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Article

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ANALYSING EU COUNTRIES' DIGITAL PROGRESS TOWARDS SUSTAINABLE DEVELOPMENT GOALS

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Abstract

The article analyses the level of digitalization in the European Union (EU) and correlates the results with the Sustainable Development Goals formulated by the United Nations. The paper provides figures on the number of enterprises receiving orders online, the share of enterprises' turnover on e-commerce, the number of employed ICT specialists by sex (female), and the number of individuals using the Internet for interacting with public authorities in order to determine the differences between the member states. The next step carried out in the current article was to conduct a three-year forecast of the indicators listed previously. The methods used to make predictions are Autoregressive Integrated Moving Average (ARIMA) and Double Exponential Smoothing. The results highlight a projected increase in individuals using the Internet for interacting with public authorities, the rise in e-commerce turnover, the expansion of high-speed Internet coverage, and the growth in the percentage of female-employed ICT specialists. Furthermore, the originality of this research lies in providing valuable insights into the correlation between digitalization and sustainable development in the European Union. The forecasted trends indicate positive advancements toward multiple Sustainable Development Goals (SDGs). These findings demonstrate the EU's commitment to achieving SDG targets related to effective institutions, public access to information, economic productivity, technology access, quality education, and gender equality. The study emphasises the crucial role of digitalization in driving sustainable development and underscores the progress made by the EU in aligning its efforts with the SDGs.

Keywords: digitalization, sustainable development goals (SDGs), forecasts, autoregressive integrated moving average (ARIMA)

JEL Classification: C53, Q56, Q01, O33

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Introduction

Digitalization and sustainable development are two fundamental concepts that redefine how modern society approaches economic and social progress. Digitalization refers to the process of transforming information, data, and processes into digital formats with the aim of enhancing efficiency, accessibility, and information management (Organisation for Economic Co-operation and Development, 2019). Simultaneously, sustainable development focuses on balancing economic growth, social rights, and environmental protection, considering the current and future needs of society (United Nations, 2017). Together, these two concepts can catalyse sustainable digital progress aimed at addressing social issues.

The intersection of digitalization and sustainable development goals in the European Union has gained significant importance as the EU seeks to address complex global challenges. Digitalization has become a key driver of societal and economic transformation worldwide, offering opportunities to enhance economic growth, increase efficiency, promote innovation, and address environmental and social challenges. Simultaneously, the pursuit of sustainable development goals (SDGs) has gained significant importance on the EU's agenda, reflecting the collective commitment to address pressing global challenges.

Forecasting methods have been described that use historical information to create models that impact future data. The authors used historical data from 2013 to 2021 related to the analysed indicators to forecast the values for 2022 to 2024.

This academic text aims to explore the intricate relationship between digitalization and the SDGs in the European context. By examining the potential opportunities, challenges, and projections for key digitalization indicators, the study sheds light on the EU's progress in achieving sustainable development targets. It emphasises the need for a comprehensive understanding of how digitalization can drive economic prosperity, enhance social inclusion, and mitigate environmental impacts while aligning with the broader SDG framework.

Overall, the article provides valuable insights into the digital development of the EU member countries and highlights the differences among them. The data and analysis can be useful to policy makers and businesses to understand the e-commerce landscape in the EU and to make informed decisions. It also provides a comprehensive examination of the intersection of digitalization and sustainable development goals in the EU. It underscores the significance of digitalization as a catalyst to achieve sustainable development targets, while emphasising the importance of collaboration and partnerships among stakeholders. By harnessing the potential of digital technologies, the EU can advance economic prosperity, social inclusion, and environmental sustainability, demonstrating its commitment to the SDGs. In the following sections, the paper will focus on reviewing the specialised literature regarding digitalization and sustainable development. Moreover, the research methodology will be presented and the main results obtained will be analysed. Additionally, it will provide conclusions, discuss the research limitations, and outline future directions for analysis.

1. Review of the scientific literature

Recent years have witnessed a swift expansion of technological advancement (Stanley et al., 2018). Therefore, it is not unexpected that the digitalisation process has been acknowledged as one of the significant and rapidly evolving phenomena that is affecting both society and industry (Chinie et al., 2022; Juhász et al., 2022). The usage of ICT in households,

organisations, and by citizens has been the subject of a lot of intriguing literature and science research in recent years. There is a connection between the GDP and information and communication technologies, according to the scientific literature (Dima et al., 2019; Busu et al., 2020). However, the scientific literature reveals that there is a variation in results and perspectives regarding the importance and nature of this link.

More recent studies show that ICT has an impact on growth through the following channels: enhancing living quality; increasing business competitiveness and diversifying the economy (Dima and Vasilache, 2009). Other authors demonstrate that the usage of e-commerce and e-business increases productivity and economic growth, on the one hand, and the efficiency and flexibility of banking operations, on the other (Albiman and Sulong, 2017; Paraschiv et al., 2022). According to Hasbi and Dubus (2020), ICT significantly reduces transaction costs in the financial services industry. While the majority of studies that look at the connection between ICT and economic growth imply a positive association, similar to our study, some report null connections in terms of importance, therefore the results are far from uniform, according to Mayer et al. (2020). On the other hand, there are research directions that contradict the result obtained by the current study and challenge the existence of a connection between ICT and economic performance. Thompson and Garbacz (2011) or Haller and Lyons (2015), for instance, found no significant evidence of a link between specific ICT factors and productivity.

Digitalization represents a key factor in achieving sustainable development goals (Camodeca and Almici, 2021). This statement, aligning with the findings of the current research, is supported by the study conducted by Camodeca and Almici (2021), who carefully examined the connection between digitalization and sustainability, thus illustrating the essential potential of digital technology in the implementation of SDGs (Sustainable Development Goals). The use of digital business models and technology can sustainably support innovation and growth within companies (Bican and Brem, 2020). Furthermore, digital marketing capabilities can promote a sustainable attitude within organisations, fostering sustainable development (Diez-Martín et al., 2019).

Adeleye and Eboagu (2019) show evidence that the fast development of ICT has boosted e-commerce, increased human capital development, encouraged information dissemination, and network externalities in addition to creating new jobs. Another investigation showed a connection between income, proficiency in the English language, involvement in social networks, and access to ICT (Seifert et al., 2018; Pinzaru et al., 2022). The authors claim that these elements significantly affected people's capacity to use information and communication technology.

By concentrating on 45 nations between 1993 and 2015, Donou-Adonsou (2019) discovered that, given improved education, the Internet boosts to economic growth. ICT infrastructure is found to have a positive impact on the economic growth of EU member states by Toader et al. (2018) when they look at the period between 2000 and 2017. Moreover, ICT boosts the economic growth of G-20 countries, according to Nguyen et al. (2020) and Clodnițchi and Tudorache (2022), who look at the effects of ICT and innovation on carbon emissions and economic growth for 13 G-20 countries from 2000 to 2014. These findings support the hypothesis that the development and implementation of Information and Communications Technology have a significant and positive impact on global economic growth, being considered a key factor in supporting sustainable development and socio-economic progress.

2. Research methodology

For this chapter, theoretical aspects related to data forecasting will be described, including ARIMA and Double Exponential Smoothing models. ARIMA models are used to make predictions based on historical data. Acronomun consists of three components: AR – the autoregressive component, in which the current values are determined based on past values, MA – moving average, the present values depend on the past errors of the model, and I – describes the differentiation order for the data to become stationary. The model is written in the form of ARIMA (p, d, q), where p denotes the number of lags of the autoregressive component, d describes the differentiation order of the data, and q determines the lag of moving average (Hayes, 2022).

The double-exponential smoothing model involves the application of two equations for level and trend, and is recognised for its ability to give more weight to more recent historical information, at the expense of those more distant in time (Gardner, 1981).

The first test used to determine the soundness of the model is to calculate the errors of each method used. In this sense, the Root Mean Squared Error (RMSE) was applied, which determines the difference between the current and predicted values. About this it should be remembered that the closer the value is to 0, the better the model (Allwright, 2022).

Another test intended to show the accuracy of the model concerns the autocorrelation of errors at lag 1 and is named after the statisticians James Durbin and Geoffrey Watson (Kenton, 2021). The values of this test lie between 0 and 4. When the value is 2, or close to it, the errors are not autocorrelated. If the value is less than 2, there is positive autocorrelation, and when it exceeds 2, there is negative autocorrelation.

The last calculated test refers to Thiel's U1 inequality coefficient, and it is desired to determine the degree to which a method used for forecasting is better than a naive guess (Oracle, 2017). To ensure that the prediction is as good as possible, the value of this test must be as close as possible to 0. A value of this test equal to 1 implies that the predicted model is no better than a simple guess.

The data used in this research were obtained after querying the databases made available by Eurostat for the period 2013-2021. To be able to make forecasts for the years 2022-2024, the methods and tests described previously were implemented using the Crystal Ball extension. The paper begins with a cross-sectional analysis (year 2021), for the 27 EU member states for digitalization indicators (companies that have received online orders, share of turnover of companies in e-commerce, employed female ICT specialists, persons which uses the Internet for interaction with public authorities and high-speed Internet coverage). The next step consisted of a longitudinal analysis of the EU average values for the previously described indicators (2013-2021), followed by the forecast for the next three years.

3. Results

Through this research, the authors wanted to determine the European context regarding aspects related to digitization. Thus, the research can be divided into three large subsections, the first referring to the graphical presentation of the countries, the axes of the graphs being represented by the observed indicators. In the second subsection, the results obtained for the forecasts made

for the period 2022-2024 are illustrated both graphically and tabularly. In the last subsection, the intersection of digitalization and Sustainable Development Goals is debated.

3.1 Observing the European context

Next, the context of the European Union will be detailed with regard to aspects related to digitization.

In figure no. 1, on the oX axis, are represented the enterprises having received orders online (at least 1%) (ent_o_o), and it can be noted that the highest percentage of these enterprises is in Denmark (over 35%), followed by Sweden and Ireland. At the opposite pole, with a percentage less than 10% is Luxembourg, followed by Bulgaria, Romania, and France, with values exceeding 10%, but not reaching 15%. On the oY axis, the share of enterprises' turnover on e-commerce (s_turn) is highlighted, it can be noted that the highest percentage, over 35%, is obtained by Ireland, the lowest value, below 5%, is obtained by Cyprus, and approximately half of the countries have values between 15 and 25%.

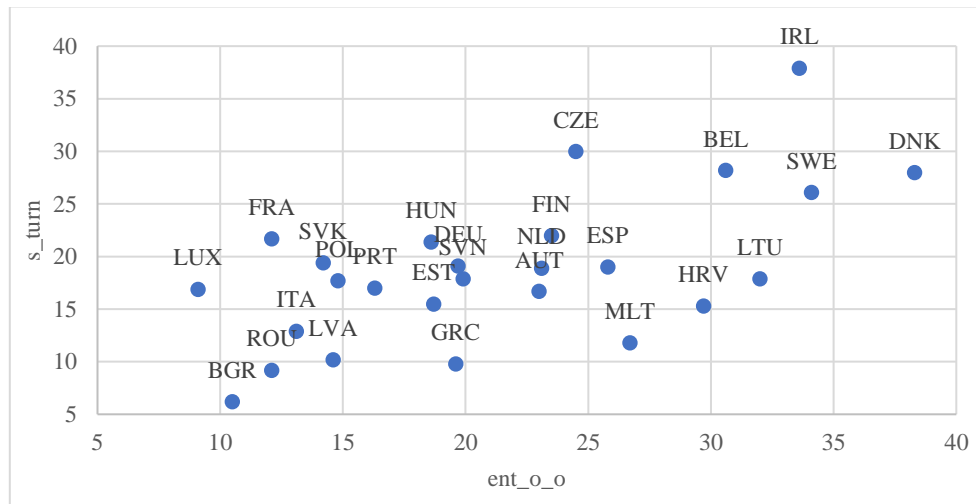


Figure no. 1. Enterprises having received order online and share of enterprises' turnover on e-commerce

According to figure no. 2, it can be seen that Bulgaria, Romania and Malta are the countries where the percentage of women working as ICT specialists (eictf) exceeds 25%, most of the countries having values between 15 and 25%, the countries with values lower than 15% being the Czech Republic, Hungary, and Slovakia. For the percentage of individuals using the Internet for interacting with public authorities (ind_p_a), it is noted that Romania and Bulgaria have the lowest values, most countries having values that exceed 50%, the Nordic countries, and Ireland having percentages of this indicator of approximately 90% or more.

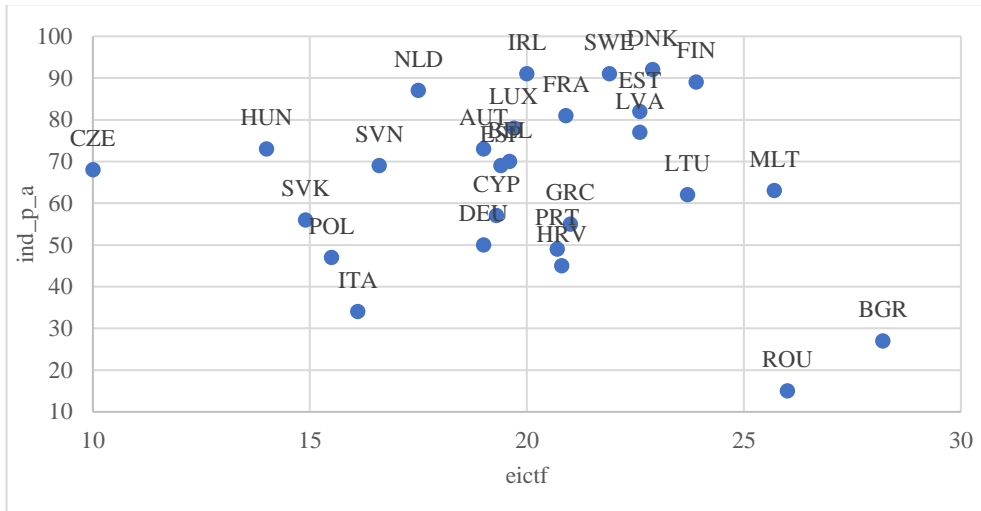


Figure no. 2. Employed ICT specialists by sex (female) and Individuals using the Internet for interacting with public authorities

Figure no. 3 shows that, apart from Greece, where the coverage percentage is approximately 20%, all other states have values that exceed 40%. For Malta, the percentage of high-speed Internet coverage (hs_i) seems to be 100%, being closely followed by Luxembourg, Denmark, and Spain.

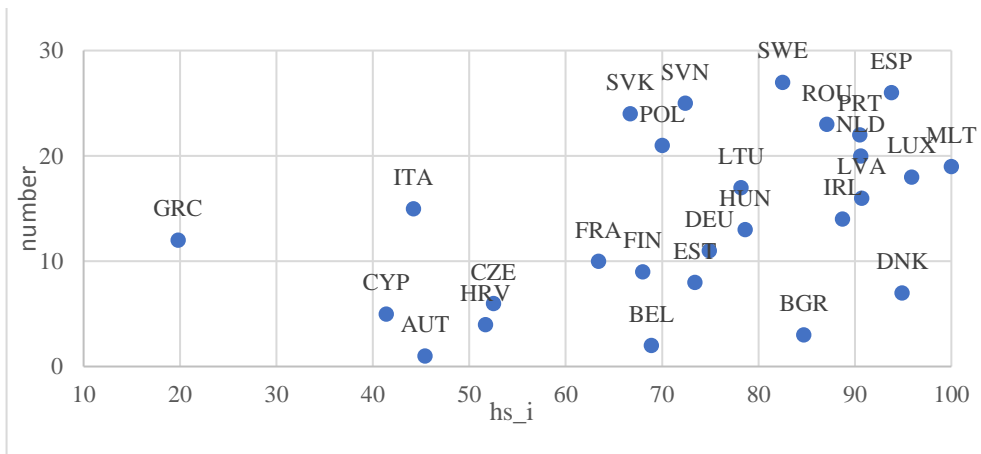


Figure no. 3. High-speed Internet coverage

From table no. 1 it can be seen that between the percentage of enterprises having received order online and the percentage of individuals using the Internet for interacting with public authorities there is a direct relationship of medium intensity.

Table no. 1. Correlogram

	ent_o_o	eictf	hs_i	ind_p_a	s_turn
Enterprises having received order online and share of enterprises' turnover on e-commerce (ent_o_o)	1.00				
Employed ICT specialists by sex (female)(eictf)	0.07	1.00			
High-speed Internet coverage(hs_i)	0.13	0.35	1.00		
Individuals using the Internet for interacting with public authorities (ind_p_a)	0.50	-0.12	0.23	1.00	
Share of enterprises' turnover on e-commerce (s_turn)	0.61	-0.36	0.21	0.62	1.00

Between the percentage of enterprises having received order online and the share of enterprises' turnover on e-commerce, a direct link is observed, with a higher intensity compared to the previous case, of 0.61. The strongest relationship between the analysed data, of 0.62, is found between the percentage of individuals using the Internet for interacting with public authorities and the share of enterprises' turnover on e-commerce.

3.2. Data forecasting

In this section, the historical course of the previously described indicators from 2013 to 2021 for the European Union average (27 states) will be described, subsequently trying to predict some values for the next three years.

According to the description of the historical data (Table no. 2), it is noted that the average for the 9 years analysed is 50%, the values deviating, on average, from this value by 5.29%. Regarding the forecast, it is noted that an increase in these percentages is expected at the EU level.

Table no. 2. Individuals using the Internet for interacting with public authorities – forecast results

Forecast results				Statistics	
Date	Lower: 2.5%	Forecast	Upper: 97.5%	Minimum	42.00
2022	60.06	61.94	63.81	Mean	50.00
2023	60.49	62.93	65.37	Maximum	58.00
2024	62.56	66.71	70.86	Standard Dev.	5.29
Forecast accuracy					
Method	Rank	RMSE	Theil's U	Durbin-Watson	
ARIMA(2,1,1)	Best	1.14	0.4487	2.00	
Double Moving Average	2nd	1.16	0.5049	2.02	
Double Exponential Smoothing	3rd	1.69	0.7511	1.14	

It can be seen that for the analysed model the data do not have a seasonal component and are described by an ARIMA type process (2,1,1) for which the RMSE has the lowest value, also the Durbin-Watson test has a value of 2, sign that the model errors are not autocorrelated. And Theil's U test also has the lowest value, a smaller value compared to 1, it can be stated that the forecasting technique is better than guessing. According to this model, the data were

differentiated to the 1st order and are described both by the past values (two lags ago) and the model errors (of the 1st order).

For the share of enterprises' turnover on e-commerce, it is worth noting that the minimum value was 13.1% (table no. 3), the maximum was 19.8%, and the average was 16.9%, the analysed values differing, on average, by 2.4% from the previously mentioned value. In terms of the forecast, an increase in these values is expected.

Table no. 3. Share of enterprises' turnover on e-commerce - forecast results

Forecast results				Statistics	
Date	Lower: 2.5%	Forecast	Upper: 97.5%	Minimum	13.10
2022	19.61	21.36	23.11	Mean	16.92
2023	19.52	21.40	23.28	Maximum	19.80
2024	19.91	22.87	25.83	Standard Dev.	2.41
Forecast accuracy					
Method	Rank	RMSE	Theil's U	Durbin-Watson	
ARIMA(2,1,1)	Best	1.06	0.63	2.45	
Double Moving Average	2nd	1.20	1.04*	0.83**	
Damped Trend Non-Seasonal	3rd	1.36	0.88	2.12	

In this case, also, the data do not show a seasonal component. As in the previous case, the model is described by ARIMA (2,1,1), the root mean square error being 1.064, the lowest value for the three proposed model variants, also having a value lower than 1 for Theil's U test and a value of 2.45 for Durbin-Watson test, it can be stated that the errors are not significantly correlated, and the prediction is correct. For this indicator, the value of 17.6% was posted in the Eurostat database before the end of 2022, and the value predicted by the model for this year is 21.36%. Perhaps this value proposed by Eurostat will change in the course of next year because at the time of the analysis, the year 2022 had not yet ended, but the predicted value is close to reality.

From table no. 4, an increase in high-speed Internet coverage can be seen during the forecast period.

Table no. 4. High-speed Internet coverage - forecast results

Forecast results				Statistics	
Date	Lower: 2.5%	Forecast	Upper: 97.5%	Minimum	15.60
2022	73.42	81.30	89.18	Mean	36.09
2023	77.23	92.17	107.10	Maximum	70.20
2024	78.42	103.03	127.65	Standard Dev.	19.34
Forecast accuracy					
Method	Rank	RMSE	Theil's U	Durbin-Watson	
Double Exponential Smoothing	Best	4.79	0.68	1.87	
Damped Trend Non-Seasonal	2nd	4.79	0.68	1.87	
ARIMA(0,2,0)	3rd	5.55	0.66	2.86	

For this indicator, according to Table no. 4, the model with the lowest value for RMSE is Double Exponential Smoothing for which the value of the Durbin-Watson test is very close to 2, a sign that the errors are not autocorrelated, and the value for the Theil's U test is 0.68, lower compared to 1, it can be stated that the forecasting technique is better than guessing.

According to the information provided in Table no. 5, an increase in value can be observed for the year 2022, followed by a downward trend.

Table no. 5. Enterprises having received orders online (at least 1%) - forecast results

Forecast results				Statistics	
Date	Lower: 2.5%	Forecast	Upper: 97.5%	Minimum	13.80
2022	18.86	19.57	20.29	Mean	16.74
2023	17.41	19.38	21.36	Maximum	19.00
2024	15.75	18.78	21.80	Standard Dev.	1.68
Forecast accuracy					
Method	Rank	RMSE	Theil's U	Durbin-Watson	
ARIMA(2,1,1)	Best	0.43	0.41	1.75	
Damped Trend Non-Seasonal	2nd	0.78	0.79	1.13	
Double Exponential Smoothing	3rd	0.84	0.83	1.33	

As in the previous cases, one can observe an autoregressive model of order 2, a moving average model of order 1, differentiated from order 1. According to the correlogram in Figure 4, the three indicators that had significant links, of medium intensity, were described by the same ARIMA model (2,1,1). This model has the lowest value for root mean square error, of 0.43, the value for Durbin-Watson is relatively close to 2, and the Theil's U test shows the lowest value, much lower than 1, so the model is correct, for which errors are not autocorrelated.

The value for the year 2022 of this indicator appeared in the Eurostat database, of 19.7% for the EU average, the value predicted by the model being 19.57 percent, being very close to the reported one.

According to the information provided in Table no. 6, the second-best solution according to the RMSE value, a Double Exponential Smoothing model is created, for which the trend of the forecasted values is upward.

Table no. 6. Employed ICT specialists by sex (female) - forecast results

Forecast results				Statistics	
Date	Lower: 2.5%	Forecast	Upper: 97.5%	Minimum	16.30
2022	19.09	19.66	20.24	Mean	17.37
2023	19.09	20.23	21.36	Maximum	19.10
2024	19.19	20.79	22.39	Standard Dev.	0.94
Forecast accuracy					
Method	Rank	RMSE	Theil's U	Durbin-Watson	
Double Exponential Smoothing	Best	0.35	0.79	1.60	
ARIMA(0,1,1)	1st	0.29	0.64	0.91	
Damped Trend Non-Seasonal	3rd	0.36	0.80	1.74	

Table no. 6 shows an average value of 17.37% of women employed as ICT specialists in the European Union, the values deviating from this value, on average, by 0.94 percent for the analysed years. For this model, the value of the Durbin-Watson test is 1.6, quite close to 2, it can be stated that the errors are not significantly autocorrelated, and the value for the Theil's U test is less than 1, being a good model. Although the RMSE value is lower for the ARIMA (0,1,1) model, it was not chosen because the Durbin-Watson test value is less than 1, indicating a positive autocorrelation of the errors.

3.3. Exploring the intersection of digitalization and sustainable development goals in the European Union

Digitalization has become a key driver of societal and economic transformation worldwide. In the European Union (EU), the pursuit of sustainable development goals (SDGs) has gained significant importance. As the EU seeks to address complex global challenges, understanding the intersection of digitalization and the SDGs becomes crucial. It can enhance economic growth, increase efficiency, and promote innovation while addressing environmental and social challenges. Furthermore, digitalization plays a pivotal role in fostering social inclusivity and reducing inequalities. It enables improved access to education, healthcare, and public services, particularly in remote and marginalised areas. E-commerce and digital platforms can provide new economic opportunities, empowering individuals and communities. By bridging the digital divide, the EU can strive for inclusive growth and leave no one behind.

The intersection of digitalization and sustainable development goals in the European Union presents a wide range of possibilities and challenges. By harnessing the potential of digital technologies, the EU can advance economic prosperity, social inclusion, and environmental sustainability. However, addressing the intersection of digitalization and the SDGs necessitates collaboration and partnerships among various stakeholders. Governments, industry, civil society organisations, and academia must work together to shape policies, promote innovation, and share best practices. Therefore, the research conducted in this study involved historical data and various digitalization indicators from Eurostat to make predictions for the next two years. The COVID-19 pandemic marked a significant setback in the evolution of Sustainable Development Goals (SDGs) in Europe, with indicators experiencing a halt or even regression for the first time. In this respect, we analysed a potential connection between the current and potential future development of digital indicators on sustainable growth.

One significant finding of the analysis is the projected increase in the percentage of individuals using the Internet to interact with public authorities (Table no. 2). This result has implications for sustainability, particularly in relation to Sustainable Development Goals (SDG) Target 16.6 and Target 16.10. SDG Target 16.6 focuses on developing effective, accountable, and transparent institutions at all levels, while SDG Target 16.10 aims to ensure public access to information and protect fundamental freedoms.

Another key finding of the research conducted in this study is the projected increase in the share of enterprises' turnover in e-commerce in the following years (Table no. 3). This result has important implications for sustainability, particularly in relation to Sustainable Development Goal (SDG) Target 8.2, as well as other relevant targets within the SDG framework. SDG Target 8.2 aims to achieve higher levels of economic productivity through diversification, technological upgrading, and innovation, with a particular focus on encouraging entrepreneurship and fostering sustainable business practices.

The increase in high-speed Internet coverage (Table no. 4) directly contributes to SDG Target 9.C, which focuses on significantly increasing access to information and communication technologies (ICTs) and striving to provide universal and affordable Internet access in least-developed countries.

One significant result of the research conducted in this study is the projected increase in the percentage of female-employed ICT specialists in the following years. This result has important implications for sustainable development, particularly in relation to the Sustainable

Development Goal (SDG) Target 5, which focuses on achieving gender equality and empowering all women and girls.

The research results obtained in this study shed light on the correlation between various indicators and the SDG targets. Table no. 7 summarises the findings, illustrating the forecasted trends and their alignment with specific SDG targets.

Table no. 7. Research Results and Correlated SDG Targets

Research results	Sustainable development goals targets
Individuals using the Internet for interacting with public authorities (Table no. 2)	SDG Target 16.6.: Develop effective, accountable and transparent institutions. SDG Target 16.10.: Ensure public access to information and protect fundamental freedoms.
Share of enterprises' turnover on e-commerce (Table no. 3) Enterprises having received orders online (Table no. 5)	SDG target 8.2.: Achieve higher levels of economic productivity through diversification, technological upgrading and innovation
High-speed Internet coverage (Table no. 4)	SDG target 9.c.: Significantly increase access to information and communications technology SDG target 8.1.: Sustain per capita economic growth in accordance with national circumstances. SDG target 4.c.: By 2030, substantially increase the supply of qualified teachers
Employed ICT specialists by sex (female) (Table no. 6)	SDG target 5.5.: Ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making SDG target 8.5.: By 2030, achieve full employment and decent work for all women and men, and equal pay for work of equal value.

Table no. 7 showcases the forecasted trends for each research result and their corresponding SDG targets. By aligning the research findings with the SDGs, this study provides valuable insights into the progress toward sustainable development and the specific goals that are being addressed.

4. Discussions

There is a direct relationship between digitalization and economic growth, which translates into an increased impact of sustainable economic growth for countries with a high degree of digitization. In a study conducted for Ukraine, the authors observed that a 1% increase in output from the digital sector leads to a 0.83% increase in GDP growth (Novikova et al., 2022). As the goal is to increase the number of people with access to the Internet, with the current study showing an expansion of high-speed Internet coverage, it is desirable for the energy consumption associated with the installation of Wi-Fi sources providing citizens with Internet access to be minimal (Abdrabou et al., 2020). However, it is not only energy consumption that needs to be discussed, but also the performance provided by a greater number of devices (Nakıp et al., 2022).

Various studies have highlighted that e-commerce is a significant area of interest in the context of achieving Sustainable Development Goals (SDGs). Revinova (2021) argues that e-commerce is closely related to 10 out of the 17 SDGs and, for the most part, has positive effects on them. According to Ju et al. (2023), it is found that e-commerce can make

significant contributions to various aspects of sustainable development, including economic growth, poverty reduction, and environmental sustainability promotion. Additionally, Li et al. (2021) suggest that e-commerce has the potential to play a significant role in advancing the sustainable development agenda, but requires the collective commitment of all stakeholders involved to maximise its benefits.

Another aspect to consider regarding the relationship between digitalization and sustainability is gender equality, as it is observed that, on average, the percentage of women working in the EU is below 20% for the analysed period. However, there is an upward trend in this regard. This is an issue that needs to be addressed starting from the educational stage, by encouraging female students to pursue careers in these fields through the introduction of more relevant courses (Tam et al., 2020). Additionally, males tend to have more confidence in their ability to work in the ICT field (Gebhardt et al., 2019).

The interaction between citizens and the government is crucial, and digitalization serves as a channel that facilitates communication between these two parties. From the current study, one can observe an increase in the percentage of individuals using the Internet to interact with public authorities during the analysed period, as well as in the projected period. The accessibility of digital public services is crucial for sustainable development (Burlacu et al., 2019). A study conducted by Kovalenko (2023) has highlighted that certain digital public services are more popular among young people. Facilitating communication for both individuals (Wilson et al., 2019) and legal entities (Glukhikh et al., 2020) with public authorities can be achieved by creating interactive and user-friendly platforms that can be easily used by any citizen, especially for elderly individuals (Palos-Sánchez et al., 2023).

Conclusions

The purpose of this study was to assess the degree to which the concept of digitalization is integrated within the member states of the European Union and to correlate the predicted results with the SDGs. In this sense, five indicators were chosen, the analysis of which reflects the previously mentioned purpose. What could be noted is the fact that there are significant differences between the analysed countries, but at the level of the European Union average, the forecasts made were encouraging for most of the analysed indicators. Moreover, the predicted values for each indicator show a positive impact on the UN SDGs.

The study finds that Denmark has the highest percentage of enterprises that have received orders online, while Ireland has the highest share of enterprises' turnover from e-commerce. Bulgaria, Romania, and Malta have the highest percentage of women working as ICT specialists. Most countries have values that exceed 50% for the percentage of individuals using the Internet for interaction with public authorities. In 2017, Vicente Almonacid and Laurent Franck wrote a study on „Extending the coverage of the Internet of Things with low-cost nanosatellite networks”, and also, according to Couper et al. (2018), 82.9% of the target population of the National Survey of Family Growth have access to the Internet. Thus, also in the case of the EU, most of the member states have a rate of high-speed Internet coverage that exceeds 60%.

A correlogram is also presented, which shows a direct relationship of medium intensity between the percentage of enterprises that received orders online and the percentage of individuals using the Internet for interaction with public authorities, as well as a direct link with a higher intensity between the percentage of enterprises that received orders online and

the share of enterprises' turnover from e-commerce. The strongest relationship found between the analysed data is between the percentage of individuals using the Internet for interaction with public authorities and the share of enterprises' turnover from e-commerce.

According to Ze et al. (2023), ICT promotes economic growth in the long run; also, the results of their study show that financial globalization and digitalization are essential for sustainable growth. The forecasts made show that at the average level of the European Union, there will be an upward trend in the percentage of individuals using the Internet for interacting with public authorities, and also for the share of enterprises' turnover on e-commerce or high-speed Internet coverage. Even if an increase in the percentage of enterprises having received orders online was predicted for the year 2022, a slight decrease can be observed for the next two analysed years. As for the percentage of female employees in the ICT field, there is an increase in this indicator for the forecasted period, with an upward trend also in the period 2014-2021. Since digitalization is one of the pillars of the Recovery and Resilience Facility, it is not surprising the presence of upward trends in the forecast period because the European Union's plan is to build a stronger Union, in which digitization is a very important aspect.

The limitations of the current research are primarily related to the limited number of years taken into analysis. Unfortunately, data could not be identified for a longer time period for indicators in the field of digitalization, which may result in a limited degree of accuracy in the provided results. For future research, there is a desire to identify new data sources in the field of digitalization where the time periods offered are longer, thus ensuring that the obtained results are supported by a higher level of credibility. Additionally, there is an intention to identify and implement models that can provide additional information on the links between the indicators associated with the Sustainable Development Goals, as these are seen as a complex process through which the effects of achieving one target propagate to related targets, aiding in their accomplishment.

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