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# Digital Transformations of Public Administration in the Context of the COVID-19 Pandemic: EU Countries Case Study

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The digital transformation of public administration and public services has become an urgent need for many governments around the world. This article aims to explore the homogeneity and pace of digital transformation of public administration through the impact of the COVID-19 pandemic and to identify problems and forecasts of research processes at the EU level. The method of cluster analysis was used to study the similarity of the digital transformation of public administration in the EU. The pace of digitalization of public administration in the context of the COVID-19 pandemic was studied through trend analysis. The results show that the EU countries, according to the level of public administration digitalization, are grouped into five clusters, between which there are significant digital gaps. The COVID-19 pandemic has widened the gaps, potentially impacting the EU's strategy for digitalizing society and establishing e-government. Public e-services usage in 2020 to 2021 is higher than predicted by trend analysis for 2009 to 2019. This suggests an acceleration of digitalization in the EU during the COVID-19 pandemic. The proposed technique can be used to predict the level of digitization of any country or group of countries.

## Introduction

The development of technology is changing the world at an unprecedented rate, and the technological revolution is influencing the organization of governance and decision-making in both the public and private sectors. Public authorities must have a digital infrastructure that provides leadership in the field of digital transformation and contributes to added value, allowing such organizations to respond quickly to present threats and the challenges of the future (Hai *et al.* 2021).

In the run-up to the COVID-19 pandemic, public service authorities and governments in many countries developed and implemented a digital transformation strategy. After the pandemic spread to most of the world, approaches and working models for further digitization were revised to provide effective services to businesses and citizens (Ting *et al.* 2020).

This article considers digital transformation from two aspects. First, the Digital Economy and Society Index (DESI) indicator (European Commission 2021) demonstrates the level of informational transition to extensive digitized data, which will be discussed in more detail below. According to the second aspect, digital transformation is interpreted as accelerating the pace of interaction between citizens and state authorities with the help of modern information and communication technologies (Ramanujan 2009). In addition, it is related to the digitalization of all necessary information related to the specified interaction. This syntagma will be comprehended in the article's context without indicating the index.

An important goal of the digital strategy of the EU countries is the development of an open, democratic and sustainable society, which includes the digital transformation of public administration. This issue is particularly acute at the EU level, taking into account the conditions of the pandemic. The digital transformation of the interaction of state power and society during the COVID-19 pandemic is interesting because it arose at the intersection of the need to ensure anti-epidemic measures and the community readiness and technology to form society 5.0 (Narvaez Rojas *et al.* 2021). Research is currently underway into the need for a European space for digital services and reliable data protection (European Commission, Directorate-General for Communications Networks, Content and Technology 2020c). For twenty-first century Europe, concrete measures and goals are becoming more important than ever to achieve the digital transformation of public administration in a pandemic (Cavallini and Soldi 2021).

This article aims to explore the homogeneity and pace of digital transformation of public administration through the impact of the COVID-19 pandemic and to identify problems and forecasts of research processes at the EU level. The following hypotheses were proposed to analyse the problems and prospects of the COVID-19 pandemic's impact on the digital transformation of public administration:

H<sub>1</sub>: EU countries are non-uniform in terms of the digitalization of public administration.

H<sub>2</sub>: The pace of interaction between citizens and state authorities via the internet has accelerated due to the impact of the COVID-19 pandemic.

H<sub>3</sub>: The specified DESI Index and statistical data are used to study two components of digital transformation in this work.

### Literature Review

The use of new technologies in public administration is usually understood as a component of improving the efficiency of public administration, a way of digitizing documents, disseminating information, and communicating with citizens. Examining current publications related to digitization, Kraus *et al.* (2021) note that the concept of digital transformation in the literature is interpreted differently, but covers virtually all aspects of the economy from the private sector to government organizations.

Digital transformation can be defined as an organizational shift to big data, analytics, the cloud, mobile communication technologies, and social media platforms to provide goods and services (Bresciani *et al.* 2021). The digital transformation of public administration involves the use of digital technologies to provide services or administrative management in the context of replacing non-digital or manual processes with the latest processes or technologies. At the same time, digital solutions not only improve traditional methods but also affect the efficiency of services and promote innovation and creativity (Boban and Klarić 2021). As noted by Ting *et al.* (2020) it is time for organizations and governments to realize the importance of digital transformation, which is gradually changing approaches to public administration. Digitization-based public administration will have a positive impact on the economy and will be able to increase citizen involvement in civil society and e-government (Alvarenga *et al.* 2020). Therefore, digital transformation is not only a means of improving the current model of public administration. Řepa (2021) notes that for public administration, the idea of digital transformation is gradually being implemented as e-government, and Belo (2021) emphasizes the importance of moving to the National Network for Open Administration in the EU.

Li (2020), examining digital transformations, notes that the further development of business models will be based mainly on the use of digital technologies, their adaptation to the requirements of a particular structure, management system, and management needs. Rot *et al.* (2020) consider blockchain technology as an innovative solution and a tool for the effective implementation of modern management practices and models for different types of organizations and institutions in the public administration sector. A similar position is held by Tan *et al.* (2022), who note that interest in blockchain-based public administration is growing, but this still needs to be elaborated on, and questions answered: 'when will

the blockchain become an acceptable technology in public administration' and 'what public services can be provided on a blockchain basis?'.

The development of new technologies and competencies of public administration employees has led to their adaptation to remote work, remote office, and digital decision-making. According to Weber and Boban (2016), digital services are innovative, rational, efficient, and more people-oriented. Pandemic public services can lead to a change in approaches to public administration, as well as stimulate new revenue from information and administrative services. Digital transformation offers many benefits and opportunities, but also many challenges and calls, especially for developing countries. According to research by Hai *et al.* (2021) negative factors, which were especially acute in the pandemic, include limited infrastructure, lack of skills of workers in digital networks, and insufficient adaptation of management to the process of digital transformation. At the same time, at the EU level, special attention is being paid to ensuring the compatibility of digital data, services, platforms, and communication networks (Kerber and Schweitzer 2017; European Commission *et al.* 2021a).

Boban and Klarić (2021) believe that, in the context of the COVID-19 pandemic, the digital transformation of public administration is a necessary condition for the effective functioning of the public sector, as well as contributing to the development of e-government, inclusiveness, and transparency of public services. Nienaber and Woodcock (2020) argue that the crisis caused by COVID-19 has revealed both the advantages and disadvantages of the digital transformation of public administration, as achievements and shortcomings became apparent in a very short time. It was the pandemic that proved the urgency of the digital transformation of public authorities, as the introduction of new technologies can improve administrative processes and structures.

Fernandez *et al.* (2020) consider the COVID-19 pandemic's acceleration of digital services development in their work. According to these researchers, the limitations on people's mobility necessitated the advancement of digital communication and the digitalization of communication and consumption in diverse areas. However, the same trends can be traced in modern socio-technical systems (Butt *et al.* 2021). For example, in large organizations, this is already clearly manifested at the level of interaction with consumers (Kretschmer and Khashabi 2020). The pandemic catalysed the active digital transformation of public administration and began a new era of interactive society, known as Society 5.0 (Mchedlova *et al.* 2021; Aslanov 2021; Narvaez Rojas *et al.* 2021).

Although digital transformation is becoming an increasingly popular trend that no organization or country can ignore, questions about the practical implementation of digital transformation remain unanswered (Priyono *et al.* 2020). The problem of digital transformation has become particularly important in the context of the pandemic, as previous forecasts and prospects for public administration remain unclear.

## Methods and Materials

The study of similarities in the digital transformation of society in EU member states was conducted based on the Digital administration Economy and Society Index (DESI) as a complex indicator that reviews relevant indicators on Europe's digital performance and tracks the progress of the EU Member States' digitalization. The study covered the value of the DESI indicator in 27 EU member states in 2019 (before the COVID-19 pandemic) and 2021 (see Table 1).

The method of cluster analysis was used to form clusters and establish the degree of similarity of DESI data in different EU countries. An Agglomerative Hierarchical Clustering (AGNES, Agglomerative Nesting) was applied to construct clusters. Our choice of AGNES is partially substantiated by previous research. Studies, such as Bach *et al.* (2019) and Bluszcz and Manowska (2021) have already shown that a comparison of the EU countries' different characteristics can be conducted by Agglomerative Hierarchical Clustering and indicated that AGNES is one of the appropriate statistical methods to do that. In addition, this statistical method is generally well-accepted for analysing the digital development of different countries (Cruz-Jesus *et al.* 2017). We used connectivity-based clustering, which is based on the distance between objects, where objects are more related to nearby objects than to objects farther away. To analyse the uniformity of the digital transformation of public administration by cluster analysis, we group the EU countries based on the DESI. We placed the obtained data in the distance matrix and step by step selected the countries whose DESI values are closest to each other, and combined them into one cluster. The distance between objects was determined based on the Euclidean distance. In the matrix, the value in the cell formed by row  $i$ , column  $j$ , represents the distance between object  $i$  and object  $j$  in the original data set. For instance, element 1,1 represents the distance between object 1 and itself (which is zero). Element 1,2 represents the distance between object 1 and object 2, and so on (Datanovia 2019). The calculations were made with Excel using the XLSTAT statistical software. The results of cluster analysis are presented in a dendrogram.

To study the changing pace of digital transformation of public administration in the EU under the influence of the COVID-19 pandemic, trend analysis is based on the indicator 'Individuals using the internet to interact with public authorities'. This indicator is calculated as a rate of all individuals aged 16–74 years as measured by obtaining information from the EU members' government websites. In this case, 'public authorities' refers to public services and public administration activities at the local, regional or national level. To predict the number of people who use the internet to interact with public authorities without taking into account the impact of the pandemic, a trend analysis was conducted for the following 5 years (2020–2024) based on actual data for 2009–2019. To determine the impact of the pandemic, the forecast data for 2020–2021 were compared with the actual data for the same period. Data were obtained for the period 2009 to 2021 from Eurostat (2022).

**Table 1.** Digital administration Economy and Society Index components in the EU member states

Countries	Human capital		Connectivity		Integration of digital technology		Digital public services		Total	
	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021
Kingdom of Denmark	14.88	15.30	12.08	18.51	11.79	14.48	19.17	21.77	57.92	70.06
Republic of Finland	16.50	17.78	9.93	12.82	12.69	14.87	19.01	21.68	58.13	67.15
Kingdom of Sweden	15.93	16.14	12.42	14.89	11.50	14.08	18.54	20.99	58.39	66.10
Kingdom of the Netherlands	14.87	15.39	10.83	17.11	11.39	12.67	17.37	19.98	54.46	65.15
Ireland	12.17	13.52	8.38	14.10	10.68	12.01	17.91	20.65	49.13	60.28
Republic of Malta	13.35	12.27	9.86	13.53	10.10	12.71	18.65	21.05	51.96	59.56
Republic of Estonia	13.63	14.48	10.19	11.64	8.11	10.37	20.20	22.94	52.12	59.43
Grand Duchy of Luxembourg	13.32	14.05	12.02	15.24	8.61	9.86	17.60	19.84	51.54	58.98
Kingdom of Spain	11.39	12.08	11.77	15.51	8.89	9.69	17.50	20.17	49.55	57.45
Republic of Austria	13.49	13.34	8.56	13.25	8.41	10.33	17.26	19.96	47.72	56.87
Federal Republic of Germany	13.44	13.81	9.79	14.50	7.63	8.89	14.22	16.87	45.08	54.07
Kingdom of Belgium	12.67	12.70	8.45	12.10	10.70	12.44	14.28	16.46	46.09	53.70
Republic of Slovenia	11.57	11.95	10.55	13.30	9.44	10.58	14.37	17.00	45.93	52.83
Republic of Lithuania	10.93	11.54	9.71	10.43	9.24	10.30	16.82	19.51	46.70	51.78
French Republic	11.49	11.84	9.57	11.85	7.31	8.69	15.58	18.25	43.95	50.71
Portuguese Republic	10.30	11.39	10.37	12.13	8.54	9.14	15.09	17.24	44.31	50.63
Republic of Latvia	9.98	10.28	12.09	12.59	5.20	6.70	17.25	19.91	44.51	49.90
Czech Republic	11.28	11.79	9.02	11.16	8.34	9.77	12.50	14.65	41.13	49.48
Republic of Croatia	11.90	11.68	7.93	11.35	7.76	9.99	10.78	12.99	38.37	47.36
Italian Republic	8.78	8.78	8.91	10.59	7.55	10.36	13.29	15.80	38.52	46.02
Republic of Cyprus	10.30	9.92	7.11	10.45	6.73	7.63	12.84	15.46	36.98	45.53
Slovak Republic	11.06	10.94	8.49	11.56	6.71	7.27	11.42	13.43	37.68	43.46

(Continued)

**Table 1.** (Continued)

Countries	Human capital		Connectivity		Integration of digital technology		Digital public services		Total	
	2019	2021	2019	2021	2019	2021	2019	2021	2019	2021
Hungary	9.79	10.12	9.73	13.00	5.12	5.82	10.65	12.29	35.29	43.21
Republic of Poland	9.13	9.42	8.07	11.33	5.32	6.47	11.42	13.78	33.94	41.23
Hellenic Republic	8.98	10.26	5.93	9.43	6.54	7.13	8.60	10.49	30.06	41.00
Republic of Bulgaria	8.31	8.18	8.14	9.52	4.53	5.12	11.74	14.01	32.72	37.31
Romania	7.56	8.26	10.85	13.29	4.98	5.94	3.68	5.37	27.08	36.83

Sources: Compiled by the authors on the data from European Commission, Directorate-General for Communications Networks, Content and Technology (2021).

The study used data on the digitization of public administration in EU member states, which are officially published on the websites of the European Commission, in particular:

- Directorate-General for Communications Networks, Content and Technology;
- Directorate-General for Informatics;
- EU Open Data Portal;
- eGovernment Benchmark 2020 and 2021.

## Results

According to the EU report, most EU members had already begun to digitalize their public sectors and public administration, but the COVID-19 pandemic accelerated the spread of digital transformation, rendering digital technologies and services imperative for all (European Commission *et al.* 2021b). EU countries before the COVID-19 crisis invested €875 billion in 2019 in Information and Communication Technologies (ICT), Digital Equipment (DE), intellectual property (IP), software, digital licences, patents, etc. After 2019, digital investment already grew by 5% per year, and the main reason was the rapidly increasing importance of digital technology and innovation because of the COVID-19 pandemic (European Commission, Directorate-General of Communications Networks, Content and Technology 2020c). However, investment, regulation, measures, and steps on the provision of public administration and services were not homogeneous across EU countries.

The results obtained for 2019 (before the COVID-19 pandemic) are shown in Table 2, and the results for 2021 are shown in Table 3.

Each cluster includes EU countries according to the degree of similarity of public administration based on the Digital Economy and Society Index (DESI) in different EU member-states. As a result, the first cluster in 2019 included three countries with the highest level of DESI and the strongest degree of similarity (Kingdom of Sweden<sub>1</sub>, Republic of Finland<sub>2</sub>, and Kingdom of Denmark<sub>3</sub>); the second cluster – 14 countries (Kingdom of the Netherlands<sub>4</sub>, Republic of Estonia<sub>5</sub>, Republic of Malta<sub>6</sub>, Grand Duchy of Luxembourg<sub>7</sub>, Kingdom of Spain<sub>8</sub>, Ireland<sub>9</sub>, Republic of Austria<sub>10</sub>, Republic of Lithuania<sub>11</sub>, Kingdom of Belgium<sub>12</sub>, Republic of Slovenia<sub>13</sub>, Federal Republic of Germany<sub>14</sub>, Republic of Latvia<sub>15</sub>, Portuguese Republic<sub>16</sub>, French Republic<sub>17</sub>); the third cluster – eight countries (Czech Republic<sub>18</sub>, Italian Republic<sub>19</sub>, Republic of Croatia<sub>20</sub>, Slovak Republic<sub>21</sub>, Republic of Cyprus<sub>22</sub>, Hungary<sub>23</sub>, Republic of Poland<sub>24</sub>, Republic of Bulgaria<sub>25</sub>); the fourth and fifth clusters comprise just one country each (Hellenic Republic<sub>26</sub> and Romania<sub>0</sub> respectively).

The results of cluster analysis indicate the uneven digitization of public administration in the EU, as the gaps between countries are quite significant. In the time since the beginning of the COVID-19 pandemic, there has been some regrouping in the level of digitalization of public administration. The Kingdom of



**Table 2.** Results of the cluster analysis of the DESI in the EU countries for 2019

Clusters	First cluster	Second cluster	Third cluster	Fourth cluster	Fifth cluster
The first cluster (Kingdom of Sweden <sub>1</sub> , Republic of Finland <sub>2</sub> , Kingdom of Denmark <sub>3</sub> )	0	3.911	18.068	29.798	34.519
The second cluster (Kingdom of the Netherlands <sub>4</sub> , Republic of Estonia <sub>5</sub> , Republic of Malta <sub>6</sub> , Grand Duchy of Luxembourg <sub>7</sub> , Kingdom of Spain <sub>8</sub> , Ireland <sub>9</sub> , Republic of Austria <sub>10</sub> , Republic of Lithuania <sub>11</sub> , Kingdom of Belgium <sub>12</sub> , Republic of Slovenia <sub>13</sub> , Federal Republic of Germany <sub>14</sub> , Republic of Latvia <sub>15</sub> , Portuguese Republic <sub>16</sub> , French Republic <sub>17</sub> )	3.911	0	4.099	15.546	20.652
The third cluster (Czech Republic <sub>18</sub> , Italian Republic <sub>19</sub> , Republic of Croatia <sub>20</sub> , Slovak Republic <sub>21</sub> , Republic of Cyprus <sub>22</sub> , Hungary <sub>23</sub> , Republic of Poland <sub>24</sub> , Republic of Bulgaria <sub>25</sub> )	18.068	4.099	0	4.114	9.841
Fourth cluster (Hellenic Republic <sub>26</sub> )	29.798	15.546	4.114	0	5.756
Fifth cluster (Romania <sub>0</sub> )	34.519	20.652	9.841	5.756	0

Sources: Compiled by the authors on the data from European Commission (2021).

the Netherlands was added to the first cluster of countries with the highest level of digitization in 2021, countries in the second and third clusters regrouped, the Republic of Bulgaria moved to the fourth cluster with the Hellenic Republic, and the fifth cluster remained unchanged and consisted of only one country, Romania, which differs significantly from EU countries for all components of the DESI indicator.

According to experts' opinions, EU institutions and governments may need to contribute about €75 billion per year for digital investment in the near future to close the digital gap between the EU members, compared with the most digitally advanced countries. Additionally, education, upskilling, and reskilling of public administration workers and users of public service may require total investments of €42 billion per year (European Commission, Directorate-General of Communications Networks, Content and Technology 2020c).

After the clustering to visualize the data obtained in 2021, we built a dendrogram, which provides an opportunity to get an idea of the overall configuration of EU countries in terms of digitalization of public administration. The pairs of objects in the construction of the dendrogram are linked according to the level of connection, which is plotted on the *y*-axis, taking into account the number of clusters and the relationship between them (see Figure 1).

**Table 3.** Results of the cluster analysis of the DESI in the EU countries for 2021

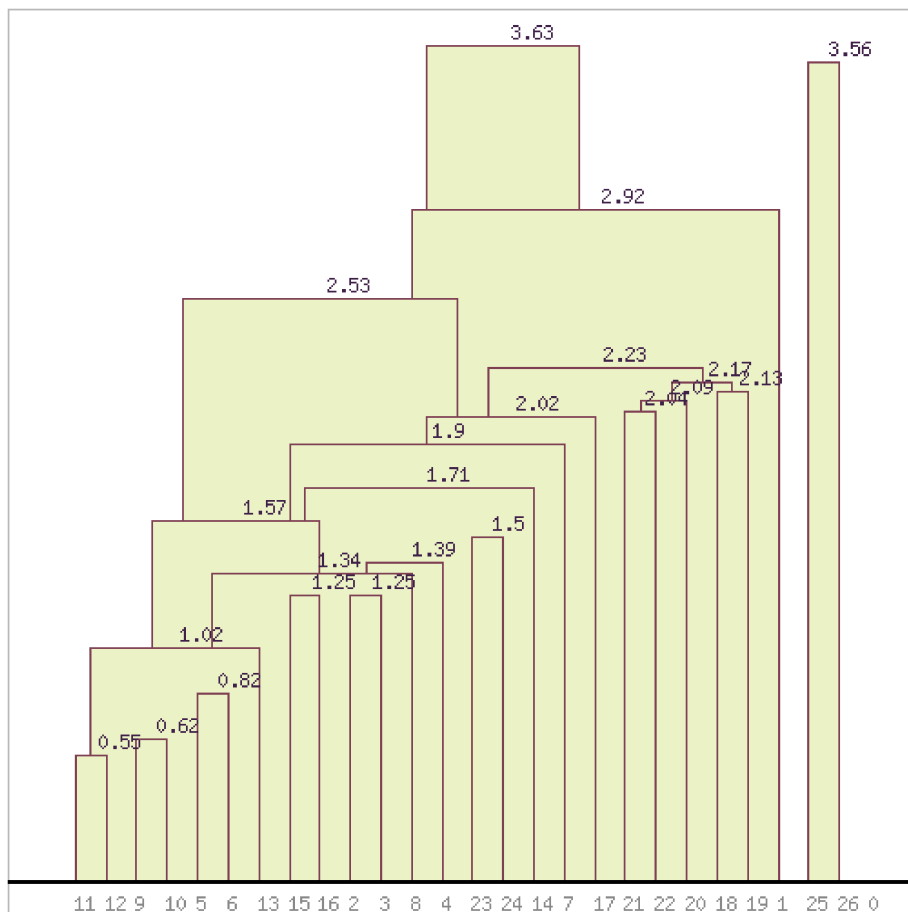
Clusters	First cluster	Second cluster	Third cluster	Fourth cluster	Fifth cluster
The first cluster (Kingdom of Denmark <sub>1</sub> , Republic of Finland <sub>2</sub> , Kingdom of Sweden <sub>3</sub> , Kingdom of the Netherlands <sub>4</sub> )	0	4.917	11.511	28.937	35.43
The second cluster (Ireland <sub>5</sub> , Republic of Malta <sub>6</sub> , Republic of Estonia <sub>7</sub> , Grand Duchy of Luxembourg <sub>8</sub> , Kingdom of Spain <sub>9</sub> , Republic of Austria <sub>10</sub> )	4.917	0	4.173	20.901	28.086
Third cluster (Federal Republic of Germany <sub>11</sub> , Kingdom of Belgium <sub>12</sub> , Republic of Slovenia <sub>13</sub> , Republic of Lithuania <sub>14</sub> , French Republic <sub>15</sub> , Portuguese Republic <sub>16</sub> , Republic of Latvia <sub>17</sub> , Czech Republic <sub>18</sub> , Republic of Croatia <sub>19</sub> , Italian Republic <sub>20</sub> , Cyprus <sub>21</sub> , Slovak Republic <sub>22</sub> , Hungary <sub>23</sub> , Republic of Poland <sub>24</sub> )	11.511	4.173	0	4.172	10.856
Fourth cluster (Hellenic Republic <sub>25</sub> , Republic of Bulgaria <sub>26</sub> )	28.937	20.901	4.172	0	6.773
Fifth cluster (Romania <sub>0</sub> )	35.43	28.086	10.856	6.773	0

Sources: Compiled by the authors on the data from European Commission, Directorate-General for Communications Networks, Content and Technology (2021).

Thus, five clusters were obtained, which allows the grouping of the EU countries according to the level of digital transformation in 2021. According to the EU Commission report, most countries with a high level of digitalization (all from the first cluster and some from the second, see Table 1 and Figure 1) reported no disruption to their public services during the first COVID-19 wave. The EU eGovernment Benchmark 2020 demonstrated that these countries are considered to be highly digitalized when it comes to the provision of public services, scoring well above the European average. The favourable level of public administration in these countries helped to ensure the continuity of public services delivery throughout the COVID-19 crisis (European Commission *et al.* 2020a).

According to the latest eGovernment report (European Commission, Directorate-General for Communications Networks, Content and Technology, 2021), the EU now faced the Non-Consolidated eGov scenario, a scenario where some countries are not fully exploiting ICT opportunities.

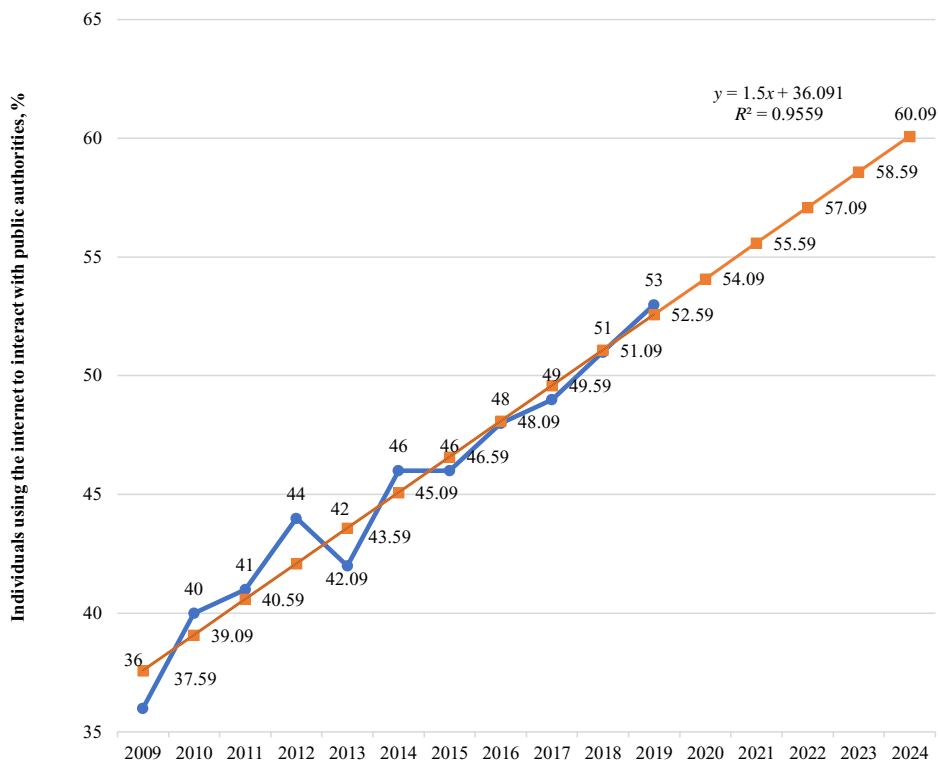
By comparing the performances of countries from clusters four and five with similar relative indicators' scores, their scores underperformed in most of the digitalization indicators. The digitalization penetration level in Romania is the worst in Europe and is lower than of any other European country with similar relative performances. The digitalization level is still relatively low, compared with similar countries such as the Republic of Bulgaria and the Hellenic Republic. The Hellenic



**Figure 1.** Cluster analysis of the DESI indicator of the EU countries for 2021  
 Compiled by the authors.  
 The numbering of the country corresponds to their numbers, given in Tables 1 and 2.

Republic and the Republic of Bulgaria are more on-track in both penetration and digitalization. It means these countries' performances are in line with the EU eGov scenario and can improve the penetration level by increasing the number of people that submit official forms online to administrative authorities or by automating processes and requesting fewer forms from citizens. Regarding digitalization, the Republic of Bulgaria and the Hellenic Republic can further improve their level of back-office and front-office digitalization.

The key source of data to measure the digitalization of public administration is the eGovernment benchmark statement which, however, only analyses the availability and features of digital public services at the country level. At the same time, a proxy of the availability of eGovernment services is considered to be the number of individuals who use the internet for interaction with public authorities



**Figure 2.** Trend analysis of individuals using the internet to interact with public authorities in the EU countries without COVID-19 pandemic impact  
Sources: Compiled by the authors on the data from Eurostat (2022).

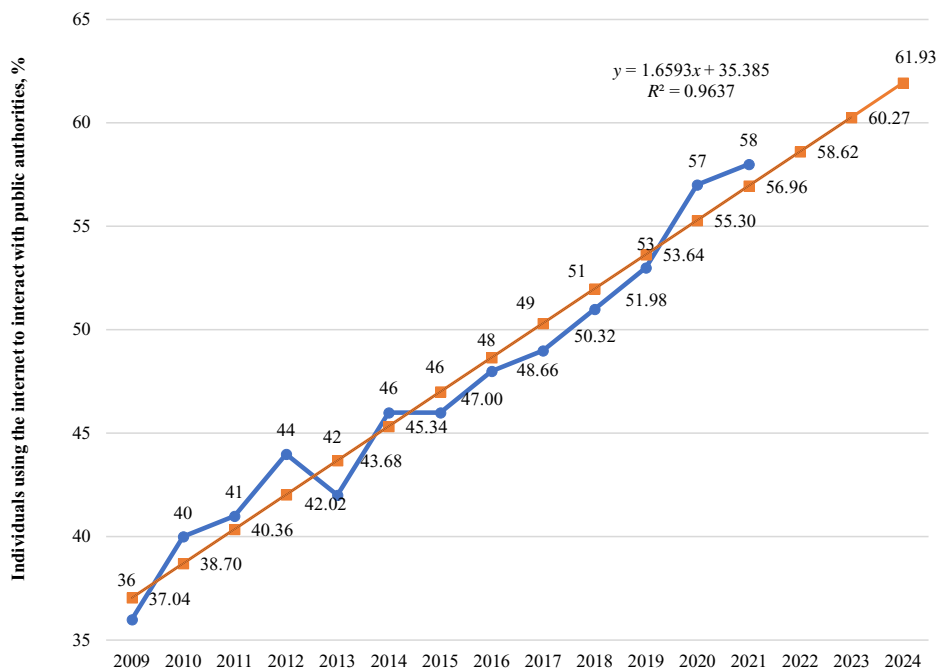
(Cavallini and Soldi 2021). Variability of this indicator is evident across different countries and can be changed as a result of different unexpected impacts.

To analyse and predict the number of individuals using the internet to interact with public authorities, the actual data for 2009–2019 (without pandemic impact) were used and, on this basis, a trend line was built for the next 5 years (2020–2024). The results of the trend analysis since 2019 are shown in Figure 2.

The processes of digital transformation of public administration that have taken place in the EU countries are expected to gradually lead to an increase in the number of people applying for digital administrative services (except for 2013, see Figure 2). Over the ten years analysed, the share of such users in the EU population increased from 36% to 53%. The projected figure for 2024, excluding actual data for 2020 and 2021, is 60.09%, i.e., about 2/3 of the EU population will apply for administrative services by electronic means – via the internet (see Figure 2).

As the pandemic has affected the ability of citizens to receive administrative services, the forecast until 2024 based on the actual data for 2009–2019 plus 2020 and 2021 is shown in Figure 3.

The obtained data confirm the hypothesis that the pace of digital transformation of public administration in the EU has accelerated due to the impact of the



**Figure 3.** Trend analysis of individuals using the internet to interact with public authorities in the EU with COVID-19 pandemic impact

Sources: Compiled by the authors on the data from Eurostat (2022).

COVID-19 pandemic, as the forecast data shown in Figure 2 differ from the actual and forecast data in Figure 3. The actual number of users in 2020 and 2021 was 57 and 58%, respectively (see Figure 3), while without the impact of the pandemic, these figures were forecast at 54.05 and 55.59% (see Figure 2). That is, if, earlier, the annual growth of users of digital administrative services was 1–2% per year, the first wave of the pandemic increased that number to 4%. Accordingly, the forecast of the analysed indicator for 2024 has also increased and is almost 62% compared with the previous forecast of 60%.

According to the EU eGovernment benchmarking report, the public services made available online by regional and local public authorities within EU member-states are lower but comparable, on average, with those made available by national authorities. The ‘online availability’ indicator scores 89% for national services, 84% for regional services, and 77% for local services. At the same time, these EU averages hide wide disparities across EU member-states.

These results correlate with the reports of most European companies in 2021 (European Investment Bank 2022a). Almost 46% of European enterprises indicated that the COVID-19 pandemic did not just increase the demand for digital products but forced businesses to go digital in communication due to the restrictions of quarantine measures. In 2022, approximately 53% of European companies

confirmed their intention to invest in developing digital technologies to improve consumer communications (European Investment Bank 2022b).

### Discussion

Due to the COVID-19 pandemic, there has been a need to reconsider the strategy for digitalizing public services and implementing accessible communication and information services. EU authorities were forced to respond to the constraints caused by the coronavirus; however, before the pandemic, many countries were reluctant to introduce e-services for citizens, and separate offices for civil servants, resulting in significant differences in the levels of digitalization of public administration.

As shown in the cluster analysis result (Tables 1 and 2), the variability of DESI is evident across EU countries; in particular, the use of digital public administration and services lag behind in the Hellenic Republic, the Republic of Bulgaria, and Romania. According to the European Commission report, it may be because digital public services are not available in these countries, or are not easily accessible (Cavallini and Soldi 2021). At the same time, the highest access characterizes countries such as the Republic of Finland, the Kingdom of Sweden, the Kingdom of Denmark, and the Kingdom of the Netherlands. Our results are in line with the conclusions of the latest eGovernment benchmarking statement, which emphasizes underperformance in penetration for the Italian Republic, the Hellenic Republic, and, to a lesser extent, the Republic of Bulgaria and the Republic of Poland. Instead, in Romania, the most evident underperformance area relates to digitization (European Commission *et al.* 2020b). Bachev (2020) has found that, in recent years, there is an improvement in the access of individuals using the internet in the Republic of Bulgaria for relations with public institutions, trading goods, and services. Nevertheless, the Republic of Bulgaria is behind other EU members with regards to the introduction of digital technologies in the economy and society, taking one of the last places in the EU for digital public administration and services (DESI).

The current study complements the results obtained by Malkowska *et al.* (2021), who studied the impact of digital transformation on EU members but did not take into account the impact of the COVID-19 pandemic. The results of cluster analysis (Tables 2 and 3, Figure 1) indicate the uneven digitization of public administration in the EU, as the gaps between countries are quite significant. In the time since the beginning of the COVID-19 pandemic, there has been some regrouping in the level of digitalization of public administration. Our data correlate with the results of Datta *et al.* (2020), who studied the digital transformation in the Italian Republic based on the Index of Digital Economy and Society (DESI). Their research shows that the digital divide between countries complicates the digital transformation, and the availability of advanced technological infrastructure is exacerbated by the low quality of digital literacy. The success of the digital transformation of public administration should be based on ensuring not 'broad' but 'full' adoption and use of digital transformation decisions by citizens (McDonnell *et al.* 2022).

As a result of the COVID-19 pandemic, there has been an acceleration in the digital transformation of public administration. That has led to a focus on factors such as the population's internet access, ownership of computer technology, and the speed of implementation of modern communication technologies. Since the factors listed are interrelated, this follows indirectly from Figures 2 and 3. The varying degrees of internet accessibility across European Union member states have caused certain restrictions for citizens when using public services (Fernandez *et al.* 2020). This can lead to social tension and dissatisfaction among citizens because the complex socio-technical system of modern society requires a particular ergonomic correction of restrictive influences (Butt *et al.* 2021). EU countries have felt the impact of these factors, and therefore, there is a need to develop their executive and administrative systems further. In particular, it can lead not only to a faster update of modern information and communication technologies but also to a general increase in digital literacy and an improvement in the quality of digital services, confirming the results of Fernandez *et al.* (2020).

The automation of processes in public administration can provide greater security, speed, practicality, and efficiency for public authorities (Martins *et al.* 2020). The increase in the number of people using the internet to interact with public authorities since the beginning of the COVID-19 pandemic (Figures 2 and 3) indicates an increase in the number and acceleration of the provision of digital administrative services to users due to the impact of the pandemic. Zait and Horodnic (2022) prove the relationship between the level of development of e-government services and the level of informal economy in the EU, with special emphasis on the impact of the COVID-19 pandemic. Boban and Klarić (2021), on the example of the EU in general and Republic of Croatia in particular, consider the best practices of digital transformation as a component for improving public governance. The authors believe that the existing systems and established processes should be open to the rapid implementation of innovative digital solutions, as they are the main condition for overcoming the crisis caused by COVID-19, and the use of digital technologies in the future will not only reduce the negative impact of potential crises, but also to create conditions for successful digitalization of power and the formation of a digital society (Boban and Klarić 2021).

### **Conclusion**

The digital transformation of public administration is one of the main components of the EU's digital strategy, which has grown significantly in the context of the COVID-19 pandemic. Most governments are aware of the importance of digital transformation and are gradually changing their approaches to public administration, involving citizens in e-government processes.

Successful implementation of digital strategies in most EU countries has led to their rapid adaptation to the challenges of the COVID-19 pandemic, remote working, distant offices, and digital solutions. Countries with a high level of digitalization of public administration have easily adapted to COVID-19 quarantine

restrictions, accelerating the pace of digitization and proving the need for further transformation of public authorities. The increase in the actual number of users of digital administrative services since the beginning of the COVID-19 pandemic and the Digital Economy and Society Index (DESI) shows that the pace of digital transformation of public administration in the EU has accelerated due to the COVID-19 pandemic. In addition, the introduction of new technologies can not only improve administrative processes and structures but also reduce the negative impact of possible futures and move to e-government at the EU level as a whole.

At the same time, the crisis caused by the COVID-19 pandemic has revealed the weaknesses and shortcomings of the digital transformation of public administration. At the EU level, there is uneven digitalization of public administration, and digital gaps between member states, which complicates digital transformation and affects the effectiveness of measures to create a National Network for Open Administration in the EU.

This study is descriptive and limited to the period of the COVID-19 pandemic. To effectively address the intensification of digital transformation and its impact on the state and society, a more thorough analysis of the underlying factors is necessary to inform future measures and improve the overall interaction between these entities. Prospects for further research are to develop measures to support countries with a low level of digital transformation of public administration and to ensure the interoperability of digital data, services, platforms, and communication networks between countries.

### Conflict of Interest

The authors declare no conflict of interest.

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