsoft's Digital Future Index of countries from 2021, are particularly significant as indicators of the level of digitalization development in European countries.

Microsoft's Digital Future Index incorporates data from over 1,000 credible sources from public institutions across 16 European countries, categorized into three groups: a) digitally advanced, b) fast-growing new digital leaders, and c) advanced digital followers. The sources include organizations such as the European Commission, the European Investment Bank,

Eurofound, UNESCO, the World Bank, the OECD, the World Trade Organization, and the United Nations (Microsoft News Center Europe, 2021).

The objective of this study is to evaluate the impact of digital development on the economic and social performance of 16 European countries, utilizing data from the 2021 Microsoft Digital Future Index. This research specifically examines how various components of digital development—such as digital infrastructure, digital business, and e-government—affect economic and social outcomes, including innovation, productivity, and sustainability. By analyzing the correlations between digital inputs and socio-economic outputs, this study aims to quantify the extent to which advancements in digitization contribute to economic and social benefits in the 16 European countries included in the Digital Future Index. Understanding the relationship between digital capabilities and economic outcomes is crucial for policymakers and business leaders to effectively allocate resources and develop strategies that maximize the benefits of digitization.

The paper begins by reviewing the relevant literature on digitization to identify key attributes of Microsoft's Digital Future Index from 2021, which reflect aspects of digital development on one hand and economic and social benefits on the other. Subsequently, descriptive statistics and ANOVA tests are employed to evaluate the differences in mean values between countries. Correlation analysis is conducted to quantify the relationship between these variables. The use of Pearson's correlation coefficient allows for the determination of the strength and direction of the association between digital inputs and economic and social benefits. The findings not only elucidate the impact of the current level of digitalization on economic growth and social development across the analyzed European countries but also provide actionable insights for policymakers regarding strategic directions for future digital initiatives.

LITERATURE REVIEW

The digitalization process has a huge impact on our society. Companies must constantly innovate to keep up with the possibilities of the digital transformation of the economy and society (Reis et al., 2018). The ways in which digitization changes the competitive landscape imply the need for strategic management to recognize that the opportunities provided by this process can quickly be transformed into competitive advantages for companies (Bonnet & Westerman, 2021). Therefore, it is not surprising that some researchers mark digital transformation as the leading phenomenon of socio-technological changes in the present time (Legner et al., 2017; Schallmo et al., 2017). Digital transformation means the widespread introduction of digital technologies into all spheres of public life and economic relations, which represent critical turning points in the development of the world economy (Vasyltsiv et al., 2022).

The modern economy is in the midst of a deep transformation, supported by the rapid development of digitalization in all spheres of society (Nedić et al., 2014). The comprehensive digitization of the economy and society is changing people's lifestyles and areas of interest, while simultaneously redefining the key principles of companies' operations (Carayannis et al., 2006). "Digital transformation in business is the integration of digital technologies in all spheres of business that brings changes and improvements, but only if it is implemented at the right time, with fully educated people" (Đoković et al., 2021: 10).

Economists point to the fact that research and technology-intensive production sectors have a key influence on the growth of average labor productivity (Brynjolfsson & Hit, 2003). On the macro level, the economic impact of digital technologies is reflected in the stimulation of innovation improvement, competitiveness growth, and the realization of sustainability concepts.

The development of the digital sector, and especially the Internet, is revolutionizing the technique of international trade for many new and existing products and services. Networking radically increases the amount and value of information available to individuals, businesses, and countries, enabling them to achieve superior economic performance (Mann & Rosen, 2001). By transforming the environment, digital technologies have created conditions conducive to the improvement of innovation and productivity growth, creating numerous opportunities that function to increase people's standard of living (Atkinson, 2004; 2007).

The digitization process of the economy and society holds undeniable importance for the economic and social development of national economies. However, its quantification varies significantly in the empirical research conducted by different authors. Numerous studies have unequivocally confirmed that smaller investments in the development and application of digital technologies correlate with a slower path towards a knowledge-based economy and a lower rate of innovation, with accompanying negative consequences not only for the quality of economic performance of companies and countries but also for the intensity of desirable social transformations (Atkinson & Ezell, 2012).

The digital economy represents a new development paradigm that explains a series of economic, social, and cultural changes brought about by digital technologies, where the Internet plays a leading role (Vidas Bubanja & Popovčić Avrić, 2018: 783). Taking into account the speed of development and the scope of the spread of digitization globally, several researchers consider it one of the most important phenomena of the twenty-first century (Zaki, 2019). The strength of the digital economy is based on knowledge as a key development resource, efficient knowledge transfer, a focus on demand, and the establishment of quality new business relationships.

Digitization can provide enormous benefits to humanity, but it can also bring about increased government control or even new forms of totalitarianism. One must be aware that the speed of change makes integration difficult, so society must find new ways to more effectively follow the digitization process.

The results of a panel analysis of 31 provinces in China from 2010 to 2019 showed that the strong digital development of the Chinese economy, thanks to the effect of spatial spillover, affected the development uniformity of the analyzed regions, influenced the level of their urbanization, altered the industrial structure, and increased the degree of openness of regional economies (Chen, 2023).

The development of the digital economy has a snowball effect because, on the one hand, it changes consumer preferences and behavior (Singgalen et al., 2019), and on the other hand, it affects the qualifications of employed human resources (Lincaru et al., 2018). These interconnected processes lead to a more efficient use of strategic resources (Vlasov et al., 2019) and an overall increase in organizational competitiveness.

The halting or reduction of economic activities in traditional economic sectors puts countries with sufficiently developed digital infrastructure, established digital technologies, and a well-prepared base of qualifications at a significant advantage (Liu, 2022). Digitization and digital transformation represent one of the primary drivers of contemporary development (Rakićević et al., 2017). The digital economy refers to an economic model that uses digital technology as its core to drive economic activity and generate benefits. In the future, all economic connections could be driven by digital technologies, which will serve as the driving force for global economic development and the engine for economic growth (Feng et al., 2019).

The G20 describes the digital economy as a wide range of economic activities that involve digitized information and knowledge as key factors of production, where modern information networks significantly expand the scope of action (Imran et al., 2022). The digital economy is also defined by several authors as the use of information and communication technologies by the state, businesses, and society (Moroz, 2017).

THE DIGITAL FUTURE INDEX AS AN ILLUSTRATION OF DIGITAL DEVELOPMENT AND THE ECONOMIC AND SOCIAL EFFECTS OF DIGITIZATION

The Digital Futures Index models the relationship between the digital development of society as an input aggregate and the key outcomes of social development as an output aggregate. The index is based on 55 indicators, of which 43 are used to evaluate digital development and 12 are used

to assess the key outcomes of digital transformations. This selection of indicators provides a comprehensive view of both the achieved level of digital transformation in individual national economies and the impact of these transformations on social and economic results.

The Digital Futures Index examines the relationship between digital development and key social outcomes and can be described as consisting of two aggregate sub-indices. The first sub-index (Input Categories Sub-index) quantifies the level of digitization based on selected indicators, while the second sub-index (Output Categories Sub-index) measures social outcomes related to digital transformation.

Each sub-index comprises categories or supporting pillars. The input sub-index of digital development includes five categories that represent the elements or potential for digital transformation activities within the national economy, as illustrated in Figure 1.

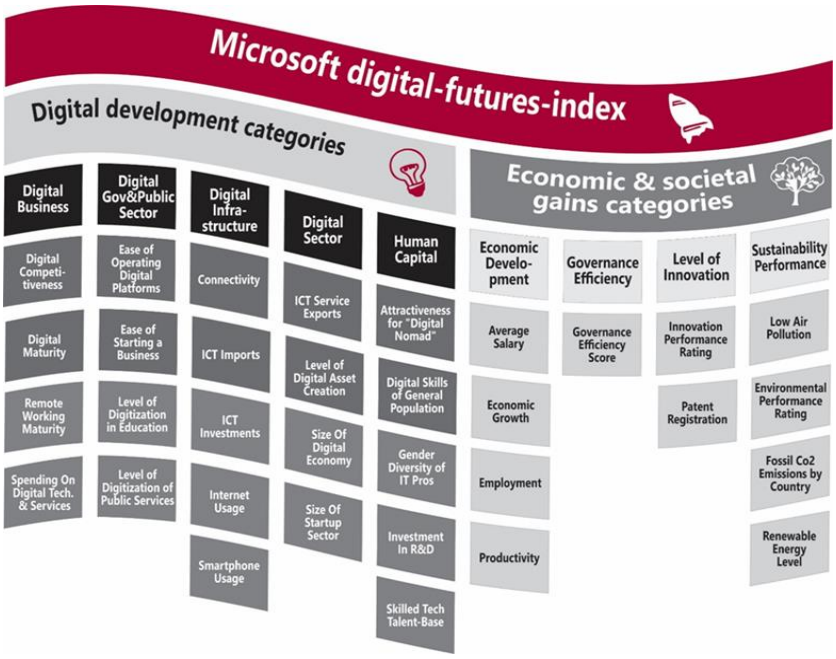

Figure 1. Structure of Microsoft's Digital Future Index
Source: Authors, based on Microsoft News Center Europe (2021)

Each category is divided into subcategories, represented by either a single indicator or an aggregation of two or more indicators. Incentive or input parameters define the potential and suitability of the environment for stimulating digital transformations in the economy, including factors such as digital competitiveness, ease of starting a business, ICT imports, ICT exports, and the technical talent base. The outputs demonstrate the results of

the input indicators, such as average earnings, productivity, patent registrations, air pollution levels, and public administration efficiency ratings.

The Digital Future Index covers 16 European countries, focusing on different regions and levels of digital development (see Figure 2). Among these 16 countries, four belong to the "benchmark" group of digitally advanced nations: the Netherlands, Denmark, Sweden, and Finland. Five countries are classified as fast-growing new digital leaders in Europe: the Czech Republic, Estonia, Malta, Slovenia, and Portugal. These countries are considered to be in a phase of "digital rise" in the second decade of the twenty-first century. The remaining seven countries are advanced digital followers (learners) in Central and Eastern Europe: Croatia, Hungary, Poland, Romania, Russia, Serbia, and Greece.

Countries Included in the Digital Future Index

The selection of the 16 economies covered by Microsoft's Digital Future Index is based on several strategic and practical considerations:

1. **Global Representation:** The economies included in the index are chosen to ensure broad representation from different regions around the world. This approach allows the index to encompass a wide range of experiences in the digital transformation of countries at various levels of economic development.
2. **Diversity in Digital Maturity**: The selected economies represent various levels of digital maturity, ranging from highly developed digital economies to those in the early stages of digital transformation. This diversity is crucial for understanding the different challenges and opportunities that countries encounter in the digital era.
3. **Availability of Data:** Another important factor in the selection process is the availability and reliability of data. Economies were selected based on the availability of sufficient data to enable accurate and meaningful comparisons across the various index indicators.
4. **Strategic Importance for Microsoft:** These economies are also strategically significant for Microsoft. The company has substantial operations, investments, and user bases in these regions, making them key areas for assessing trends in digital transformation.
5. **Innovation Centers:** Many of the selected economies are recognized as global or regional centers of innovation and technology development. Including these economies in the index helps to highlight best practices and emerging trends that may influence global digital strategies.

By focusing on these 16 economies, Microsoft's Digital Future Index aims to provide valuable insights relevant to a wide range of stakeholders, including decision-makers, companies, and educational institutions, while ensuring that the analysis is based on reliable and comprehensive data.

A Brief Description of the Data Sources and Methodology Used in the Microsoft Digital Future Index

The methodology of the Microsoft Digital Future Index is not expressed through a single formula but is based on multiple steps, including data collection, normalization, scoring, and aggregation into composite scores. Although there is no single formula that describes the entire process, key steps commonly used in indexes of this type can be identified:

Data Collection: Quantitative and qualitative data are collected from various sources, including public databases, internal Microsoft data, and third-party sources.

Data Normalization: Data from different sources are normalized to make them comparable. This often involves converting data to standardized scales, such as between 0 and 100, to facilitate easy comparison.

$$\text{Normalized value} = \frac{(\text{Value} - \text{Minimum value})}{(\text{Maximum value} - \text{Minimum value})} \times 100 \quad (1)$$

Scoring: Each indicator is assigned a score based on its significance and impact on digital transformation. Some indicators may be weighted more heavily in the overall score due to their relative importance.

Combining Scores: Scores from various indicators are aggregated to derive a composite score for each dimension (e.g., digital infrastructure, digital skills). This composite score reflects the overall performance in that dimension and contributes to the overall Digital Future Index score.

$$\text{Composite score} = \sum_{i=1}^{n} (\text{Normalized value}_i \times \text{Weight}_i) \quad (2)$$

Calculation of the Overall Index: Ultimately, the composite scores for each dimension are aggregated to compute the overall Digital Future Index for each country. This final index provides a comprehensive measure of a country's digital development and transformation performance.

$$\text{Total index} = \frac{1}{m} \sum_{j=1}^{m} \text{Composite score}_j \quad (3)$$

Where:

- n is the number of indicators within each dimension,
- m is the number of dimensions,
- **Weight** s_i are assigned to each indicator based on its relative importance.

This process enables the derivation of comparable values that reflect the overall level of digital transformation in each of the observed economies. Although the methodology involves statistical and mathematical procedures, the emphasis is on the careful selection of indicators, their normalization, and weighting to ensure that the results accurately reflect the true state of digital transformation.

THE LEVEL OF DIGITIZATION REACHED IN SELECTED EUROPEAN COUNTRIES ACCORDING TO THE DIGITAL FUTURE INDEX

In the global context of the digital economy, understanding the variation in performance across countries is critical. Countries differ in their levels of economic development, governance efficiency, innovation, and sustainability, which can affect their digital capacities and outcomes. The proposed hypothesis is as follows:

H1: There are no significant differences in mean values between countries across all analyzed index categories.

This hypothesis is crucial for understanding the existing differences in the level of digital development and the magnitude of economic and social performance. The aim is to investigate and confirm these differences, which can be of great importance when formulating national digital development policies.

Hypothesis testing primarily involves conducting an Analysis of Variance (ANOVA) to assess the statistical homogeneity of data across different index categories, including digital inputs and economic/social outcomes. The ANOVA results showed no significant difference in mean values between the countries, indicating statistical homogeneity of the data.

The results of the Analysis of Variance for the index input categories—digital inputs—yielded an F-value of 0.388 and a p-value of 0.815. Given the high p-value of 0.815, which exceeds the standard significance level of 0.05, the initial hypothesis is accepted. These results indicate no significant difference in the mean values of the data, suggesting statistical homogeneity among the analyzed countries.

Regarding the output categories of the index—economic and social outcomes—the Analysis of Variance produced an F-value of 1.692 and a p-value of 0.178. Again, the p-value of 0.178 is higher than the usual significance level of 0.05, supporting the acceptance of the hypothesis of data homogeneity. However, it should be noted that the homogeneity of the data in the output categories is less pronounced, which is expected given the substantial economic and social differences among the countries included in Microsoft's Digital Future Index.

Descriptive statistics of all input and output categories for the groups of countries included in the study were analyzed in greater detail, using graphical representations in Figures 2 and 3. These statistical metrics included mean values, standard deviations, and coefficients of variation for each index category.

The box plot diagram illustrates the distribution of index values for five different input categories of digital development by country (Figure 2). Each box plot provides insights into the median (center line), quartiles (lower and upper limits), and possible outliers in the observed population (points outside the limit values). Key insights from this analysis are as follows:

- **Wide distribution of values**: The distribution of values is relatively wide for some index categories, indicating significant differences between countries in certain areas. For example, the categories "Digital Infrastructure" and "Human Capital" show a wide range of values, suggesting varying levels of development and investment in these areas across countries.
- **Variability of medians**: Medians vary across categories, which allows for the identification of categories that generally have higher or lower values across countries. Categories like "Digital Sector" and "Human Capital" often have higher medians, indicating stronger overall performance in these areas.
- **Absence of outliers**: No outliers (points outside 1.5 IQR) were detected, suggesting that there are no countries in the observed population that significantly deviate from the majority, either through extremely high or low values in certain categories. This may suggest relatively uniform conditions, policies, or initiatives implemented by these countries.
- **Marginal Coefficients of Variation**: Ranging from 0.20 to 0.25 for input categories indicate that these variables are subject to statistically significant, but relatively even, variability. This confirms the potential for credibility of the index as a model. However, these values of the coefficients of variation also suggest the possibility of applying cluster analysis to better group the observed countries.

Digital Development Score Attributes - Digital Inputs

	1	2	3	4	5
Mean	113.0	111.0	114.6	112.9	109.4
St. Err	7.02	6.52	7.04	6.83	5.60
Median	109.3	108.4	101.8	101.1	107.7
St. Dev	28.09	26.07	28.17	27.30	22.38
Range	79.3	82.9	75.8	79.5	68.8
Min	79.4	74.1	84.6	80.7	77.2
Max	158.7	157.0	160.5	160.2	146.0
Count	16	16	16	16	16
Coef. Var	0.25	0.23	0.25	0.24	0.20
CL(95%)	14.97	13.89	15.01	14.55	11.93

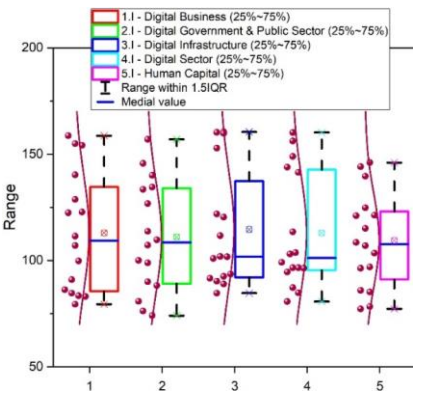

Figure 2. Descriptive Statistics for All Input Categories of the Digital Future Index
Source: Authors based on CEE Multi-Country News Center database, n.d.

The box plot diagrams in Figure 3 present the distribution of value indices across the four output categories of the Digital Future Index,

segmented by country. Key insights from the descriptive statistics for the output categories are as follows:

- **Distribution of Values**: Similar to the input categories, the distribution of values is relatively wide for "Management Efficiency" and "Level of Innovation" compared to the other two categories.
- **Variability of Medians***:* Medians vary among categories. Notably, "Management Effectiveness" exhibits the lowest median value among the observed categories, indicating a negative trend in this metric across the sample population.
- **Absence of Outliers**: As with the input categories, no outliers (points outside 1.5 IQR) are detected, suggesting that there are no countries in the observed population that significantly deviate from the majority, either through extremely high or low values in certain categories.
- **Marginal coefficients of variation**: Ranging from 0.19 to 0.32, indicate a statistically significant level of variability ('noise') in the output categories, as confirmed by the Analysis of Variance (ANOVA). However, this variability is relatively uneven, further justifying the potential application of cluster analysis to better categorize the observed countries.

Economic and Societal Gains Score Attributes - Economic/Social Outputs

	6	7	8	9
Mean	106.5	94.7	115.2	108.8
St. Err	4.98	7.53	7.38	6.20
Median	111.9	92.7	102.9	107.4
St. Dev	19.92	30.13	29.51	24.82
Range	71.0	91.4	79.7	84.0
Min	64.5	47.5	84.5	69.0
Max	135.6	138.9	164.2	153.0
Count	16	16	16	16
Coef. Var	0.19	0.32	0.26	0.23
CL(95%)	10.61	16.05	15.72	13.22

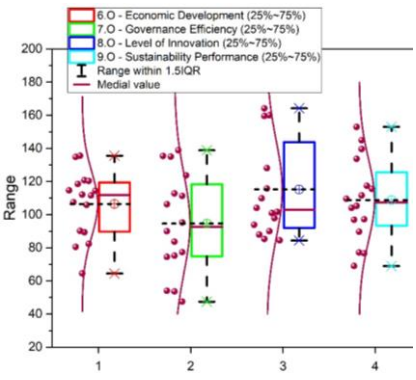

Figure 3. Descriptive statistics for all output categories of the Digital Future Index

Source: Authors based on CEE Multi-Country News Center database, n.d.

The Box plot analysis provided a visual insight into the distribution of values across different categories of digital development components and their associated economic and social benefits. This analysis allowed for the observation of potential differences in value distributions among countries and categories, laying the groundwork for further exploration of these relationships. Thus, it can be stated that the Box plot analysis established a

foundation for understanding data distribution and visually identifying potential trends or discrepancies. In contrast, correlation analysis is intended to quantitatively confirm or refute these relationships.

Hypothesis H1 was supported based on the results of the ANOVA tests, which showed no statistically significant differences in the mean values between countries for both the input and output index categories.

Analysis of the Correlation between the Degree of Digital Development and the Economic and Social Effects of Digitalization

Correlation analysis provides a quantitative measure of the relationship between variables using Pearson's correlation coefficient. This type of analysis allows for the assessment of both the strength and direction of the relationship between digital development components and the economic/social benefits to society.

This dual approach offers a deeper understanding of the relationships between variables and lays the foundation for drawing conclusions about the connection between digital development levels and economic and social benefits.

Hypothesis H2: There is a correlation between the achieved level of digital development and the economic and social benefits of the digitization process.

Identification of Variables: First, key attributes were identified as variables that reflect different aspects of (a) digital transformation and (b) economic and social benefits.

Data Preparation: Relevant data for these variables were collected for a sample of 16 countries from the most recent Microsoft Digital Development Index database (Microsoft News Center Europe, 2021).

Correlation Analysis: Correlation analysis was conducted to explore the relationship between these variables, both in aggregate form (input and output sub-indexes) and as individual attributes. Pearson's correlation coefficient was calculated to evaluate the statistical significance, strength, and direction of the relationship between the observed variables.

Analysis of Results: The results were analyzed to identify key correlations and their implications for digital development. The following findings were detected: *There is a strong positive linear correlation between "Digital Inputs" (input component of the index) and "Economic/Social Outputs" (output component of the index), indicating a relatively strong relationship*.

These findings support hypothesis H2, suggesting a robust connection between digital transformation and economic and social benefits in individual national economies.

Correlation analysis (shown in Figure 4) between "Digital Inputs" (input component) and "Economic and Social Outputs" (output component) indicates a relatively strong linear correlation, with an R^2 value of approximately 0.73. This value suggests that about 73% of the variability in economic and social outputs can be explained by changes in digital inputs. This highlights the importance of digital factors in shaping economic and social development and underscores the potential to enhance these outcomes through strategies aimed at improving digital capacity.

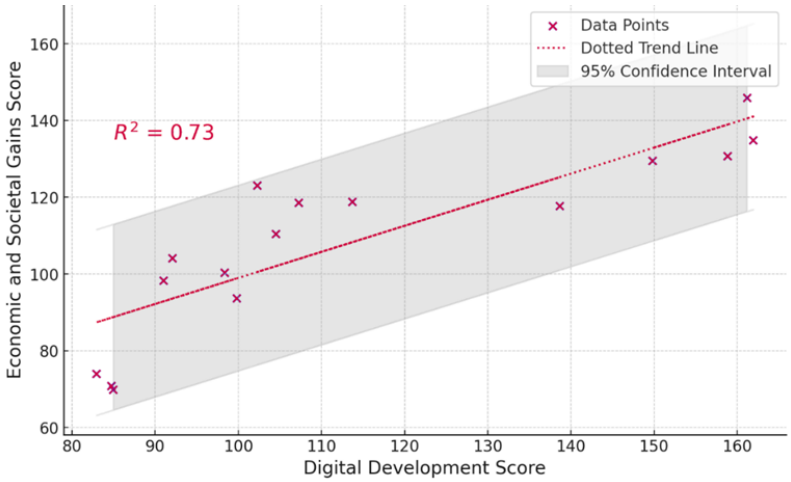

Figure 4. Correlation between the value of digital development and economic/social results

Source: Authors based on CEE Multi-Country News Center database, n.d.

The clear connection between digital progress and economic-social gains can be explained in several ways:

- **Digital Transformation of the Economy**: The digitization of business processes significantly enhances efficiency and productivity, which leads to economic growth. Innovations in the digital sector often result in the creation of new products and services, opening new markets and business opportunities.
- **Improved Access to Information**: The advancement of digital technology enhances access to information, education, and resources, leading to the development of a more educated and adaptable workforce, which is better equipped to innovate and respond to market changes.
- **Improving Social Inclusion**: Digital technologies facilitate greater social inclusion by providing access to digital services and platforms, which can improve the quality of life and reduce social inequalities.

- **Efficiency of Public Services**: The digitization of the public sector contributes to more efficient delivery of public services, positively impacting the economic and social well-being of citizens.
- **Attracting Investments**: Countries with advanced digital development are often more attractive to foreign investors, which directly impacts economic growth and development.
- **Encouraging Entrepreneurship and Innovation**: Digital infrastructure supports the establishment of startup companies and fosters innovative business practices, which are crucial for economic progress.

It is important to note that although a correlation may indicate a strong relationship between two variables, it does not necessarily imply causation. Further, more detailed research is required to establish causality.

CORRELATION ANALYSIS OF CERTAIN CATEGORIES OF DIGITAL INPUTS AND ECONOMIC/SOCIAL OUTPUTS

Correlation analysis between specific categories of digital inputs and economic-social outputs provides a deeper insight into the relationship between different segments of the Digital Future Index. The correlations between all categories of the Digital Future Index are presented in Figure 5. This analysis specifically focuses on the correlation between pairs where one category represents an input and the other represents an output within the observed index (as indicated in the figure).

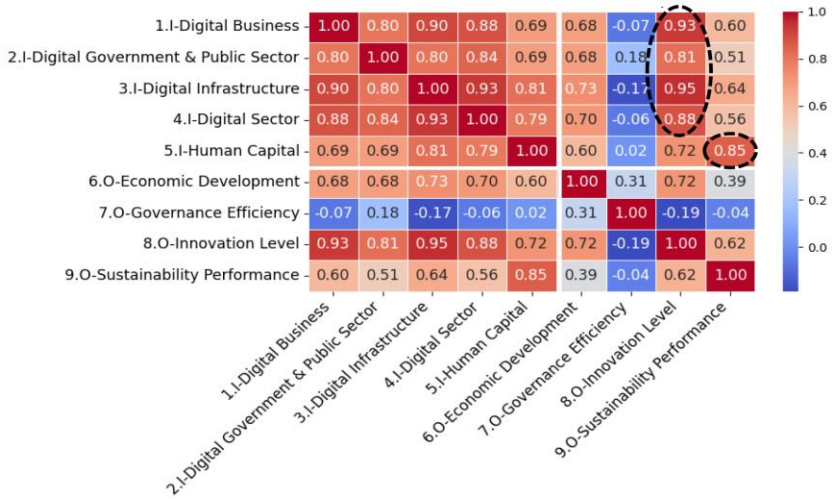

Figure 5. Correlation between all input and output categories of the Digital Future Index
Source: Authors on CEE Multi-Country News Center database, n.d.

Statistically significant positive correlations (at a significance level of 1%) can be observed between certain pairs of input and output categories of the index.

There is a significant connection between digital business and innovation in countries, where digital business strongly depends on the level of innovation as a key driver of economic growth. Digital companies continually innovate to remain competitive, utilizing modern technologies such as artificial intelligence and IoT. This connection is further strengthened as digital business provides a platform for quick access to information and partnerships, and a highly skilled workforce further encourages research and development, which together enhances digital business.

Similarly, a robust digital government, characterized by efficient online services and e-governance, can significantly contribute to the promotion of innovation. Digital government reduces bureaucratic obstacles and increases transparency, creating an enabling environment for innovation. This type of government can accelerate the implementation of innovative solutions and support startups through simplified processes, resulting in economic growth and improved quality of life.

Digital infrastructure, such as high-speed internet and cloud technologies, also plays a crucial role in fostering innovation. Access to quality digital infrastructure allows companies to experiment and collaborate with research institutions, leading to the development of new technologies. Conversely, a high level of innovation further motivates investment in digital infrastructure, creating a positive growth cycle.

The digital sector, a leader in the application of new technologies, is strongly associated with innovation. As the digital sector grows, it enables companies to adopt new technologies and optimize business processes. This sector provides an environment in which innovation can progress rapidly, as innovative ideas and the application of various technological tools stimulate further development.

Finally, a skilled workforce plays a key role in promoting sustainable practices. In regions with a highly educated workforce, innovative solutions are developed that improve economic, social, and environmental performance. Qualified managers and experts lead the research and development of new technologies, resulting in better environmental, social, and economic outcomes, and creating a culture of sustainability within organizations.

Statistically significant positive correlations (at a significance level of 5%) are also observed between all other input categories from 1.I to 5.I with all other output categories, except for 7.O—Management Efficiency. This non-significant negative correlation between management effectiveness and other observed categories can be explained by the fact that management effectiveness is not universally related to digital business, innovation, or sustainability. Differences in managerial styles, management practices that vary from one industry to another, and a lack of standardization

in the measure of management effectiveness may result in a weak or negative correlation. For example, managers focused solely on short-term efficiency gains may neglect investing in innovation, digital transformation, or sustainable practices, which may negatively impact those areas. This correlation indicates that improving management efficiency must be aligned with long-term strategic goals that include digitization, innovation, and sustainability in order to achieve comprehensive development.

Correlation analysis, based on the Pearson correlation coefficient, reveals a significant positive correlation between digital development and economic/social outputs. This confirms the hypothesis H2.

Based on the obtained results of the correlation analysis, the following recommendations can be made for policymakers in European countries:

It is necessary to invest as much as possible in the digital transition. This is because the process of digital transition enhances the business efficiency of companies and improves the economic performance of countries and regions. Experience has confirmed the positive impact of digital transformation on reducing regional inequalities, which can be very significant for economies with large regional disparities.

The development of digitization generally results in a growing share of highly educated personnel. This, in turn, positively affects research and development activities not only in the digital sector but also across the economy as a whole.

Policymakers should particularly focus on the digitalization of public administration. Investments in digital governance can drive innovation and improve the competitiveness of companies and countries. The digital transformation of public administrations will make their services faster, cheaper, and of higher quality. E-government is more efficient, accessible, and user-friendly, and it also encourages ethical behavior and reduces the risk of corruption. Reliable e-administration is fundamental to the development of e-government.

RESULTS AND DISCUSSION

The findings of this study confirm the transformative impact of digital development on the economic and social performance of selected European countries. The results align with the research of Małkowska et al. (2021), which emphasizes the multifaceted dimensions of digital transformation in EU member states, highlighting a significant positive correlation between digital inputs and the socio-economic performance of these countries. This reinforces the notion that digitalization development acts as a strong driver for enhancing innovation, productivity growth, and promoting social inclusion.

The correlation analysis supports the idea that investments in digital infrastructure, e-governance, and digital business significantly contribute to intensifying economic growth in the selected European countries. As

Ciacci et al. (2024) discuss in their analysis of digital sustainability, such investments not only improve economic performance but also advance social development goals, including reducing inequalities and increasing public service efficiency. The findings of this study corroborate these insights, particularly regarding the positive effects of digital government initiatives on fostering economic innovation and enhancing public administration efficiency.

Moreover, consistent with Atkinson's (2007) assertion that widespread ICT adoption fosters prosperity, a strong link was observed between digital business adoption and innovation. This underscores the importance of a conducive environment for technological integration. This relationship highlights how strengthening a country's digital capacity can support entrepreneurship, improve competitiveness, and lead to the emergence of new markets. Countries with robust digital ecosystems, such as Finland and Sweden, serve as examples for less digitally developed economies, illustrating the value of long-term digitalization policies.

While the results are promising, variability among countries underscores the need for tailored approaches to digital transformation. Policymakers should consider targeted strategies to address disparities and specific demands, leveraging lessons from digital leaders to build resilient and inclusive digital infrastructures. Future research should analyze panel data and explore causal relationships to further validate these findings and refine strategic recommendations.

CONCLUSION

The analysis of data on digital development and economic/social benefits reveals a significant connection between these variables. Although ANOVA tests did not identify significant differences in means between countries for the input and output index categories, box plot analysis indicated variability in the distribution of values and medians, suggesting notable differences in performance among countries. These variations imply that while the means may not be statistically significant, the distribution and variability within the categories may reflect real performance differences.

Correlation analysis, based on the Pearson correlation coefficient, shows a significant positive correlation between digital development and economic/social outputs. This relationship suggests that countries advancing in digital transformation tend to perform better in economic and social dimensions. The analysis indicates that enhancing digital development can positively influence economic growth, productivity, innovation, and social inclusion, emphasizing the importance of digital investments for improving economic performance.

A particularly noteworthy correlation was observed between digital business, digital infrastructure, and the digital sector with the level of in-

novation. These results underscore the critical role of investment in innovation, research and development, and the education system in fostering economic growth and sustainability. Investments in digital infrastructure and the digital sector can significantly enhance innovation and economic productivity. Furthermore, the correlation between human capital and sustainability performance highlights that a highly educated and skilled workforce contributes to the advancement of sustainable practices, improving economic, social, and environmental outcomes.

These findings offer clear guidance for policy and strategic decision-making. Investing in digital transformation and innovation can have a profound impact on economic development and social well-being. This analysis underscores the necessity of a holistic approach that integrates digital development with economic strategies to achieve long-term benefits for society.

REFERENCES

Assanie, L., & Su, Y. (2022). Texas economy rides wave of changing technology and diffusion of know-how. *Southwest Economy* (Fourth Quarter)

Atkinson, R. D., & Ezell, S. (2012). Innovation economics: The race for global advantage. In *Practicing sustainability* (pp. 123–126). New York, NY: Springer New York

Atkinson, R. D. (2007). *Boosting European prosperity through the widespread use of ICT*. Information Technology and Innovation Foundation

Atkinson, R. D. (2004). The past and future of America's economy: long waves of innovation that power cycles of growth. *Edward Elgar Publishing*

Bonnet, D., & Westerman, G. (2021). The new elements of digital transformation. *MIT Sloan Management Review*, 62, 8

Bukht, R., & Heeks, R. (2017). Defining, conceptualising and measuring the digital economy. *Development Informatics Working Paper, 68*

Carayannis, E. G., et al. (2006). Technological learning for entrepreneurial development (TL4ED) in the knowledge economy (KE): Case studies and lessons learned. *Technovation, 26*(4), 419–443

Chen, Y., Xu, S., Lyulyov, O., & Pimonenko, T. (2023). China's digital economy development: incentives and challenges. *Technological and Economic Development of Economy*, 29(2), 518-538

Chiemeke, S. C., & Imafidor, O. M. (2020). An assessment of the impact of digital technology adoption on economic growth and labour productivity in Nigeria. *NETNOMICS: Economic Research and Electronic Networking, 21*(1), 103-128

CEE Multi-Country News Center. (n.d.). Digital Futures Index Archives. Microsoft. Retrieved from https://news.microsoft.com/en-cee/tag/digital-futures-index/

Ciacci, A., Ivaldi, E., Penco, L., & Testa, G. (2024). Measuring Digital Sustainability Paying Attention to the Economic, Social, and Environmental Dimensions: A European Perspective. *Social Indicators Research*, 1-29.

Đoković, G., Pušara, A., & Pavićević, A. (2021). Nove tehnologije u cilju povećanja kvaliteta tržišta rada. *Editor, 7*(2), 7–21

Feng, Z., Wang, H. and Wei, L., (2019). Research and Prospect of Digital Economy Development in Shandong Province. In X. Du, C. Huang, and Y. Zhong (Eds.),

Proceedings of the 2019 5th International Conference on Humanities and Social Science Research (ICHSSR 2019) (pp. 555-558). Atlantis Press

Herold, D. M., Ćwiklicki, M., Pilch, K., & Mikl, J. (2021). The emergence and adoption of digitalization in the logistics and supply chain industry: An institutional perspective. *Journal of Enterprise Information Management, 34*(6), 1917-1938

Imran, M., Xiangyang L., Rongyu, W., Shah, S., Yun, Z. &Muhammad, JK. (2022). The Influence of Digital Economy and Society Index on Sustainable Development Indicators: The Case of European Union. *Sustainability* 14(18):11130, doi:10.3390/su141811130

Legner, C., Eymann, T., Hess, T., Matt, C., Beohmann, T., Drews, P., & Ahlemann, F. (2017). Digitalization: Opportunity and challenge for the business and information systems engineering community. *Business and Information Systems Engineering*, 59, 301–308. doi: 10. 1007/s12599-017-0484-2

Lincaru, C., Pirciog, S., Grigorescu, A., Tudose, G. (2018). Low-Low (LL) High Human Capital Clusters In Public Administration Employment - Predictor for Digital Infrastructure Public Investment Priority - Romania Case Stud., *Entrepreneurship and Sustainability Issues,* 6(2), 729-753. http://doi.org/10.9770/jesi.2018.6.2(18)

Liu, T. C., (2022). Digital policy in European countries from the perspective of the Digital Economy and Society Index. *Policy and Internet*, 14(1), 202-218

Małkowska, A., Urbaniec, M., & Kosała, M. (2021). The impact of digital transformation on European countries: Insights from a comparative analysis. Equilibrium. *Quarterly Journal of Economics and Economic Policy*, 16(2), 325-355.

Mann, L., & Rosen, D. (2001). *APEC and the New Economy*. APEC Secretariat

Moroz, M., (2017). The level of development of the digital economy in Poland and selected European countries: a comparative analysis. *Foundations of Management,* 9(1): 175-190.

Nedić, V., Cvetanović, S., & Despotović. D. (2024). ICT as a Component of Knowledge Economy Development of Western Balkan Countries. *Industrija* 42 (4) 55–77

Rakićević, J., Rakićević, A. and Poledica, A., (2019). Logical clustering approach for analysing digital economy and society performance of countries. In V. Novak, V. Marik, M. Stepnicka, M. Navara, and P. Hurtik (Eds.), *Proceedings of the 11th Conference of the European Society for Fuzzy Logic and Technology* (EUSFLAT 2019) (pp. 550-557)

Reis, J., Amorim, M., Melão, N., Matos, P. (2018). Digital Transformation: A Literature Review and Guidelines for Future Research In: Rocha, Á., Adeli, H., Reis, L.P., Costanzo, S. (eds). Trends and Advances in Information Systems and Technologies WorldCIST'18 2018. *Advances in Intelligent Systems and Computing*, vol 745. Springer, Cham. https://doi.org/10.1007/978-3-319-77703-0_4, pp.411-421

Schallmo, D., Williams, C. A., & Boardman, L. (2017). Digital transformation of business models — best practice, enablers, and roadmap. *International Journal of Innovation Management,* 21, 17. doi: 10.1142/s136391961740014x.

Shi, Y., & Wei, F. (2024). Comparative analysis of digital economy-driven innovation development in China: An international perspective. *Journal of the Knowledge Economy*, 1-43

Singgalen, Y.A., Sasongko, G., Wiloso, P.G. 2019. Community participation in regional tourism development: a case study in North Halmahera Regency - Indonesia. *Insights into Regional Development*, 1(4), 318-332. https://doi.org/10.9770/ird.2019.1.4(3)

The Digital Economy and Society index *(DESI)*.. (n.d.). *Shaping Europe's digital future* [Internet]. [cited 2023]. Available from: https://ec.europa.eu/ digital-single-market/en/desi

Vidas-Bubanja, M., & Popovčić-Avrić, S. (2018). Izazovi digitalne transformacije privrede Srbije / The challenges of digital transformation of the Serbian economy. In *How to Cope with Disrupted Times* (pp. 782-788). Ljubljana

Vlasov, A.I., Shakhnov, V.A., Filin, S.S., Krivoshein, A.I. (2019). Sustainable energy systems in the digital economy: concept of smart machines. *Entrepreneurship and Sustainability Issues*, 6(4), 1975-1986. http://doi.org/10.9770/jesi.2019.6.4(30)

Wladawsky-Berger, I. (2023). Digital Economy: The evolution of the digital economy. *Ubiquity, 2023*(March), 1-6

Zaki, M. (2019). Digital economy (advantages, challenges, applications). *The Spirit of Laws*, 88 (85): 2-46

Vasyltsiv, T., Mulska, O., Levytska, O., Lupak, R., Semak, B. and Shtets, T., (2022). Factors of the Development of Ukraine's Digital Economy: Identification and Evaluation. *Science and Innovation*, 18(2): 44–58

УТИЦАЈ ДИГИТАЛНОГ РАЗВОЈА НА ЕКОНОМСКЕ И ДРУШТВЕНЕ ПЕРФОРМАНСЕ ОДАБРАНИХ ЕВРОПСКИХ ЗЕМАЉА

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Резиме

Циљ ове студије је сагледавање утицаја дигиталног развоја на економске и друштвене ефекте шеснаест европских земаља, на основу података из Мајкрософтовог Индекса дигиталне будућности за 2021. годину. Овај Индекс обухвата податке из преко 1.000 веродостојних извора из јавних институција у шеснаест европских земаља, разврстаних по критеријуму аутора овог рада у три групе: а) дигитално напредне, б) нове брзо растуће дигиталне лидере и в) напредне дигиталне следбенике. Извори података укључују организације попут Европске комисије, Европске инвестиционе банке, УНЕСКО-а, Светске банке, ОЕЦД-а, Светске трговинске организације, Организације уједињених нација.

Истраживање испитује утицај појединих индикатора достигнутог дигиталног развоја земаља попут нивоа развијености дигиталне инфраструктуре, развијености дигиталног пословања и развијености е-управе на економске и друштвене резултате, укључујући иновације, продуктивност и одрживост. Анализом корелације између дигиталних инпута и изабраних друштвено-економских резултата, ова студија има за циљ да квантификује допринос дигитализације побољшању изабраних економских и друштвених бенефита шеснаест европских земаља укључених у Мајкрософтов Индекс дигиталне будућности у 2021. години.

Рад почиње прегледом релевантне литературе о дигитализацији како би се идентификовали кључни атрибути Мајкрософтовог Индекса дигиталне будућности из 2021. године, који одражавају најважније аспекте дигиталног развоја, с једне, и економске и друштвене користи, с друге стране. Након тога, за процену разлика у средњим вредностима између земаља користе се дескриптивна статистика и АНОВА тестови. Корелациона анализа се спроводи да би се квантификовао однос између ових варијабли. Употреба Пирсоновог коефицијента корела-

ције омогућила је одређивање интензитета и правца повезаности између дигиталних улаза и економских и друштвених бенефита.

Посебно је уочљива корелација између достигнутог нивоа дигиталног пословања и развоја дигиталне инфраструктуре и иновативности. Ови резултати наглашавају критичну улогу улагања у истраживачко-развојне и образовне активности у подстицању економског раста и реализацији циљева одрживог развоја. Притом, инвестиције у развој дигиталне инфраструктуре могу значајно побољшати глобалну продуктивност земаља. Штавише, констатована корелација између људског капитала и перформанси одрживости наглашава да високо образована и квалификована радна снага доприноси унапређењу одрживих начина пословања, побољшању економских, друштвених и еколошких резултата.

Разумевање односа између дигиталних могућности и економских резултата је од кључног значаја за креаторе политике и пословне лидере да ефикасно алоцирају ресурсе и развију стратегије које максимизирају користи од дигитализације. Добијени резултати објашњавају утицај достигнутог нивоа дигитализације на економски раст и друштвени развој у посматраним европским земљама, а такође емитују недвосмислену поруку креаторима политика развоја о оправданости будућих иницијатива по питању дигиталног развоја.