

CORRELATION ANALYSIS REGARDING PUBLIC SECTOR DIGITALIZATION AND ITS FACTORS OF INFLUENCE

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ABSTRACT

This research paper aims at explaining from a statistical perspective the relationship between digitalization in the public domain and several considered factors of influence. The analysis envisaged twenty-nine European countries as compare to the EU-27 average. By applying correlation analysis, the association between variables of interest will be captured. In the same time such type of analysis is able to render the strength of the link between variables. After presenting the correlation results, one can observe that for Romania, the link between digitization and digital skills is very weak. In the same time there is a strong association between digitization in the public sector and the degree of broadband coverage, as well as between it and the way of using the Internet (telephony and video activities). When the digitization process in the public system and the integration of digital technologies are put into balance, a weak correlation can be distinguished. A moderate association, but positive also appears between digitization in the public sector and the frequency of Internet access. Situations are different for each country included in the analysis.

KEYWORDS: *correlation, digital skills, digitalization, internet use, public services.*

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1. INTRODUCTION

The topic of digitalization is the subject and object of many research papers and a phenomenon that gained momentum with the onset of the Covid-19 pandemic, although it had technological progress as its starting point. This century, technological advance has been accelerated, providing an opportunity to develop the living standard of humanity. From the development of mobile phones, the evolution of artificial intelligence or the ability to manage a large database, the digital world is present in a large part of everyday activities. As time passed by, the internet became available for a higher number of individuals. According to the World Bank (2016, p.2), in 2015 the number of internet users reached the threshold of 3.2 billion, which led to a tripling of the number of users as compared to 2005, when there was only one million. This organization emphasizes that the business environment, people and government authorities are more connected than ever before. The existence of the internet is leading to a new era of digitalization, in which private and public sectors need to reassess the way they operate to keep up with new trends.

The present paper aims to highlight the link between digitalization in the public field and factors that could influence it. The perspective of the analysis will be a macroeconomic one, taking into account several states in Europe, many of them members of the European Union. The research will rely on correlation analysis to capture the degree of association between digitalization and

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influencing factors. Both elements will be quantified using indicators capable of capturing as much as possible the specific aspects of the studied phenomenon.

2. LITERATURE REVIEW

The word digitalization defined in The Explanatory Dictionary of the Romanian Language (2023) implies the action of "transforming analogue signals into digital signals", a word equivalent to "digitisation", different from what we find in the literature as "digitalization". The digitalization process leads to the creation of new innovative products and services. This idea is sustained by Almeida, Santos and Monteiro (2020, p. 97) who state that although it is not new to society, technological advancement and opportunities make this field a continuously changing one. The same authors (2020, p. 101) notice that the period of the Covid-19 pandemic has accelerated the process of digitalization in most areas with which humans interact. Although it is a modern process, people's reluctance to change has implied the emergence of a need to connect with people in the period of social distance to facilitate the development of digitalization.

Brennen and Kreiss (2016, p. 5) present a definition of digitalization as a broad concept that involves most areas of everyday life to be translated into digital communication and different types of advertising. In fact, scientific literature shows us that digitalization, in Almeida, Santos and Monteiro's view (2020, p. 97) is a more complex process, the mixture of advanced technologies intertwined with systems in physical and digital format. A complex view of digitalization is offered by Parviainen et al (2017, p. 74) enlarging the scope of analysis of the process by rethinking the whole perspective offered by digital technology, not just the simple transformation into a digital process.

The speed at which the world around us is developing shows us ways in which we can benefit from this process called digitalization, whether we are talking about online sites on which we shop, apps on which we can do accounting or through which the public environment interacts with its citizens. Parviainen et al (2017, p. 74) point out that digital transformation of companies helps in increasing efficiency or offering new services to their customers. An example of this was offered by restaurants, in 2020, when the Covid-19 pandemic occurred, refocused on transporting food to customers when they could not reach their locations. Referring to the same idea, Almeida, Santos and Monteiro (2020, p. 97) found that digitalization enables companies to invest in automation and standardization of processes to optimize the response to customer needs.

Citizens can benefit from digitalization if the government chooses to invest in the development of the processes that the state and its citizens perform. Globally, public authorities are promoting the digitalization of the sector to support interaction between citizens and authorities (Lindgren et al., 2019, p. 427). By digitalizing the public sector Gideon (2020, p. 224) suggests applying IT technologies to improve accessibility and efficiency of public authorities by lowering costs and increasing productivity. With the help of this process, the main objective of public administration is to increase the quality of services offered by decreasing waiting times, increasing transparency and offering irreproachable services (Lindgren et al., 2019, p. 427). This process starts from the principle of forgetting enormous piles of documents and turning them into simplified processes for both people and the state. However, the digitalization of the public sector is not just about direct interaction between a government official sitting at a desk and citizens. Stoica and Radu (2023, p.752) talk about the digitalization of activities that are also reflected in public transport, health services, supply of utilities, street lighting or waste management. Therefore, the digitalization of the public sector includes a broad area that covers most of the activities we interact with on a regular basis. Therefore, the many areas in which we interact with digitalization captures the need for

authorities to find out the needs of citizens and their expectations, taking into account economic and democratic aspects (Lindgren and van Veenstra, 2018, p. 1).

Following the aim to digitalize the vast majority of the processes we can carry out in our interaction with the state, the scientific literature also draws attention to the problems that can arise. Trischler and Trischler (2022, p. 1254) pointed out that the lack of personal data laws creates risks for the population. Agostino, Salitererr and Steccolini (2021, p. 163) talk about the risk of confidential information falling into the hands of the wrong people as a consequence of officials' data misinterpreting or improper use.

The digitalization of public institutions is based on a gradual shift towards self-service, in which the user of the service carries out the operations he needs on his own. Trischler and Trischler (2022, p. 1254) draw attention to an important aspect of this type of interaction with the state: service consumers need the necessary knowledge. This knowledge goes by the name of digital competence, skills that Hofmann and Ogonek (2018, p. 127) define as "the technological and cognitive abilities and skills to apply information and communication technology to investigate and solve problems and to develop new knowledge". These skills may be easier to acquire for younger people and more difficult for older people. The same authors (2022, p.1254) highlight that digitalization is based on the following presumption: that users have high-speed internet, smart devices and that the population knows how to use technology. On the other hand, the desire and need for digitization also implies that public employees should be provided with the necessary digital skills (Hofmann and Ogonek, 2018, p. 127) in order for them to provide support for user help and guidance. Thus, in order to gain the full benefits of digitalization, skills development must be treated with as much importance as technological development (Distel, Ogonek and Becker, 2019, p. 287).

An important element of digitalization is internet access. Kangoh and Rusell (2023, p. 1) talk about the importance of high-speed internet, considering that it offers the possibility for consumers to find out more and higher quality information. The same authors (Kangoh & Rusell, 2023, p. 19) analyze the differences between urban and rural regarding internet access, with rural being disadvantaged. Thus, we can observe another drawback of digitalization, as there is a possibility that the rural population will be cut off from certain services.

According to a study developed by Eurostat (2022), the internet was used across the European Union for virtual mailbox, instant messaging, product and service information, internet calls and online streaming. On the other hand, the same study shows that it was used the least for online courses or skills development. We can therefore see the diversity of internet use, but digitalized public services are not among users' preferences.

The digitalization of most processes is closely linked to the timing of technology. For example, Plesner and Justesen (2018, p. 1178) talk about digitalization in detail or the fourth generation of information technology. Through this, the institutions realize smart cities or analyze big data bases. Another example of this type is provided by Lindgren et al. (2019, p. 430) who discuss the opportunities that the public can benefit from in terms of data mining, artificial intelligence, sensors and service automation, all of which can lead to decreased waiting times and increased transparency. We can therefore see different ways in which new technologies can encourage the digitalization process to develop.

3. METHODS

Within this research study, there are several steps that have been followed in order to develop the analysis. They will be further presented:

- (1) The selection of macroeconomic indicators capable of highlighting specific economic phenomena and reliable in terms of time and space (as they were retrieved for 29 European countries and also for the EU-27 level).
- (2) The statistical analysis of the selected macroeconomic indicators which is able to provide an overview of the research theme.
- (3) The correlation analysis. This type of analysis captures the association between items of research interest and is capable of rendering the strength of the link between them.
- (4) The discussion of results.

To analyze the correlation between the chosen variables, we will refer to two elements of great importance: (1) The Pearson correlation coefficient; (2) Colton's rules of correlation interpretation (Leech et al., 2014; Pirnau et al., 2019). Thus, with the help of the Eviews 13.0 software, the calculation of the Pearson correlation coefficients (which take values between -1 and 1) for the digitization – opportunities relationship will be carried out. The interpretation of the value will lead to finding out the intensity of the correlation, while the sign will lead to finding out the direction of the relationship (the + sign shows a directly proportional relationship, and the – sign shows an inversely proportional relationship). For interpretation, the following intervals will be used:

-  A very weak to no relationship if a correlation coefficient registers values between -0.25 and 0, and between 0 and 0.25.
-  A weak relationship for values between 0.25 and 0.50 or -0.50 and -0.25.
-  A moderate relationship for values between 0.50 and 0.75 or -0.75 and -0.50.
-  A strong relationship for values between 0.75 and 1 or -1 and -0.75.

For a better visualization of results, the following colour scheme will be used, as shown in table 1.

Table 1. Colour scheme for correlation interpretation

	values between -0.25 and 0, and between 0 and 0.25.	a very weak relationship
	values between 0.25 and 0.50 or -0.50 and -0.25	a weak relationship
	for values between 0.50 and 0.75 or -0.75 and -0.50	a moderate relationship
	for values between 0.75 and 1 or -1 and -0.75	a strong relationship

Source: authors conception

4. RESULTS

In order to measure the digitalization of the public environment in the European Union, the European Commission has created an index that captures digital progress (European Commission, 2022). The acronym DESI stands for Digital Economy and Society Index. Four dimensions are captured within this index (European Commission, 2022):

1. human capital – internet access skills and advanced skills;
2. connectivity – network coverage, mobile network and network pricing;
3. integration of digital technologies – digitalization of business and online commerce;
4. digitalization of the public environment – e-government.

The results provided by the European Commission are shown in Figure 1. We can see that Romania is at the bottom of the ranking along with countries like Bulgaria, Greece and Poland. Although we have values close to average for the human capital or connectivity dimension, we tend to be disadvantaged by the integration of digital technologies and the digitalization of the public sector, which puts us at the bottom of the DESI ranking. Moreover, as Reis, Santo and Melão (2019, p. 241) suggest, the population’s low level of acceptance regarding innovation is a major problem for authorities, and this is reflected on the entire community.

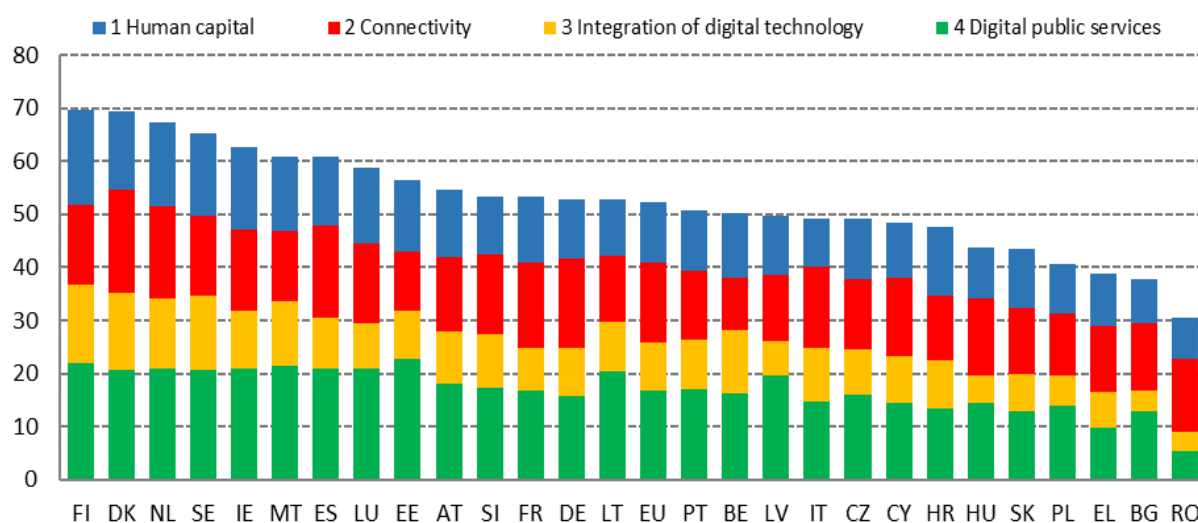


Figure 1. DESI index in 2022
 Source: European Commission (2022)

Another relevant aspect to look at how the digitalization of the public sector is evolving at European level is to understand the progress made by the member states, represented by the relative annual growth rate of the DESI indicator (European Commission, 2022), captured in Figure 2.

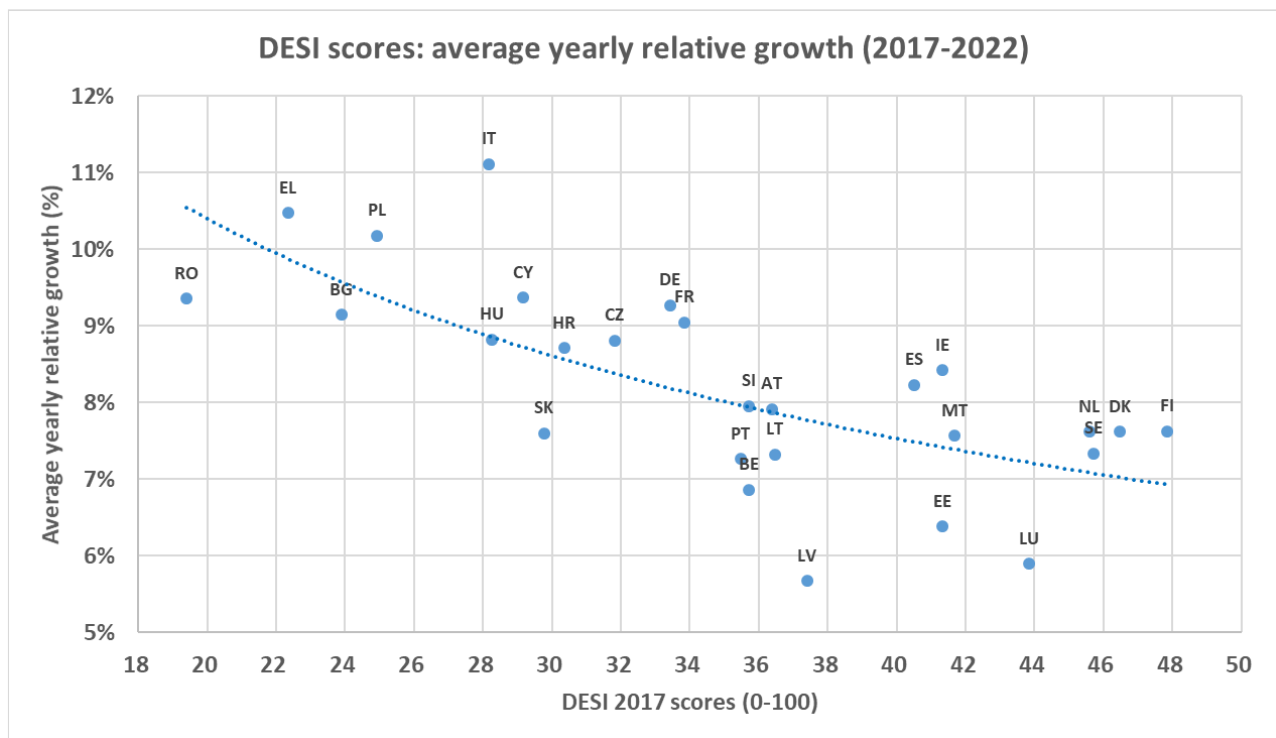


Figure 2. Annual growth for DESI index
 Source: European Commission (2022)

Within this graph, one can observe that countries above the convergent line performed above expectations, while those below the convergent line performed below the European Commission's expectations (European Commission, 2022). Therefore, it can be said that our country is failing in the digitalization of the public sector, which affects many aspects of society, and that time (one of the most important resource) is wasted in queues at government institutions.

4.1. Analysis of macroeconomic indicators on digitization and opportunities for it

The authors of this study chose as an indicator to express the level of digitization in the public domain, *Internet use: interaction with public authorities (last 12 months)* (see Figure 3) (Eurostat, 2023a). High levels of this indicator can be observed for the Nordic countries, while Romania, Bulgaria and Italy have very low levels.

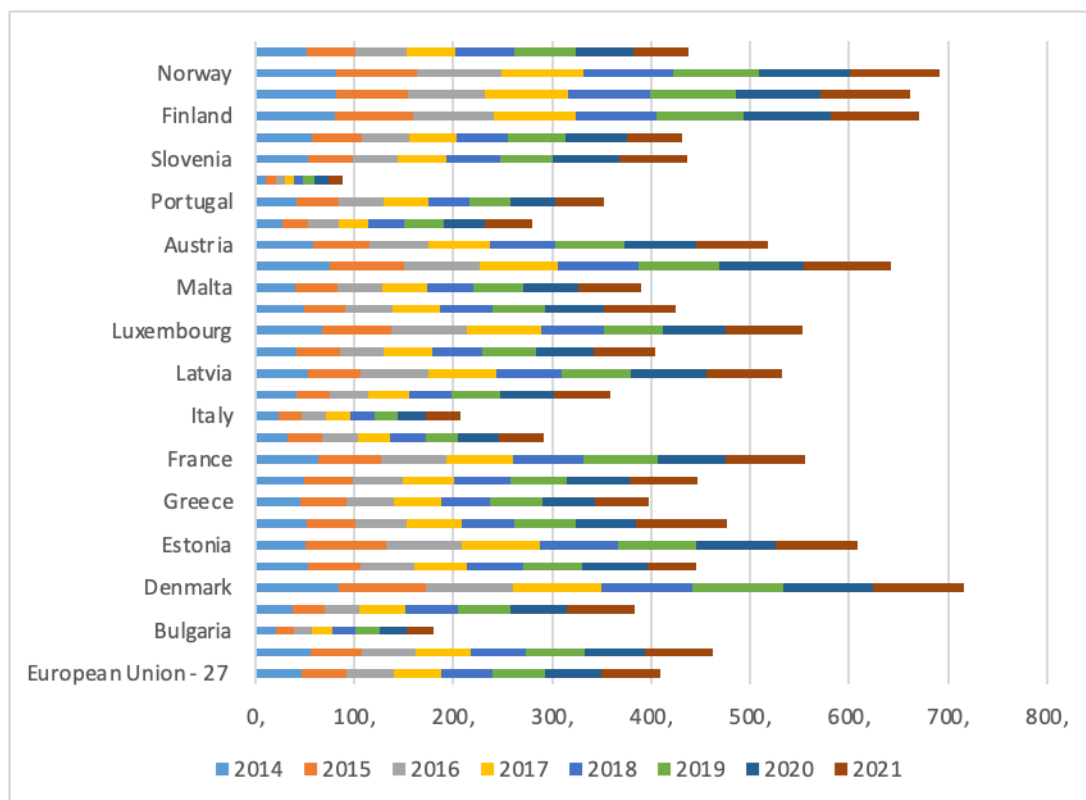


Figure 3. Internet use: interaction with public authorities (last 12 months)

Source: authors with data from Eurostat

In order to define the opportunities that can facilitate the development and integration of digitization in the public environment and the digital transformation of the entire field, indicators were chosen to represent: digital skills of internet users (Eurostat, 2023b), internet access (Eurostat, 2023c), internet use (which can be diverse, depending on the interests of individuals) (Eurostat, 2023d; 2023e), coverage with high-speed internet services (Eurostat, 2023f), internet use in the last 12 months (Eurostat, 2023g), the integration of digital technologies (as an example used: cloud services) (Eurostat, 2023h).

In figure 4, it can be seen how countries such as Greece, Lithuania, Poland, Portugal, Croatia, Italy, Bulgaria and Romania present a frequency of internet access below the EU-27 average, while Luxembourg and Norway are leading countries in this opportunity to digitalization. At the level of 2014, Romania registers the lowest frequency of internet access, of only 47.7% of all individuals, but the indicator shows an upward trend, reaching a level of approximately 82% in 2021.

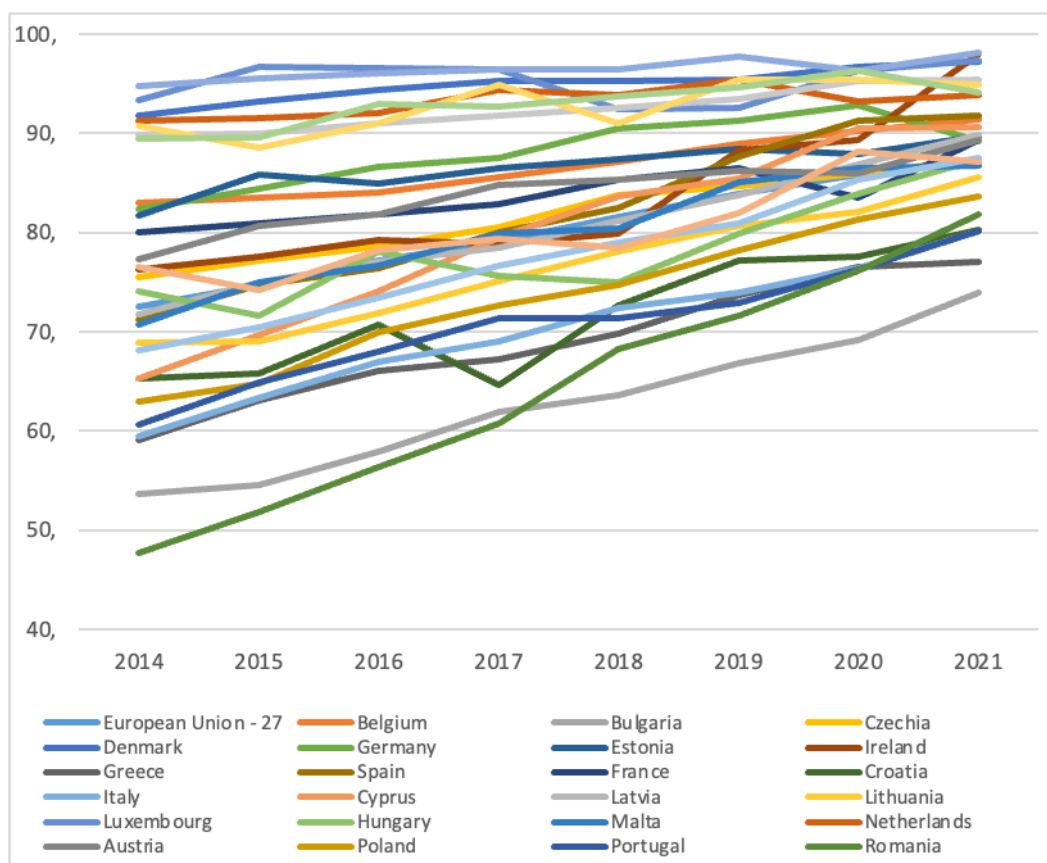


Figure 4. Frequency of internet access: once a week (including every day)
 Source: authors with data from Eurostat

Figure 5 indicates a characteristic of users' digital behaviour through the way they use the internet. Thus, five activities carried out mainly by those who access virtual space were included, with data at the level of 2021: making telephone or video calls, participating in social networks (creating a user profile, posting messages or other contributions on Facebook, twitter, etc.), finding information about goods and services, activities based on internet banking, and searching for health information. Thus, high levels of the indicator for internet banking activity can be observed. In general, this activity recorded increasing values over time. For example, in Romania, in 2014, only 4.3% of internet users were oriented towards internet banking activities. In 2021, this percentage reaches approximately 20%. Bulgaria and Greece are in similar situations.

In Romania, socializing activities (making phone or video calls, participating in social networks) seem to predominate in internet use, followed by finding information about goods and services and searching for health information. However, these users have a low level of digital skills in our country as compared to the EU-27 level, according to figure 6. The highest percentages of people who have basic or above basic digital skills are registered in Luxembourg, Norway and Denmark. It can be seen from figure 6 that for most of the states included in the analysis, there have been no major changes over time regarding the level of digital competence of internet users.

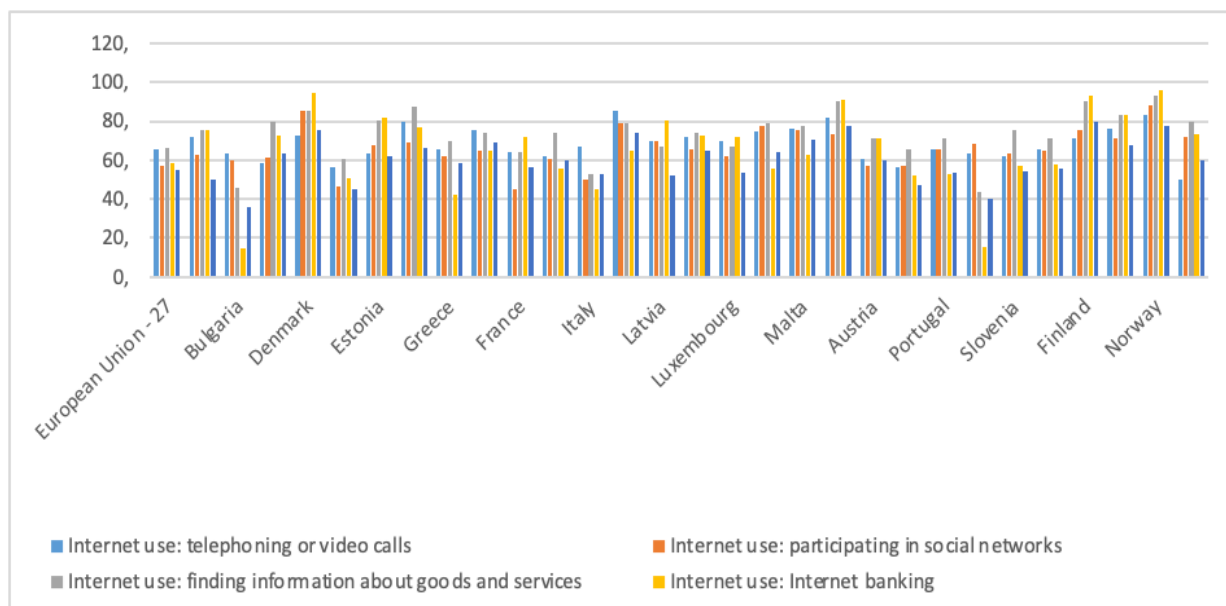


Figure 5. Internet use by activities (2021)

Source: authors with data from Eurostat

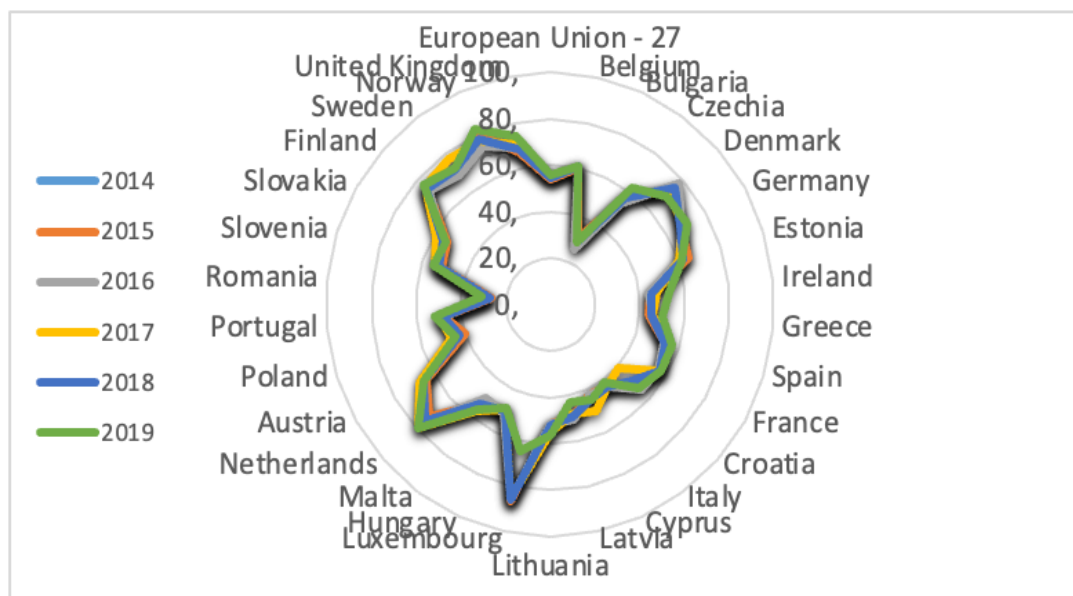


Figure 6. Individuals who have basic or above basic overall digital skills

Source: authors with data from Eurostat

Regarding the integration of digital technologies, cloud services are provided as an example in figure 7 below. This refers to the use of internet storage space used to save documents, images, music, video or other files. High growth rates of this indicator are found for countries such as Cyprus, Hungary, Latvia and Lithuania, even for Romania. However, these states record poor performance regarding the degree of digital technologies integration, below the EU-27 average. In 2020, Sweden, Denmark and Hungary show a very high degree of cloud services use.

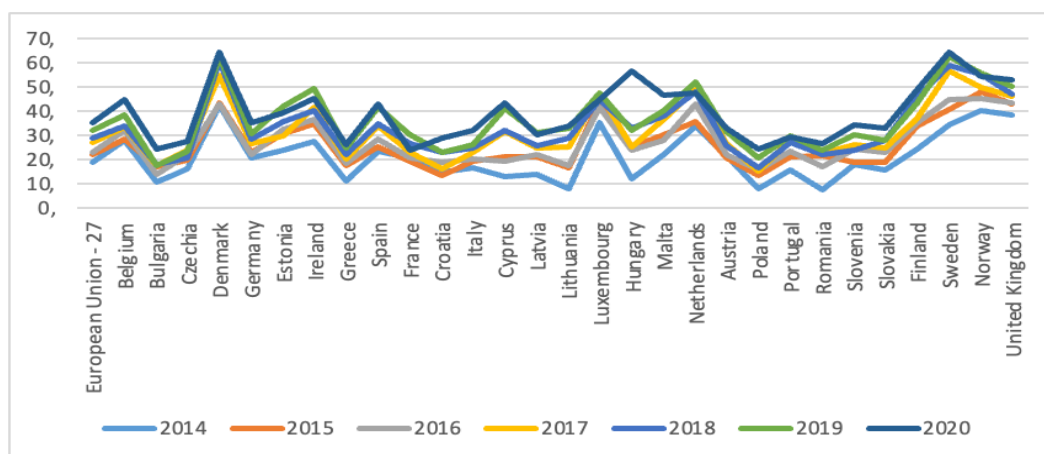


Figure 7. Used internet storage space to save documents, pictures, music, video or other files

Source: authors with data from Eurostat

Regarding coverage with high-speed internet services, it can be seen from figure 8 that Romania exceeds the EU-27 average. Major challenges are faced by countries such as Greece, Italy, Croatia and Poland, which are struggling to improve broadband coverage rate. There may be some large demographic disparities in these countries that act as barriers for using high-speed internet services. In addition, is the low level of digital skills, already shown in figure 6.

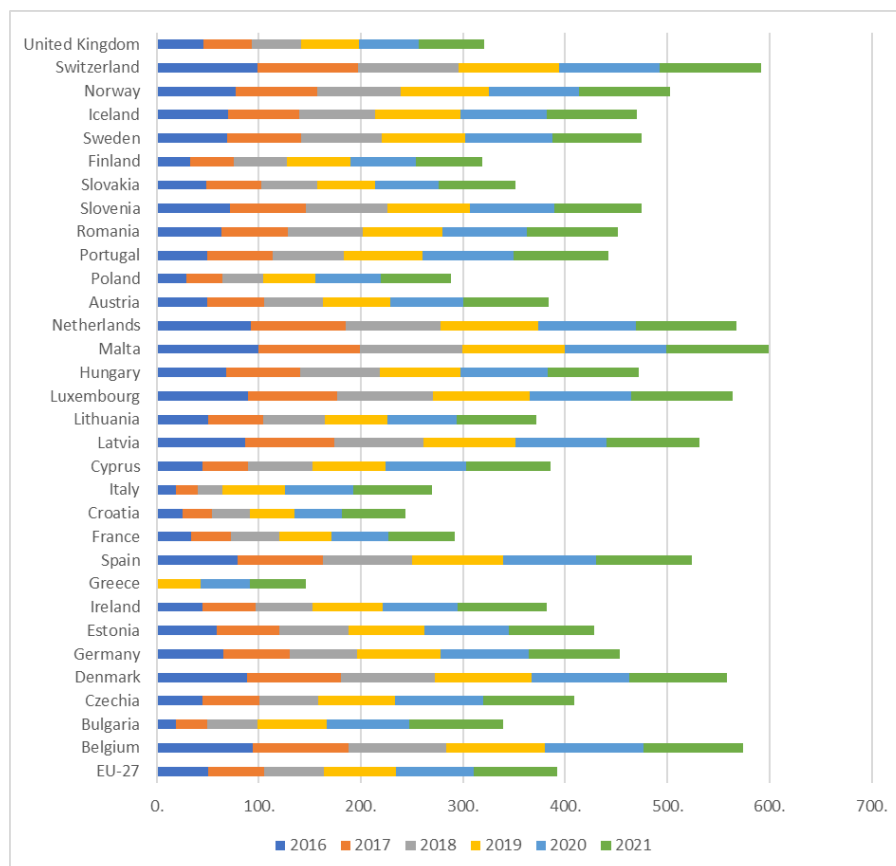


Figure 8. Broadband internet coverage by speed (More than 100 Mbps)

Source: authors with data from Eurostat

Considering the presentation of the indicators that outline an overview of digitalization in the public sector in EU countries and especially in Romania, the present research will propose one types of statistical analysis, in order to highlight the link between the digital transformation process in the public sector and the opportunities that can facilitate and boost this transformation. Thus, the correlation analysis will be using the indicators presented in order to highlight various relationships / associations between them.

4.2. The analysis between digitalization and factors of influence

The colour scheme presented in the methodology section has been used in order to provide a better visualization to the results obtained after performing the correlation analysis.

The values of the correlation coefficient between digitalization in the public sector and the frequency of internet access are presented in table 2, on the first column. The relationship between them is positive and strong, for most of the European countries considered in the analysis. There are also situations (for instance for Germany, Great Britain, Norway, Portugal, Romania, Slovakia and the Netherlands) for which the relationship between them is positive, but moderate.

According to table 2, second column, the relationship between digitalization in the public sector and ways of using the Internet (telephone and video activities) is strong and positive for almost all European states, with some exceptions: (1) Luxembourg, for which the relationship is positive, but very weak; (2) Estonia, for which the association is weak; (3) Slovakia, Portugal, Great Britain, Latvia, Germany, for which the association is moderate.

Regarding the correlation between digitalization in the public sector and the way of using the internet, with activities of searching for goods and services, an inversely proportional (negative) relationship can be observed for France, but moderate in intensity level. This type of relationship gives an idea that a high level of digitalization in the public sector is associated with a low use of the internet to search for goods and services, and vice versa, a low level of digitalization in the public sector is associated with a high use of the internet to search for goods and services.

A special situation in the study of the correlation: digitalization in the public sector - opportunities, appears when it is associated with the indicator on digital skills of internet users (in table 2, fourth column). Thus, when referring to the nature of the relationship, it can be observed that there are many inversely proportional associations (with the “-” sign), while when referring to its intensity, one can appreciate that four distinct groups of countries can be distinguished:

- (1)The group of countries where the link between digitalization and digital skills is strong (Belgium, Finland, France, Greece, Ireland and Spain);
- (2)The group of countries where the link between digitalization and digital skills is moderate (Croatia, Cyprus, Czech Republic, Denmark, Germany, Italy, Malta, Great Britain, Portugal, The Netherlands);
- (3)The group of countries where the connection between digitalization and digital skills is weak (Estonia, Poland, Slovenia, Hungary);
- (4)The group of countries where the link between digitalization and digital skills is very weak (Austria, Bulgaria, Latvia, Lithuania, Luxembourg, Norway, Romania, Sweden).

Table 2. Correlation coefficients

	Digitalization – internet access	Digitalization – internet use (telephone and video)	Digitalization – internet use (for goods and services)	Digitalization – digital skills	Digitalization – cloud services use	Digitalization – internet use	Digitalization – broadband coverage
EU - 27	0.96	0.99	0.81	0.54	0.85	0.96	0.98
Austria	0.87	0.94	0.13	-0.028	0.58	0.86	0.96
Belgium	0.87	0.89	0.64	-0.84	0.88	0.87	0.82
Bulgaria	0.89	0.88	0.76	0.18	0.61	0.90	0.95
Croatia	0.75	0.73	0.61	0.66	0.58	0.73	0.79
Cyprus	0.83	0.91	0.92	0.57	0.71	0.86	0.91
Czech Republic	0.95	0.95	0.92	0.58	0.58	0.95	0.93
Denmark	0.90	0.76	0.39	-0.58	0.82	0.79	0.93
Estonia	0.84	0.35	0.40	-0.47	0.71	0.85	0.55
Finland	0.96	0.96	0.72	0.75	0.72	0.95	0.94
France	0.98	0.95	-0.61	0.80	0.73	0.97	0.89
Germany	0.69	0.55	0.65	0.50	0.74	0.71	0.37
Greece	0.97	0.97	0.95	0.83	0.82	0.97	0.90
Ireland	0.92	0.89	0.94	0.97	0.43	0.92	0.89
Italy	0.76	0.83	0.94	0.71	0.54	0.75	0.78
Latvia	0.88	0.68	0.87	-0.07	0.77	0.85	0.82
Lithuania	0.98	0.89	0.88	-0.001	0.84	0.98	0.97
Luxembourg	0.75	0.12	0.36	0.02	-0.03	0.45	-0.15
Malta	0.87	0.98	0.88	0.74	0.67	0.88	0.73
Great Britain	0.71	0.59	0.78	0.65	0.67	0.57	0.58
Norway	0.66	0.90	0.81	-0.05	0.73	0.69	0.65
Poland	0.96	0.96	0.83	0.33	0.78	0.96	0.97
Portugal	0.63	0.65	0.49	0.59	0.33	0.63	0.47
Romania	0.72	0.84	0.57	0.13	0.38	0.71	0.82
Slovakia	0.62	0.68	0.62	-0.44	0.36	0.69	0.29
Slovenia	0.83	0.92	0.86	-0.27	0.63	0.86	0.78
Spain	0.94	0.94	0.78	0.79	0.75	0.94	0.90
Sweden	0.86	0.92	0.64	-0.10	0.71	0.78	0.85
The Netherlands	0.61	0.99	0.88	0.59	0.70	0.48	0.90
Hungary	0.92	0.90	0.94	-0.29	0.54	0.93	0.89

With regard to the next correlation, the one between digitalization in the public sector and the degree of cloud services use, only one situation does follow the pattern of strong and moderate associations, namely the situation of Luxembourg, for which the coefficient of correlation has a value of -0.03. It indicates a very weak, perhaps even non-existent relationship between the two variables of interest. For Romania, the association is weak, positive, but without raising concerns because, as previously stated, as a country, it has a low level of digital skills as compared to the EU-27 level.

Analysis of the correlation between the degree of internet use and the digitalization process indicates strong associations for more than two-thirds of the analysed countries. Two weak associations were reported, for Luxembourg and the Netherlands, while for the remaining states, the associations are moderate. The percentage of those who have used the Internet in the last 12 months is increasing from year to year for all countries included in the analysis, so the positive associations reinforce the idea of opportunity for digitization in the public system. Similarly, the annual increase in broadband coverage supports the positive associations emerging from the calculation of the correlation coefficients in Table 2, last column. Only for Luxembourg, this association is either very weak or non-existent, according to the low value of the coefficient.

5. CONCLUSIONS

The connections between digitalization in the public sector and several influence factors acting as opportunities for digitalization development, were under investigation. Among key findings of the correlation analysis, after studying the association relations between the level of digitalization in the public sector and its opportunities, the following can be highlighted for Romania: (1) it is one of the countries for which the link between digitalization and digital skills is very weak; (2) in Romania, there is a strong association between digitalization in the public sector and the degree of broadband coverage, as well as between digitalization and the way of using the internet (telephoning and video activities); (3) a weak correlation is distinguished when the digitization process in the public system and the integration of digital technologies are put into balance (the indicator refers to cloud services); (4) There is a moderate, positive association between digitalization in the public sector and the frequency of internet access, for Romania.

At EU-27 level, only the correlation coefficient between digitalization and digital skills indicates a moderate relationship, while the others are indicating strong associations between variables. The highest values of a correlation coefficient is reported for The Netherlands, when analysing digitalization in the public sector in relation to the internet use (telephone and video).

Observing all correlation coefficients, it can be highlighted that only for digitalization – digital skills, there are many inversely proportional associations reported when referring to the nature of the relationship. These means that the chosen variables move in opposite directions, and that improvements in the digital skills do not have an influence on the overall digitalization process for countries such as Denmark, Slovenia, Slovakia, Estonia.

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