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The Relationship Between Digital Performance and Production of Greenhouse Gas Emissions in EU Countries: Correlation Analysis and ANOVA Method

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Abstract

Agricultural activities produce the significant amounts of greenhouse gas emission. The importance of an ever-changing climate means that digital technologies and their environmental impact are more frequently discussed in the context of the 5th Industrial Revolution. It is important to minimize environmental threats and reduce production waste on the way to a sustainable path. The main scientific aim of the paper is to examine, based on correlation analysis and ANOVA method, the relationship between two variables, digital performance of individual EU countries expressed by the indicator Digital Economy and Society Index and production of Greenhouse Gas Emissions, specifically how digital technologies affect the environment and how to transform digital technologies to supporting the European Green Deal and accelerate sustainable growth. The reasons are that digital technologies can play an important role in reducing greenhouse gas emissions. According to the results, it has been proven that exists a positive correlation between two variables regarding as a weak correlation between DESI and GHG emissions. Analysis of variance indicates the highly significant differences between variables. Countries with the higher DESI index produce more Greenhouse gas emissions as well but in a weak manner.

Keywords

Agriculture, correlation analysis, digital economy and society index, digital performance, European Green Deal, greenhouse gas.

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Introduction

Today, we can see a typical example of how the COVID-19 pandemic has highlighted the importance of digital asset economies and how networks, data, connectivity, as well as digital skills sustain our economies and societies by allowing us to continue working. Expanding the use of information technology is needed to ensure its proper functioning by adapting to new requirements in line with the EU strategic priorities, but also by linking them to best practice in the field (Bălăcescu et al., 2021).

Digital transformation is not only a single step for upgrading specific functions in an organization, it is an integration of information technologies in process or activity that trigger fundamental changes in organizations. Digital transformation has become the crucial factor to enable organizations to be more competitive, innovative, and prosperous (Feroz et al., 2021). The digital transformation of businesses opens up new opportunities and accelerates the development of new and reliable technologies. The digital transformation depends on the level of the economy (measured by GDP) and the availability of the country's resources. The changing climate attracts more attention to environmental challenges. In response to these, new strategies have been created to protect the health of citizens and transform the economy to be resource efficient. Countries face a big opportunity, where merging the environmental path and economic growth can accelerate competitiveness whether other countries are unwilling to transition to green digital transformation. The leaders of the EU attach importance to the transition of clean digital technologies to becoming greener as a crucial factor for climate and environmental sustainability. The policy alignment of green digital technologies has significant potential and should support digitalization that accelerates environmental protection (European Green Digital Coalition, 2021).

The changing climate is an existential threat to the world. A European Union has presented its main activities to support digital transformation to be greener by using smarter technologies. This initiative strives to achieve a climate-neutral continent by 2050, which is a key objective of the European Green Digital Coalition (European Commission, 2021). Following, digital technologies are a crucial factor in determining climate neutrality and environmental sustainability. We can state that digitalization may be beneficial to the environment in the future. Given the importance of digital technologies in supporting the competitiveness of businesses and the innovative digital economy European Commission created index Digital Economy and Society Index (DESI) to measure the digital competitiveness of European Union (EU) member states. DESI covers five key areas of digital development: connectivity, human capital, use of internet, integration of digital technology, and digital public services. Index provides a comprehensive overview of digital development in the EU and allows member states to benchmark their digital performance and helps to prioritize investments in areas where they lag behind other countries and to assess the impact of their digital policies against other countries. It also serves as a tool for policymakers to identify areas for improvement and to develop policies to enhance the digital competitiveness of their country.

Understanding the relationship between digital economy and greenhouse gas emission can be the critical aspect of economic and social development and can inform policy decisions and help countries achieve sustainable development goals. Digital technologies may offer opportunities to reduce greenhouse gas emissions through improved energy efficiency (optimize energy systems), smart transportation systems, and more effective waste management practices, promote the use of renewable energy sources. All this could lead to a reduction in greenhouse gas emissions.

The greenhouse gas emissions refer to the release of gases such as carbon dioxide, methane, and nitrous oxide into the atmosphere, which contribute to global warming and climate change. Greenhouse gas emissions are typically associated with human activities, such as transportation, electricity generation, industrial processes, and agriculture. While DESI and greenhouse gas emissions are not directly related, there may be some indirect connections between them. For example, a country with a high level of digitalization may have more efficient transportation systems, better energy management, and more effective waste management, which can help reduce greenhouse gas emissions. Similarly, digital technologies can enable the development of smart grids, renewable energy systems, and other solutions to help mitigate climate change.

The first part of the paper deals with a critical analysis of the literature, basically in the area of Digital transformation, European Green Deal and Digital economy and society index. This section mentions the importance of using digital technology in organizations and its benefits for the sustainable future. The next part contains empirical analysis of the relationship between two specific indicators, the Digital Economy and Society Index (DESI), which monitors Europe's overall digital performance and measures the progress of individual EU countries in terms of their digital competitiveness and indicator Greenhouse gas emissions, which measures total national emissions. For data collection process, official European Union reports and for data analysis was used statistical software SPSS Statistics. The final part of the paper concludes the main results of the study and presents the relationship between digital performance and the progress of EU countries with the change in climate and environmental challenges that may turn into opportunities.

Theoretical background

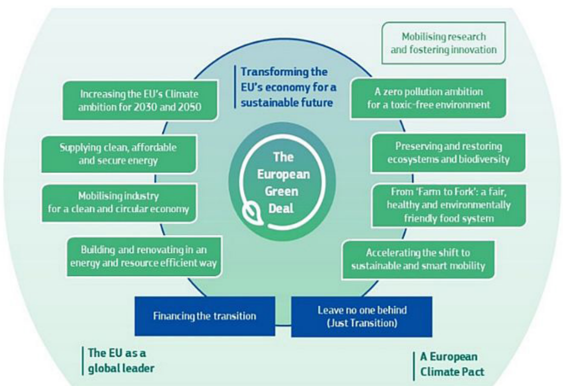
The European Green Deal

Climate change and environmental degradation pose an existential threat to Europe and the world. To overcome these challenges, a Green Agreement for Europe was established to transform the Union into a modern, competitive, resource-efficient economy where these goals are set: it will reach zero net greenhouse gas emissions by 2050; economic growth will be decoupled from resource use, and no individual or region will be left out (Krämer, 2020).

Under the agreement, actually the 27 Member States of the European Union have committed themselves to transforming Europe into the first climate-neutral continent by 2050. This will open up new opportunities to innovate, invest, and create new jobs. Following Franklin Roosevelt's New Deal, based on social and cultural programs to overcome the Great Depression in the 1930s and to promote similar solidarity in a similar way, the European Commission presented the Green Deal of the EU as a 'new growth strategy that aims to transform the EU into a fair and prosperous society' (Ossewaarde and Ossewaarde-Lowtoo, 2020).

The agreements should reduce emissions in the long term, tackle energy poverty, reduce dependence on foreign energy supplies, and improve the health and living conditions of the population. Great emphasis is placed on the environmental area (mainly in the area of reducing CO_2 emissions, reducing greenhouse gas emissions, but also increasing the share of energy from renewable sources), but the required changes can be perceived as a change for a better future with economic and social benefits. Emission reductions are connected with: unemployment rates below 7% and rates of youth unemployment below 15% across EU member states by 2030; strengthening convergence and cohesion; average annual growth rates of EU GDP above 2% until 2030; inflation rates in line with price stability as defined by the ECB; etc. (Wolf et al., 2021).

In Figure 1 we can see elements of the European Green Deal, an integral part of the strategy developed by the current Commission and aimed at, inter alia, implementing the UN 2030 Agenda for Sustainable Development and the Sustainable Development Goals (United Nations, 2020, Wrzaszcz and Prandecki, 2020).



Source: Own processing based on European Commission (2019)

Figure 1: The ambitions of the European Green Deal.

A key goal of the European Green Deal is to make Europe the first climate-neutral continent by 2050, and smarter and greener use of technologies will help it. Technology can improve energy and resource efficiency, facilitate the circular economy, lead to a better allocation of resources; reduce emissions, pollution, biodiversity loss, and environmental degradation. At the same time, the ICT sector must ensure the environmentally sound design and deployment of digital technologies (European Commission, 2021).

From digitization to digital transformation

Digital transformation is considered a comprehensive system that includes the process of digitization and digitalization and embraces the ability of digital technology to capture and analyze data. Digital transformation is an iterative technological process of constant change that leads to automating and optimizing business processes in organizations (Lombardi, 2019).

Digitization

The concept of digitization is handled with automated routines and tasks based on the process of converting data from analogue to digital format. Clerck (2017) pointed out the importance of connecting digitization and automation and highlighted the fact that transforming analogue data to digital format is done for a reason, which is automating business processes and workflows. To measure the benefits of digitization, a report by PricewaterhouseCoopers determined six key attributes. Measuring ubiquity, affordability, reliability, speed, usability, and skills helps to recognize the level of digitization in a company (Sabbagh et al., 2012). The positive impacts of digitization are seen on economic strength, societal well-being, and effective governance. Digitization is not the ultimate aim of digital transformation but is a major milestone to attain in the complex process of digital transformation. Without digitization, neither digitization nor digital transformation can be achieved.

Digitalization

The concept of digitalization uses digital technologies and digitized data (digitized and natively digital) that generally improve the way of communication in organizations. Digitalization generates revenue, improves business processes by their transformation, and creates an environment for digital business, whereby digital transformation is essential. Digitalization is considered the milestone toward a fully digital business using digitized data (processed by digitization) and cutting-edge technologies (El Hilali et al., 2020).

Digitalization can help improve the availability of information on the characteristics of products sold in the EU. For instance, an electronic product passport (e.g. Smart CE marking) could provide information on a product's origin, composition, repair and dismantling possibilities, and end-of-life handling (European Commission, 2021). For the EU organizations to run their business, the driving forces of digitalization are extremely important to accomplish internal communication or share information with business partners, government, and customers. The same driving forces have a tremendous impact on reducing business operating expenditures (OPEX), such as payroll, office supplies, utilities, marketing, or taxes (Trașcă et al., 2019).

Digital transformation

Digital transformation follows the process of digitization and digitalization and is driven by digital technologies where the effect of these enables 'unprecedented things' to be achieved (Brynjolfsson and McFee, 2014). The significant impact of digital transformation on business processes across all industries enables managers to focus on the connectivity of machines and devices to enable operations to be more efficient and quickly respond to market changes (Clerck, 2017). Westerman et al. (2011) define digital transformation as 'the use of technology to radically improve the performance or reach of enterprises'. They identified three axes to focus on in a digital transformation of a given business: customer experience, operational processes, and business model. Rogers (2016) determined five domain strategies that are the most influenced: customer, competition, data, innovation, and value proposition. The authors Uhl and Gollenia (2016) discussed the impact of these and found that the keys to succeed in transforming an organization to fully digital are customer centricity, innovation capability, operational excellence using data capabilities, and competitive mindset.

Digital transformation is expected to have high annual growth, simplify and streamline established processes, ensure higher data security, and increase the company's competitiveness and profitability. To ensure intelligent production, automation is necessary, which leads to the transition to advanced technologies. The synergy of production and information technologies brings great progress (Ustundag and Cevikcan, 2017). A convergence of different digital technologies such as Internet of Things (IoT), additive manufacturing, big data, artificial intelligence, cloud computing, and augmented and virtual reality have made significant progress and moved beyond the ability and understanding of the individual (Rindfleisch et al., 2017; Nambisan, 2017). This development is referred to as the fourth industrial revolution. The advent and widespread adoption of information and communication technologies in various domains of human endeavor have established a connection between the digital economy and novel viewpoints on the drivers that shape its progress and prosperity (Košovská et al., 2022). The process from digitization to a fully digital organization requires a thoughtful approach with a specific plan, a list of stakeholders, identified benefits, but also with potential complications.

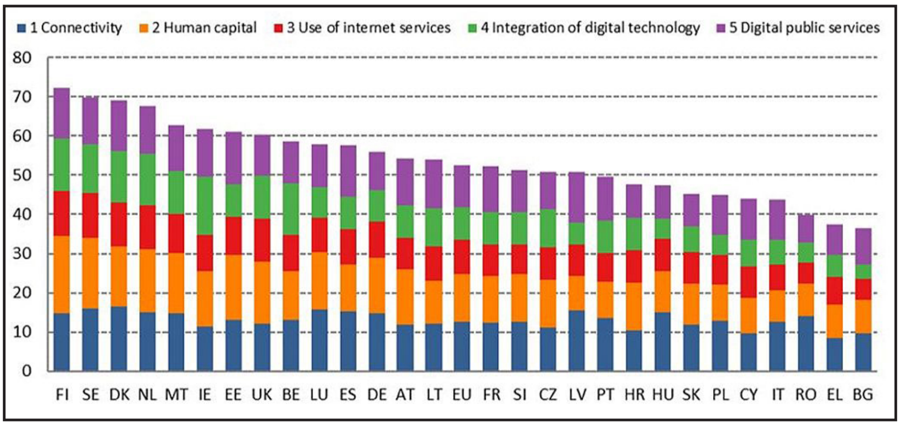
Digital Economy and Society Index

To characterize and compare the progress of individual countries of the European Union, it is used in digitization the Digital Economy and Society Index (DESI). It is a composite index that summarizes relevant indicators on Europe's digital performance and tracks the evolution of EU member states across five main dimensions. Through DESI, we can monitor Europe's overall digital performance and track the progress of EU countries in digital competitiveness. By providing data on the state of digitization of each Member State, it helps them identify areas requiring priority investment and action. DESI country reports contain quantitative data obtained from DESI index indicators in all its five dimensions (which group 37 indicators overall), knowledge of country policies and best practices:

- Connectivity – Fixed broadband take-up, fixed broadband coverage, mobile broadband, and broadband prices;
- Human capital – Internet user skills and advanced skills;
- Use of Internet – Citizens' use of Internet services and online transactions;
- Integration of digital technology, business digitization, and e-Commerce;
- Digital public services – e-Government.

The ranking of member states in the Digital Economy and Society Index for 2020 is shown in Figure 2.

As we can see in Figure 2, the most advanced digital economies in the EU are Finland, Sweden, Denmark, and the Netherlands. On the other hand, Bulgaria, Greece, Romania, and Italy have



Source: European Commission (2020)

Figure 2: Digital Economy and Society Index 2020.

the lowest scores on the index. Based on data before the pandemic, the Czech Republic is the strongest in the integration of digital technologies, where its results exceed the EU average. The score here is high due to good results in the field of electronics trade. The share of people employed in the field of information and communication technologies and the number of graduates in this field has grown significantly (European Commission, 2020).

Materials and methods

According to the aim of the paper, research of the relationship between two indicators, DESI index and Greenhouse gas emissions is provided. Investigating the relationship between the DESI index and greenhouse gas emissions can help identify areas where digital technologies can be leveraged to address climate change and reduce environmental impact. For example, digital platforms can enable the sharing of resources and reduce the need for physical travel, while remote work and virtual meetings can reduce emissions from transportation.

The DESI was developed according to the guidelines and recommendations in the OECD Handbook on the construction of composite indicators: methodology and user guide. The data collection process for the Digital Economy and Society Index (DESI) is conducted by the European Commission, in collaboration with national statistical offices and other relevant stakeholders. The process involves the collection of data from various sources, including surveys, administrative data, and statistical databases. The European Commission selects a set of indicators that are relevant for measuring the digital competitiveness of EU member states. These indicators are grouped into five categories: connectivity, human capital, use of internet, integration of digital technology, and digital public services. The data is validated and checked for errors and inconsistencies to ensure the quality and accuracy of the data and aggregated and calculated to produce scores for each indicator and overall scores for each category and country. The data collection process for DESI is conducted on an annual basis, with the results being published in the form of a report that provides an overview of the digital competitiveness of EU member states. The report also includes recommendations for policymakers and other stakeholders to improve the digital development of their country. The limitation of the index DESI is that measures the digital competitiveness of EU member states, and therefore does not provide insights into the digital development of non-EU countries. This limits the usefulness of DESI for businesses and policymakers interested in global digital trends.

The total DESI score for each country consists of the results of five areas. There are overall weights attributed to the main dimensions of DESI, which reflect the priorities of EU digital policy. The indicators for each area are as follows:

Connectivity (25 %): Overall fixed broadband take-up; At least 100 Mbps fixed broadband take-up; Fast broadband (NGA) coverage; Fixed Very High-Capacity Network (VHCN) coverage; 4G coverage; Mobile broadband take-up; 5G readiness; Broadband price index.

Human capital (25 %): At least basic digital skills; Above basic digital skills; At least basic software skills; ICT specialists; Female ICT specialists; ICT graduates.

Use of Internet services (15 %): People who never used the internet; Internet users; News; Music, videos and games; Video on demand; Video calls; Social networks; Doing an online course; Banking; Shopping; Selling online.

Integration of digital technology (20 %): Electronic information sharing; Social media; Big data; Cloud; SMEs selling online; e-Commerce turnover; Selling online cross-border.

Digital public services (15%): e-Government users; Pre-filled forms; Online service completion; Digital public services for businesses; Open data.

The DESI index was used from the European Commission report for the years 2020, 2019 and 2018. Results 2020 report data for the year 2019. The United Kingdom is still included in the 2020 DESI, and EU averages are calculated for 28 Member States. Data on greenhouse gas emissions were used for comparison with the DESI index, given that there is an effort to reduce them in the future, as mentioned in the European Green Deal (European Commission, 2020).

Greenhouse gases are those that trap heat in the atmosphere. Carbon dioxide (CO_2) is the main greenhouse gas emitted by human activity. The main human activity that emits CO_2 is the burning of fossil fuels (coal, natural gas and oil) for energy and transport. Changes in CO_2 emissions from the combustion of fossil fuels are influenced by many long-term and short-term factors, such as: population growth, economic growth, changing energy prices, new technologies, etc. The general procedure for calculating greenhouse gas emissions from fossil fuels (in this case, natural gas) according to the U.S. Environmental Protection Agency (EPA) is as follows:

- Determine the amount of natural gas consumed (in units of volume or weight).
- The hydrocarbon content of the natural gas is determined. As a rule, standard emission factors for each type of hydrocarbon are used.
- Calculate the total amount of carbon dioxide (CO_2) produced by the combustion of natural gas, as: Amount of natural gas consumed (in units of volume or weight) x emission factor for the hydrocarbon type x CO_2 emission factor for the hydrocarbon type (United States Environmental Protection Agency, 2021).

Then correlation is used to describe the linear relationship between two continuous variables, DESI index and Greenhouse gas emissions. The digital economy has the potential to play an important role in reducing greenhouse gas emissions by enabling more efficient and sustainable ways of working and living. By using correlational analysis to explore the relationship between DESI and greenhouse gas emissions, we can identify whether there is a correlation between digital development and reduced emissions. If we find a negative correlation between these two variables, we can infer that states with higher levels of digital development tend to use energy more efficiently, which could lead to lower greenhouse gas emissions. This can provide valuable insights for policymakers and businesses looking to develop strategies for reducing emissions while promoting economic growth.

The correlation coefficient is measured on a scale that varies from + 1 to 0 to – 1. The complete correlation between two variables is expressed by either + 1 or -1. Very relation labels the strength of association for absolute values of r 0-0.19. Regarded as a weak correlation is the strength of correlation for absolute values of r 0.2-0.39, 0.40-0.59 as moderate, 0.6-0.79 as a strong, and 0.8-1 as very strong correlation. When one variable increases, as the other increases the correlation is positive; when one decreases as the other increases, it is negative. The complete absence of correlation is represented by 0. In terms of research, a correlational study is generally used to study quantitative data and determine trends between the DESI index and Greenhouse gas emissions. The correlational study helps to isolate the variables and identify the interaction between them. For the purpose of the study, a statistical software SPSS Statistics is used. The statistical method, analysis of variance (ANOVA), determines if there are statistically significant differences between selected variables based on the variance observed between them. ANOVA is based on the assumption that the data being analyzed is normally distributed, and that the variances of the groups being compared are approximately equal (Kaufmann and Schering, 2014). A p-value index measures the probability that the observed difference may occur by chance. The lower the p-value indicates the low probability of null hypothesis. In other words, the null hypothesis has a low support in the observed data and should be rejected.

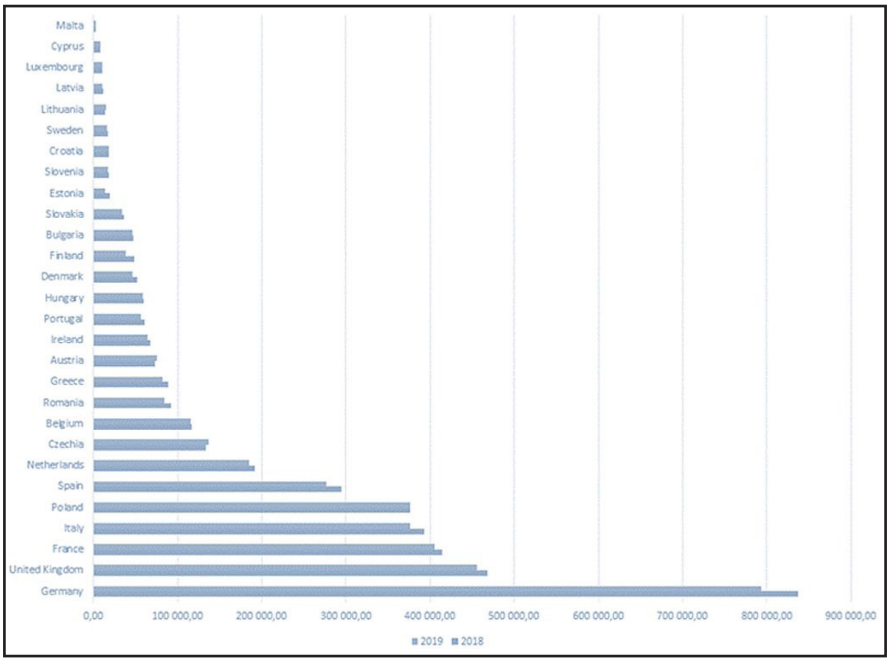
Results and discussion

Over the past 20 years, Greenhouse gas emissions, especially from fossil fuels and industry, have been continuously increasing. At the beginning of the century, global emissions were roughly 23 billion metric tons, but by 2018 they had reached a record high of 43.91 billion metric tons. In 2019, the reduction of emissions was affected by COVID-19, which amounts to an unprecedented 2,500 million metric tons worldwide. Most countries around the world were put under strict lockdowns, meaning transportation and industrial activities were significantly reduced. This was mainly due to the strict lockdowns put in place.

Figure 3 presents the comparison of greenhouse gas emissions in the European Union 28 in 2018 and 2019. The member states are ranked according to their level of greenhouse gas emissions from the countries with the least pollution (Malta, Cyprus, and Luxembourg) to the largest polluters (France, Germany, and the United Kingdom).

At first glance, it might seem that emissions are largely related to a country's development and living standards. However, this is not entirely true. For example, many highly developed countries in Europe have relatively low greenhouse gas emissions, for example Sweden, Luxembourg, or Finland. There are several potential factors, influencing the production of greenhouse gas emissions: climate and geography, energy efficiency, carbon pricing and policies, lifestyle and culture and investment in innovation. While Finland and Sweden have colder climates and rely heavily on renewable energy sources like hydroelectric power, wind power, and biomass, which emit fewer greenhouse gases than fossil fuels, then Germany relies heavily on coal for its energy needs and renewable energy sources such as wind and solar power still make up a relatively small proportion of the country's energy mix. Germany has a large and diverse manufacturing sector, including industries such as steel, cement, and chemicals, which are energy-intensive and produce significant greenhouse gas emissions.

Highly developed countries such as Denmark and Sweden have more efficient buildings, transportation systems, and industrial processes, which can reduce energy consumption and emissions. Denmark is known for its energy-efficient buildings, which use a combination of insulation, ventilation, and renewable energy sources to reduce energy consumption. The country also has a strong public transportation system, including a network of cycling paths and a well-developed public transit system in its capital city, Copenhagen. Sweden has made significant investments in energy efficiency and renewable energy, particularly in its buildings sector.

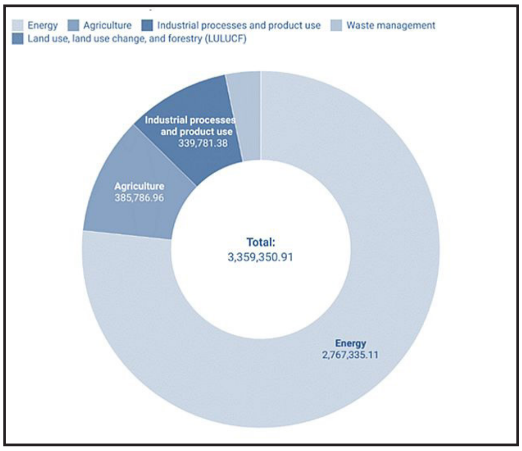


Source: Own processing based on Eurostat (2021)

Figure 3: Comparison of greenhouse gas emissions in thousand tons in EU 28 in 2018 and 2019.

In 2019, emissions have decreased across all sectors, which is particularly attributed to the effect of the global pandemic COVID-19. The largest producer of greenhouse gases in the European Union is, in absolute terms, Germany, which is also the most populous country in the Union. In the coming years, improvements in energy efficiency are expected to be the main driver of the decline in overall greenhouse gas emissions. Due to technological innovations, less energy was consumed while more goods and services were produced. Furthermore, the energy consumed relied relatively less on carbon-intensive fuels and more on renewables. The EU has decoupled its economic growth from greenhouse gas emissions, as these technical developments make it possible to increase economic growth while generating fewer emissions.

To better understand the driving forces behind the reduction in GHG emissions is projected in Figure 4 to see more detail on the sources of human activities. Figure 4 shows GHG emissions broken down by source sectors classified by emitting economic activities. Eurostat statistics recognize five key sectors: Agriculture; Energy; Waste management; Industrial processes and product use; Land use, land use change, and forestry.



Source: Own processing based on Eurostat (2021)

Figure 4: Global Greenhouse gas emissions by source sector in thousand tonnes in EU 28 in 2019.

The primary source of GHG emissions is the energy sector (27.67 billion metric tons), and global energy demand is expected to continue to increase in the coming decades, as populations and economies grow. Agriculture sector produces 3.8 billion metric tons and Industrial processes and product use produce 3.39 billion metric tons. Despite the decline in GHG emissions in 2019, we expect a continuous decline in GHG emissions in coming years. In the energy sector, there are significant interventions that will lead to climate change in general.

For each year, 2018 and 2019, the correlation coefficient (R) and the determination coefficient (R Square) between DESI and GHG emissions were calculated separately. Table 1 illustrates the summary of the model.

Regarding the correlation coefficient, there is an existing correlation between the considered variables, but a positive linear correlation is weak between DESI and GHG emissions. The estimated value of the determination coefficient is 0.065 in 2018 and 0.045 in 2019, which means that the proportion of variation of GHG emissions is 6,5% explained by the variation of DESI in 2018 and the variation of GHG emissions is 4.5% explained by the variation of DESI in year 2019.

According to Table 2, statistical analysis of variance (ANOVA) was used to compare the means of the observed variables using SPSS software. It involves calculating the sum of squares (SS) for each group, which measures the amount of variation in the data that can be attributed to differences between groups. We are to statistically evaluate whether the increase in the average of GHG emission values has been influenced by the DESI index in or whether it is only a random phenomenon. Thus, we test the null hypothesis that the mean values of all groups are equal, and we perform the testing on the basis of an analysis of the relationships between the variances in the individual groups.

Model Summary 2018 and 2019								
Model	R	R Square	Adjusted R Square	Change Statistics				
				R Square Change	F Change	df1	df2	Sig. F Change
2018	0.255	0.065	0.029	0.065	1.802	1	26	0.191
2019	0.213	0.045	0.009	0.045	1.236	1	26	0.276

Source: Author´s calculation (2022)

Table 1: Model Summary 2018 and 2019.

Source of Variation	SS	df	MS	F	P value	F criteria
Between Groups	14901.34	1	14901.34	381.88	0.0000	4.02
Within Groups	2107.124	54	39.02082			
Total	17008.46	55				

Source: Author´s calculation (2022)

Table 2: ANOVA.

The P-value determines the probability that the difference may occur by chance. In Table 2, the significance of the factor is $p < 0.001$. There is a statistically significant level of observed variables. The low level of the p-value means that in 99.99% of the occurrences the correlation is weak. The null hypothesis has very little support in the observed data and can be rejected at the significance level $\alpha = 0.05$.

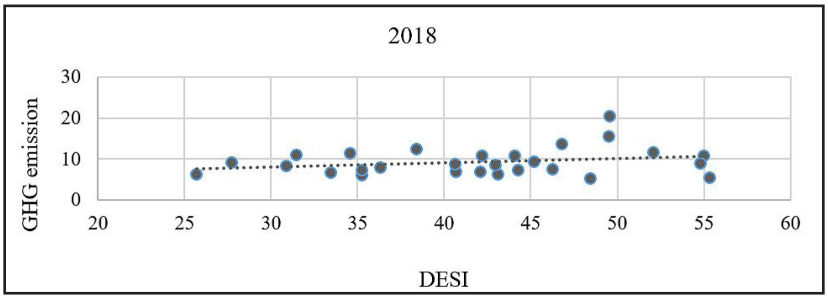
To understand how digital technologies influence the environment and to recognize the importance of transitioning digital technologies to support The European Green Deal and accelerate sustainable growth, we analyzed aspects of Greenhouse gas emissions and the Digital Economy and Society Index (DESI). Correlation analysis explains the significance of linear correlation based on assumption; if there is a change in one variable, this will reflect in the other, based on the dependence of each other. The correlation coefficient measures the strength of two continuous variables. This analysis follows the assumption that a higher degree of digitization should improve environmental aspects. To complement the calculation results, a graphical representation of these relationships in individual years is also given.

Carbon dioxide is mostly associated with global climate change, which will lead to global warming in the next decades. The DESI index reflects the pace of technology and development and the extent of digital transformation in the country. A positive correlation between variables indicates a positive relationship. If one variable increases, the other variable increases too. Weak correlation means that the two variables of interest have a weak linear relationship and when one variable increases the other variable increases as well but in a weak manner.

An outlier country of Germany (DE) is a point that does not fit the general trend of the data set. Finland, Sweden, Denmark, and the Netherlands are leaders in the digital performance in the European Union (European Commission, 2020). Countries with the highest values of Greenhouse gas emissions (Germany, UK, and France) display a medium or low score of digital performance. In 2019, Germany is an outlier of the linear trend line despite the 6 % decline in emissions year on year. The reduction in emissions is primarily caused by the COVID-19 pandemic that pushed down the use of fossil fuels. Malta ranks 6th out of the 28 EU countries in the Digital Economy and Society Index in 2019 and reduces GHG emissions year per year.

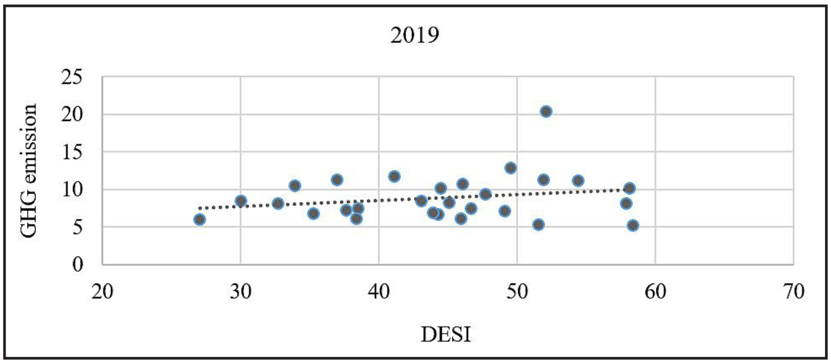
Digitization is a key factor in increasing energy and material efficiency. The Internet supports logistics, and artificial intelligence can help optimize and streamline processes. For many sectors, this is a simple step in business activities, but one of the most problematic sectors in terms of reducing emissions is the transformation of the food system and agriculture. In addition, it will be difficult to introduce more sustainable agricultural practices around the world. The main obstacles that can slow down progress are, in particular, poor spatial planning and regulation, a focus on rapid profits, insufficient funding, or a lack of knowledge. This can be a topic for further discussion, for further research within a specific industry.

The findings of this study have to be seen in light of some limitations. DESI indicator measures the digital competitiveness of EU member states, and therefore does not provide insights into the digital development of non-EU countries. The second limitation of the research can be the causation. While it may be possible to identify a correlation between DESI indicators and greenhouse gas emissions, establishing a causal relationship between the two can be challenging. There may be other factors, such as economic development or population growth, that contribute to greenhouse gas emissions, making it difficult to attribute changes solely to changes in DESI indicators.



Source: Own processing based on European Commission data, 2021

Figure 5: Correlation analysis of Greenhouse gases and DESI, 2019.



Source: Own processing based on European Commission data, 2021

Figure 6. Correlation analysis of Greenhouse gases and DESI, 2019.

Conclusion

Despite the fact that climate fluctuations have always occurred in the past, today's pace and scale changes are alarming. The goal is to make Europe the first continent to be connected by oil-independent transport, houses that do not waste energy, electricity produced mainly from renewable sources, environmentally friendly agriculture, and an industry based on innovative technologies and energy-effective processes. The member states of the European Union have committed themselves to making Europe a carbon-neutral continent by 2050. After this year, they will only emit enough emissions to eliminate them. By achieving carbon neutrality, the EU wants to contribute to the global fight against global warming, to which it has committed itself by signing the Paris Climate Agreement.

At present, when businesses and countries are dealing with the aftermath of Covid-19, digitalization is currently one of the most important trends that change society and business. Therefore, attention needs to be paid to digital performance and to digital competitiveness as one of the EU's priorities. Based on the DESI index, we can compare countries in the level of digital performance. The results for 2020 show that the most advanced digital economies in the EU are Finland, Sweden, Denmark, and the Netherlands.

In connection with the European Green Deal and its future goals, we focused on the connection between digital technologies (digital performance) and the reduction of Greenhouse gases, whether there is a relationship between countries with high levels of digital performance and a downward trend in emissions. Empirical research reveals that, based on the correlation coefficient in 2018 and 2019, there is an existing correlation between the variables considered, but positive linear correlation is weak between DESI and GHG emissions. When one variable increases, the other variable tends to increase as well, but in a weak or unreliable manner. According to the aim of this paper, the hypothesis is rejected. The countries with a higher DESI index produce more greenhouse gas emissions as well, but in a weak manner. Although the analysis of variance indicates the highly significant differences between variables, there is a need to assess where these differences occur, which requires the follow-up analysis called post hoc analysis. Even though, based on the information found, the paper does not provide confirmation of a strong positive relationship between the two variables under study and the calculated low value of the correlation coefficient informs of a weak relationship, this finding may provide a basis for further research. Another research of the correlations can be done, for example, by means of regression analysis. Therefore, based on our results, we cannot say that countries with high level of digitalization have low GHG emissions. Countries with the highest values of Greenhouse gas emissions (Germany, France and Poland) display a medium or low score of digital performance. For example, Germany is the largest emitter of Greenhouse gas in the European Union, which is also the most populous country in the Union and does not fit the general trend of the dataset with medium score of DESI index.

Nonetheless, these results must be interpreted with caution and a number of limitations should be borne in mind such as limitation on European countries only and establishing a causal relationship between the two.

In the future, it would be advisable to continue to monitor the relationship with other evidential bases proving the dependence of observed variables and evaluate their development also due to restrictions of the European Green Deal. These findings can support the correlation.

The pandemic has clearly shown us that digital services are our future. The goal for the near future will be to strengthen Europe's capacity for new digital technologies that can help optimize production, reduce emissions and waste, boost organizations' competitive advantages, and bring new services and products to consumers. Digital technologies should be a key factor in determining climate neutrality and environmental sustainability. We can state that digitalization will be beneficial to the environment.

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