

Analysis of the Connection Between the Digital Economy and Society Index and Economic Growth. The case of Romania

Alina CRISMARIU (SOMITCA)

Stefan cel Mare University of Suceava, Suceava, Romania
e-mail: somitca.alina@usm.ro

Sorin SOMITCA

Stefan cel Mare University of Suceava, Suceava, Romania
e-mail: sorin.somitca@gmail.com

Elena HLACIUC

Stefan cel Mare University of Suceava, Suceava, Romania
e-mail: elena.hlaciuc@usm.ro

Correspondence should be addressed to: Alina CRISMARIU (SOMITCA); somitca.alina@usm.ro

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Abstract

Nowadays the concept of digitization is found in all areas of economic life and has become a necessity more than a trend, a focus at European level and a determining factor of economic growth. For this reason, starting with 2015 at EU level, the Digital Economy and Society Index is calculated, a complex index, which incorporates five components considered essential for assessing the size of the digital economy. The Digital Economy and Society Index includes five main components: connectivity, human capital, internet use, digital technology integration, digital public services. In this paper we intend to determine the connection between the five main components of Digital Economy and Society Index and economic growth in Romania. In this sense we used data series for the period 2015 - 2020 and as a research method we used simple linear regression. This analysis aims to highlight the level at which Romania is within the 28 EU states, as well as to highlight the role that the components of the digital economy and society have in economic growth. This analysis is useful in order to determine the level at which our country is compared to European Union countries and to identify which component of the Digital Economy and Society Index has a significant influence on economic growth. Last but not least, based on the conclusions obtained, it is possible to determine the measures to be taken and especially the vulnerabilities that hinder the performance of digitization.

Keywords: DESI, digital economy, GDP, economic growth, simple linear regression.

JEL classification: O30, O47, O52

Introduction

The concept of digitalization or digital transformation can be defined as the totality of “changes associated with the application of digital technology in all aspects of human society” (Bejinaru, 2013). "Nowadays, digital technologies are transforming every area of economic and social life" (Smada & Cristescu, 2020) and the public sector is no exception.

In this context, digital skills are playing a key role from a dual perspective: to benefit from modern technologies, but also as a mandatory requirement for the labor market. The rapid evolution of technology, as well as its presence in all areas, turns digital competence into a basic competence, a primary need necessary for integration into society. For this reason, the training of digital skills should be a priority for decision-makers, regardless of hierarchical level. There are several areas for action, which decision-makers should focus on in order to benefit from digitization, and the key is collaboration with other stakeholders. The directions that should be followed are shown in figure no. 1.



- Training skills for the future, including training young people
- Promoting lifelong learning and stopping the "brain drain."
- Supporting the adoption of technology by the public sector.
- Supporting the adoption of technology by the private sector.
- Strengthening regional cross-border digital collaboration.
- Improving the ecosystem for start-ups.

Figure no. 1 - Directions for decision-makers to digitize

Source: McKinsey Global Institute - *The rise of Digital Challengers, How digitization can become the next growth engine for Central and Eastern Europe* available at:
<https://www.mckinsey.com/~media/McKinsey/Featured%20Insights/Europe/Central%20and%20Eastern%20Europe%20needs%20a%20new%20engine%20for%20growth/The-rise-of-Digital-Challengers.ashx>

Digitization is also a priority for the European Union, which has launched the Digital Europe program, part of the EU budget for 2021-2027. With an allocated budget of 7.5 billion euros, the stated aim of this program is to "accelerate the recovery and drive of Europe's digital transformation."¹ "Digital Europe "also aims to build the EU's strategic digital capabilities and facilitate the widespread deployment of digital technologies for use by European citizens, businesses and public administrations²".

Literature Review

Ben et al. (2017) say that the development of the digital economy and society is a priority for the European Commission, in order to keep up with countries such as the USA, Japan and South Korea. De Groen et al. (2017), Ben et al. (2017), Urban and Hoskova –Mayerova (2017) consider that this is the result of the DESI development index, a tool that quantifies the level of technological development at macro and micro level. Bumbac and Vasilcovschi (2016) analyzes the evolution of digitalization in EU Member States and especially the case of Romania in order to provide ways to recover the gap between them. The conclusion of this study is that the evolution of the Internet and the development of IT technologies have become an instrument of economic growth on which the European Union should focus. Cosmulese et al. (2019) considered that it is necessary to assimilate European approaches in the field of digital evolution. Also Gherman et al. (2021) highlights that “a very important feature of our age is certainly the accelerated evolution of the technological field” and Kholiavko et al. (2021) “the central role in the development of the economy is given to knowledge and their transfer between the various subsystems.”

Burlacioiu et al. (2018) compare the pattern of digital technology in Romania with the countries of the European Union, starting from the volumes of the DESI index for the period 2017-2018. The conclusion of the study is that special attention should be paid to the impact that digital technologies have on young people in Romania in order to compensate for the lack of digital skills of the population. Stoica and Bogoslov (2017) consider that “Romania faced many challenges” and „it managed to perform better from period to period”. The study shows that the progress obtained by Romania is not sufficient to cover the country's digital skills deficit. The study by Karnitis (2019) et al. determines the key factors of digitization, priority investment areas that can provide the most dynamic socio-economic progress, as well as return on investment. The digital economy as a result of the "interaction between the personal computer, telecommunications, the internet and electronics"³.

„One of the most extraordinary achievements of humanity in recent years is technology”⁴ and “digital skills need to be developed and schools must also be supported in that they need to have access to high-speed connections and have tools available to help young people learn in a digital environment.”⁵ Bakumenko and Minina’s (2020) study conducted an analysis of the impact that digital technologies have on GDP using two study groups, developed countries that have a significant share of services in their economy, as well as investments in high-tech products, and the other group involved twenty-three countries, mainly represented by developing countries, which still have a large share of production in GDP.

Research Methods Used

The aim of the research is to highlight the relationship between the components of DESI (connectivity, human capital, internet use, digital technology integration, digital public services) and economic growth using the case of Romania, in the period 2015-2020. The analyzed period was imposed by the availability of data, DESI being calculated only from 2015. „In order to measure economic growth, the gross domestic product (GDP) is considered the most important macroeconomic factor.”⁶ The data used in our analysis were collected as follows: DESI values are taken from <https://digital-agenda-data.eu/> and GDP value from <http://uis.unesco.org/>. The data were analyzed using econometric modeling using Excel. The first step in our analysis is to determine whether the DESI and GDP components are associated, as well as the degree of association between them using the correlation matrix. Finally, using econometric modeling in Excel we performed a regression analysis, which allows certain predictions in our case to estimate a value of the GDP variable when we have a value of the associated variable, namely the DESI components.

Our research is quantitative and aims to demonstrate and emphasize the importance of digitalization and digital technologies in ensuring economic growth. We can also say that it falls within the positive theory, and the tool used is the case study. The hypothesis of the study is that the level of digitalization influences the national economic growth.

Basic Content of the Paper

The Digital Economy and Society Index (DESI) is a global index calculated by the EU in 2015, which incorporates five components considered essential for assessing the size of the digital economy. Figure no. 2 captures the components of each share in DESI.

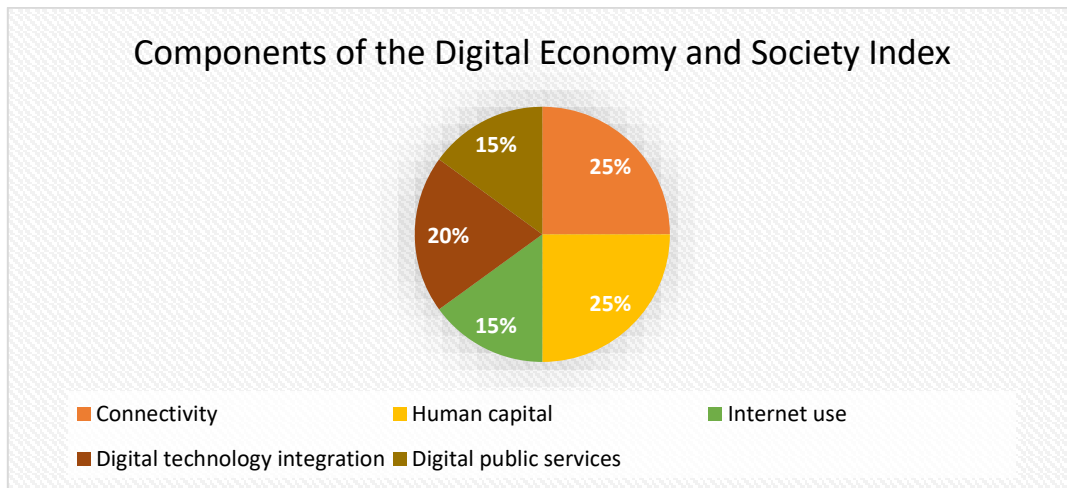


Figure no. 2 – Components of the Digital Economy and Society Index

Source: Processing after Digital Economy and Society Index available online at <https://digital-agenda-data.eu/datasets/desi/visualizations>

The 5 elements incorporated in DESI are in turn decomposed into sub-dimensions, listed in figure no. 3.

1. Connectivity	2. Human capital	3. Use of internet services	4. Integration of digital technology	5. Digitization of public services
<ul style="list-style-type: none"> 1a - Fixed broadband operation 1b - Fixed broadband coverage 1c - Mobile broadband coverage 1d - Broadband price index 	<ul style="list-style-type: none"> 2a - Digital skills 2b - IT specialists 	<ul style="list-style-type: none"> 3a - Use of internet services 3b - Online activities 3c - Transactions 	<ul style="list-style-type: none"> 4a - Business digitalization 4b - Electronic commerce 	<ul style="list-style-type: none"> 5a - E-Government

Figure no. 3- DESI sub-dimensions

Source: Processing after Digital Economy and Society Index available online at <https://digital-agenda-data.eu/datasets/desi/visualizations>

Next, we will analyze the values of the DESI index at global level for 2020, but also at the level of the component elements, by relating its value for Romania to the values of the EU member states.

Thus, the data on the index of the digital economy and society for 2020 place Romania on the 26th place out of the 28 Member States, weaker positions registered only by Greece and Bulgaria, as can be seen in figure no. 4.

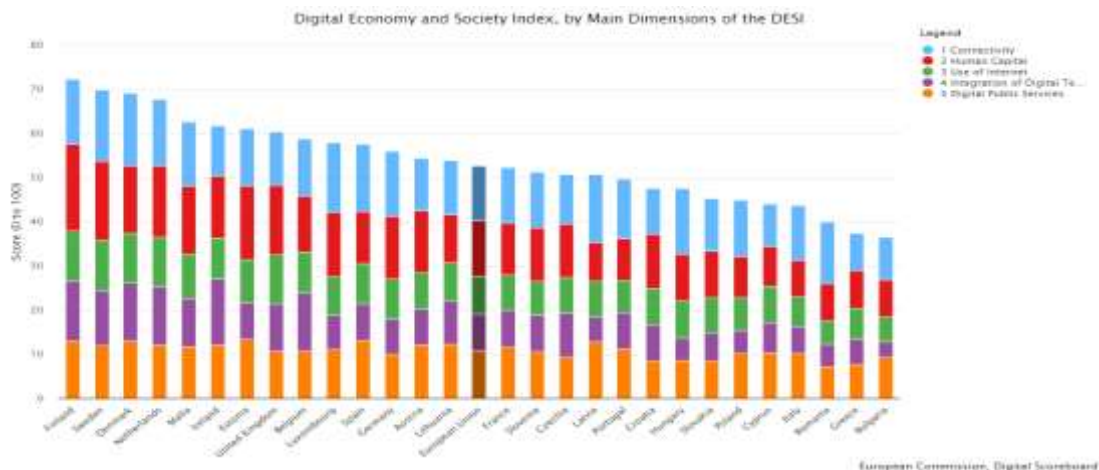


Figure no. 4 - The DESI index at European level

Source: Digital Economy and Society Index available online at <https://digital-agenda-data.eu>

Analyzing the main components of DESI, we find that in terms of connectivity, Romania ranks 11th, a very good position among European countries, which is explained by the use of broadband internet and very high speeds. This can be seen in figure no. 5.

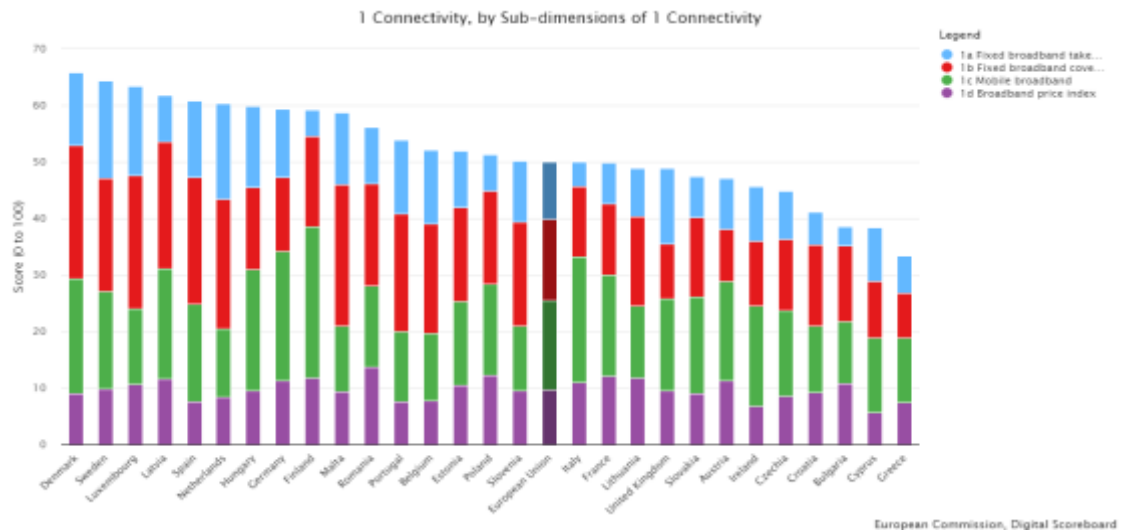


Figure no. 5 - Connectivity in the EU

Source: Digital Economy and Society Index available online at <https://digital-agenda-data.eu>

Things are not as good in terms of Human Capital, the second component, which reflects the digital skills of the EU population, at training levels. Romania obtained a score of 13.6 for 2a - digital skills, respectively 19.5 for 2b - IT specialists, occupying the penultimate place in Europe. Finland ranks first in this respect with double values for the two sub-dimensions, respectively 38.2 for 2a and 40.2 for 2b. Figure no. 6 suggestively illustrates Romania's position.

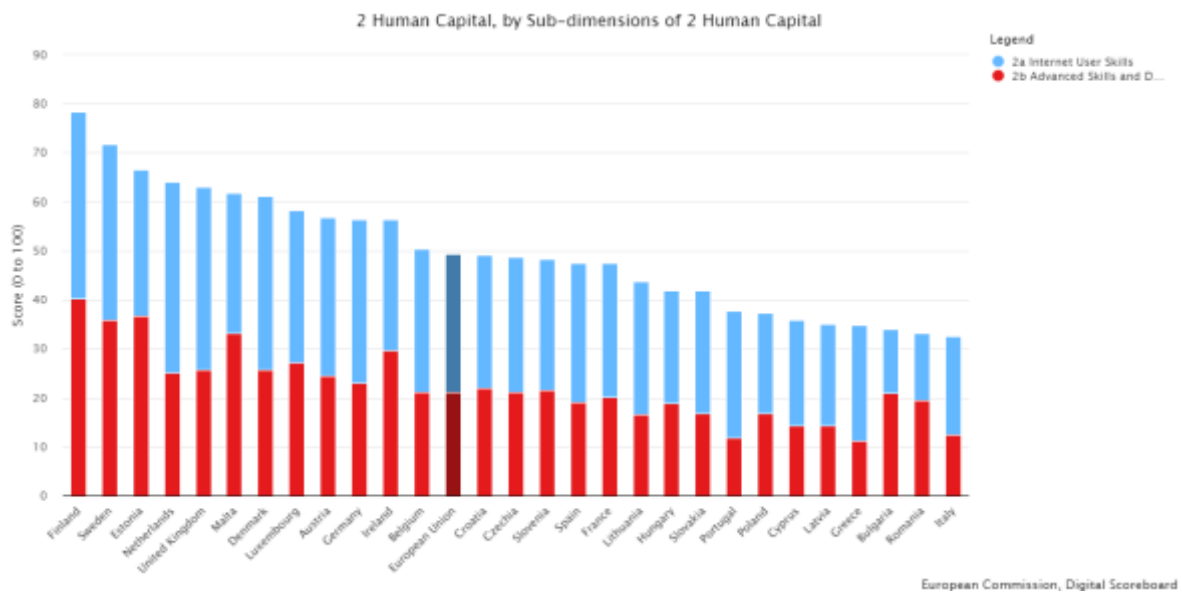


Figure no. 6 - The Human Capital Component in the EU

Source: Digital Economy and Society Index available online at <https://digital-agenda-data.eu>

The third component of DESI, the use of internet services, places Romania on the last place in Europe, according to EU data. Thus, even if our country benefits from a good connectivity, translated by high speed, the use of internet services are at the lowest level in Europe. The situation is similar for all three subcomponents (3a - use of internet services, 3b - online activities and 3c - transactions), as can be seen in figure no. 7.

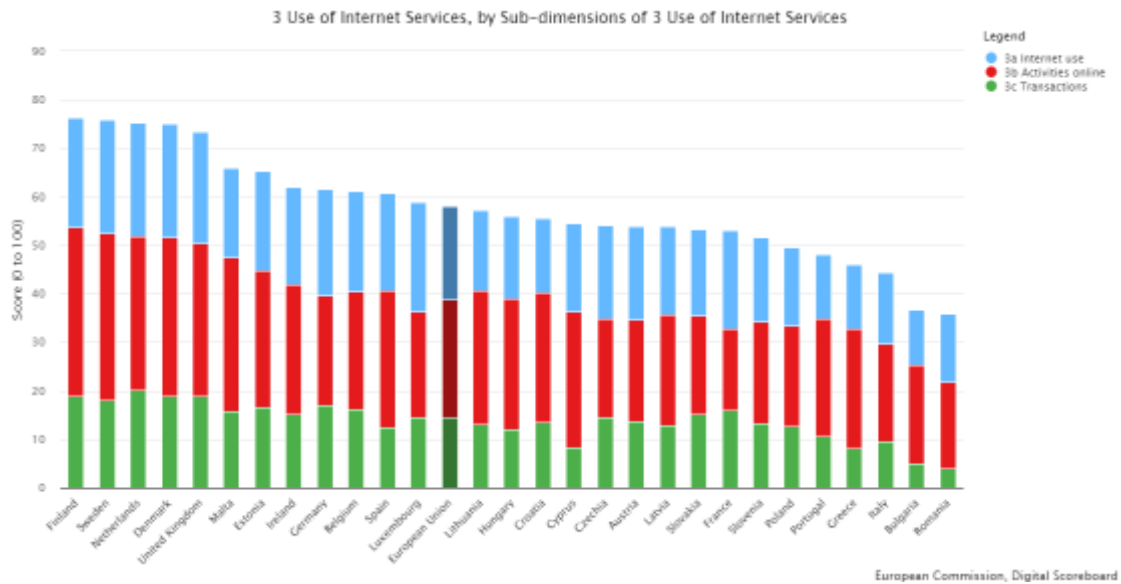


Figure no. 7 - DESI component - Internet use

Source: Digital Economy and Society Index available online at <https://digital-agenda-data.eu>

The evaluation of the fourth component element of the DESI index - the integration of digital technologies - places our country on the 27th place out of the 28 states. Thus, Romania registers a low score in terms of business digitalization, but also of electronic commerce, as can be seen in figure no. 8.

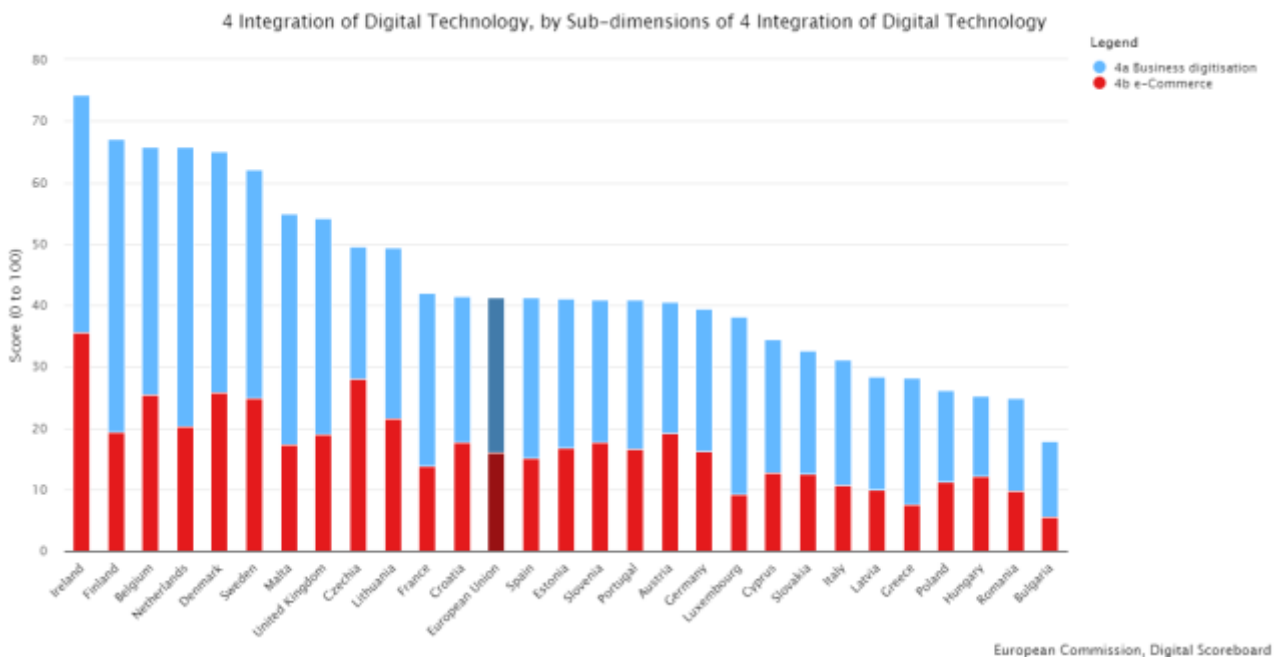


Figure no. 8 - DESI component - Integration of digital technologies

Source: Digital Economy and Society Index available online at <https://digital-agenda-data.eu>

Regarding the digitalization of public services, the last component of DESI, Romania is on the last place among the analyzed countries, which denotes a weak digitalization of the public sector. As can be seen in figure no. 9, the best score is obtained by Estonia, considered the most digitized country in Europe, 99% of the public services of this country being provided online.

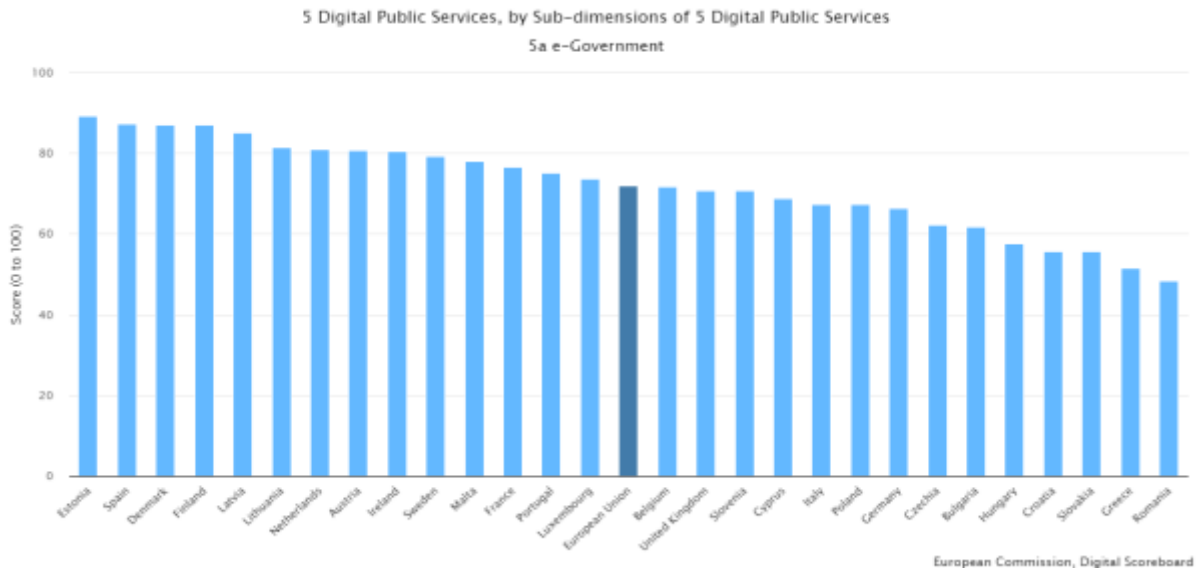


Figure no. 9 - DESI component - Use of public services

Source: Digital Economy and Society Index available online at <https://digital-agenda-data.eu>

As we can see, out of the five dimensions analyzed, only the first dimension - connectivity - places Romania in the first half of the ranking, and the others on the last places in Europe. As a conclusion of this report regarding the situation in Romania, we can say that despite the fact that we have an increased connectivity of internet services, the part of their implementation and exploitation is deficient.

Next, starting from the DESI values, we want to analyze the connection between the five dimensions and the economic growth, expressed by GDP per capita for Romania. DESI values are taken from <https://digital-agenda-data.eu/> and GDP value from <http://uis.unesco.org/>. Our analysis takes into account the period 2015-2020 because the DESI index is calculated starting with 2015.

In our study we start from the hypothesis that the level of digitalization influences the national economic growth. We will use simple linear regression to determine the influence that each dimension has on Romania's GDP and we will use abbreviations from table no. 1.

Table no. 1 - Abbreviation of the variables used

<i>Variables</i>	<i>Abbreviation</i>
<i>GDP per capita</i>	<i>GDP per capita</i>
<i>1. Connectivity</i>	<i>desi_1_conn</i>
<i>2. Human capital</i>	<i>desi_2_hc</i>
<i>3. Using the internet</i>	<i>desi_3_ui</i>
<i>4. Integration of digital technologies</i>	<i>desi_4_idt</i>
<i>5. Digitalization of public technologies</i>	<i>desi_5_dps</i>

Source: own processing

The first step in our approach is to determine the degree of correlation between our variables. The result is highlighted in table no. 2.

Table no. 2 - Correlation matrix

	<i>desi 1 conn</i>	<i>desi 2 hc</i>	<i>desi 3 ui</i>	<i>desi 4 idt</i>	<i>desi 5 dps</i>	<i>GDP per capita</i>
<i>desi 1 conn</i>	1					
<i>desi 2 hc</i>	0.957	1				
<i>desi 3 ui</i>	0.972	0.893	1			
<i>desi 4 idt</i>	0.977	0.936	0.915	1		
<i>desi 5 dps</i>	0.988	0.945	0.982	0.959	1	
<i>GDP per capita</i>	0.954	0.946	0.964	0.877	0.962	1

Source: Own processing

As we can see from the table, the correlation relationship between the considered variables is positive and significant. The lowest value of the correlation coefficient is 0.877 between the integration of digital technologies and GDP, but this value is also high.

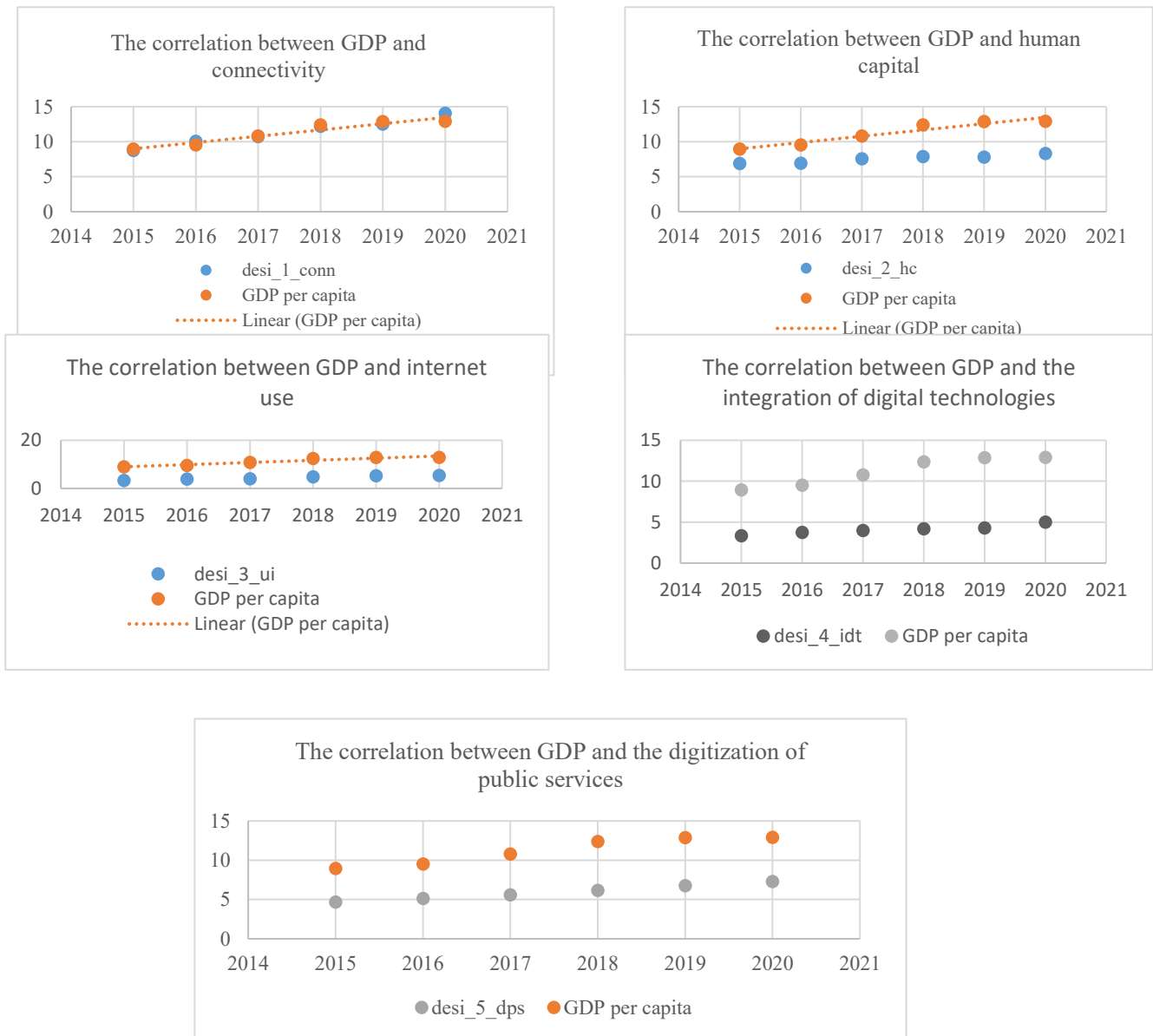


Figure no. 10 - The relationship between economic growth and the components of DESI

Source: Own processing

As can be seen from figure no. 10 the relationship between the five components of DESI is a positive one, ie an increase of one component has the effect of increasing GDP (all correlation coefficients being positive). Also, a correlation coefficient higher than 0.75 is interpreted as a very good association between the analyzed variables.

Observation:

As we can see in the correlation matrix between the five independent variables there is a high correlation, ie each variable influences the other variables. In this context, performing a multiple linear regression is not relevant. For this reason we will perform a number of five simple linear regressions between each DESI component and GDP. In other words, we will determine the individual impact that each DESI component has on GDP.

By applying the simple linear regression for each of the component variables of DESI and GDP, we obtained the centralized data in table no. 3.

Table no. Error! No text of specified style in document. – The results of the linear regression between the DESI components and GDP

	Intercept	Coefficients	Standard Error	t Stat	P-value	R Square	Significance F
<i>desi_1_conn</i>	1.354448402	0.867650894	0.136738959	6.345309	0.00316	0.909631	0.00316
<i>desi_2_hc</i>	-10.6808724	2.906352938	0.498860702	5.825981	0.004324	0.894576	0.004324
<i>desi_3_ui</i>	2.471437143	1.985833935	0.274292654	7.239836	0.001932	0.929097	0.001932
<i>desi_4_idt</i>	-0.02740118	2.758471944	0.756791734	3.644955	0.021869	0.768595	0.021869
<i>desi_5_dps</i>	1.200651373	1.692954082	0.240146364	7.049676	0.002135	0.925509	0.002135

Source: own processing

Next we will explain the results from table no. 3.5.

➤ For the Connectivity component (*desi_1_conn*) of the DESI index, we find that 91% of the GDP variable is explained by the linear relationship with the degree of connectivity (the value of R square), and the residual variation is 9%. Given that the value of Significance F is less than 0.05, in this case the null hypothesis is rejected, that means that the correlation between the two variables is significant. The regression line $Y = aX + b$ in our case is $GDP = 0.867650894 * desi_1_conn + 1.354448402$. The regression line indicates that with a 1% increase in connectivity level, GDP increases by 0.86%. The influence of the connectivity component is not very great, which is also explained by the fact that in this chapter Romania registers a good position, explained by the use of broadband internet and very high speeds.

➤ Regarding human capital component (*desi_2_hc*), 90% of GDP change is explained by the linear relationship with this component. And in this case, the value of F is less than 5%, which explains the significant relationship between the two variables. The regression line between the two variables is of the type $GDP = 2.906352938 * desi_2_hc - 10.6808724$. The regression line indicates that with a 1% increase of human capital level, GDP increases by 2,96%. The influence of the human capital component on economic growth is significant. Thus, one of Romania's priority areas in the field of digitalization is investing in the development of the digital competences of the population, but especially of the labor force. Even if the percentage of the influence of human capital on GDP is low, in absolute value this influence is appreciable.

➤ The linear relationship with the *desi_3_ui* component (internet use) explains 93% of the GDP variation, the difference of 7% being the residual variation. Significance F is 0.001932, less than 0.05, a result interpreted as a significant relationship between GDP and *desi_3_ui*. The regression line based on our analysis is $GDP = 1.985833935 * desi_3_ui + 2.471437143$, that means that that with a 1% increase of using the internet, GDP increases by 1,99%.

➤ 77% of the GDP variation is explained by the linear relationship with *desi_4_idt* - integration of digital technologies. Even if the level obtained is the lowest of the 5 variables, still its value being over 75% shows us a strong connection between the two variables. The linear regression expressed in the equation is: $GDP = 2.758471944 * desi_4_idt - 0.02740118$. The regression line indicates that with a 1% increase in integration of digital technologies component, GDP increases by 2,76%. This result indicates the importance of digital technologies in economic mechanisms, as well as the fact that Romania must invest heavily in digital technologies, both in the public and private sectors. The integration of digital technologies is the second component of DESI as an impact on GDP.

➤ Regarding the relationship between *desi_5_dps* and GDP, it is also significant (Significance F = 0.002135) and 92.5% of GDP change is explained by the linear relationship with the digitization of public services. The linear equation between these is: $GDP = 1.692954082 * desi_5_dps + 1.200651373$, indicating that with a 1% increase in digitization of public services component, GDP increases by 1,2%. The result obtained for this component is somewhat predictable, because the impact of public services on GDP is minor, the public sector not having a major contribution to economic growth.

As a general observation, we note that the greatest impact on GDP of all DESI components have human capital and integration of digital technologies, the coefficient with which it influences GDP being 2.91%, respectively 2,76%. The hypothesis has been confirmed and we can say that the level of digitalization influences in a significant way the national economic growth.

Conclusion

The paper analyzes the relationship between DESI components and economic growth in Romania using data series from 2015-2020. The period was imposed by the available data.

DESI is an indicator calculated at European level that indicates the degree of development of the digital economy and society for the 28 countries in the European space. DESI comprises 5 components (connectivity, human capital, internet use, digital technology integration, digital public services), each with a different weight in the final calculation.

By econometric modeling using linear regression and applying specific steps we managed to demonstrate that each component of the DESI index has a significant influence on economic growth, in the case of Romania. We also we obtained the impact that each component of the DESI index has on economic growth in Romania for the period 2015-2020. Making a list of DESI components in order of influence on GDP we can say that the greatest impact has human capital followed by digital technology integration. On the other hand, the least impact on GDP has connectivity with a value three times lower than human capital.

Romania needs to take important steps in terms of digitalization, not only to keep up with other European countries, but also to contribute directly to the country's economic growth.

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²Ibidem

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