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Classification of European Union Countries in the Context of E-government: a Cluster Analysis

[Klasifikace zemí Evropské unie v kontextu e-governmentu: shluková analýza]

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Abstract: E-government is currently a term that has been resonating in the public space for several years, which is why a lot of attention is being paid to it. Some states of the European Union are doing better, and some are worse in this area. Given this trend, all states must increase their efforts towards more effective e-government. The article aims to create clusters of European Union states in 2020 and 2022 according to their level of e-government. The sample consists of 27 states of the European Union, and the indicators used include the E-Government Development Index, E-participation index, Online service index, Telecommunication Infrastructure Index, and Human capital index. In addition, the objective of the article is achieved through correlation and cluster analysis. The countries of the European Union were divided into six clusters in 2020 and 2022. The best cluster in both years includes Finland, Estonia, the Netherlands, Denmark, and Sweden, while the worst countries include, for example, Bulgaria and Romania. In general, the countries that were the best/worst in 2020 are also the best/worst in 2022.

Keywords: cluster analysis, e-government, E-Government Development Index, E-participation index, European Union.

JEL classification: C38, H11, H83, O33

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Introduction

Information and communication technology (ICT) is essential across the entire economy these days. Due to its popularity and obvious advantages, it was also used by state authorities, i.e., public administrations, a few decades ago (Fan et al. 2022). Currently, not only in the European Union, governments face new challenges in the field of state management, but also the growing demands of their citizens regarding the use of ICT (Lee-Geiller and Lee 2019). The use of ICT in public administration is considered an efficient, effective, and transparent process through which the government, citizens, and other entities are connected and through which traditional distribution channels in the form of offices are replaced (Fan et al. 2022). E-government aims, among other things, to involve citizens more in political processes, a more effective exchange of information, and the provision of services between the government and other entities (Angelopoulos 2010). E-government could lead to an improvement and increase in the performance of the government and the entire public sector. It also increases citizens' awareness of government programs and proposals, improves the transparency of government decisions, and can lead to a reduction in corruption Avotra et al. (2021).

The transaction channels within which the exchange of information and the provision of services take place can principally be grouped into several areas, namely Government-to-Citizens (G2C), Citizens-to-Government (C2G), Government-to-Business (G2B), Business-to-Government (B2G), Government-to-Employee (G2E) and Government-to-Government (G2G) Mensah, Zeng and Mwakapesa (2022). E-government is used by entities, for example, to access various services in the healthcare sector, when filling out tax returns, for requests for a driver's license, or in general for various documents, etc. (Fan et al. 2022).

On the other hand, the implementation of e-government entails several risks and challenges, such as finance, digital culture, management skills, infrastructure, human resources, and their skills, as well as legislation (Mensah, Zeng and Mwakapesa 2022). According to Samsor (2021), these challenges can be divided into 3 areas – organizational challenges, social obstacles, and ICT obstacles. The ICT development of the given country is also important, as it can serve as an important "building block" for the very implementation of e-government Avotra et al. (2021). The development or change of e-government is a very slow and gradual process that must be considered as a long-term concept. At the same time, it is necessary to constantly develop it and invest in it both financial and non-financial means Siddiquee (2016).

The EU countries have different levels of success in e-government, and there are often significant differences between these countries. The same is true in developing countries, where, according to Furuholt and Wahid (2008), approximately 60% of e-government initiatives did not meet the required goals.

The structure of the article is as follows. The introduction is followed by an overview of the literature on e-government. The methodology deals with the description of the data and methods used. The empirical part, based on correlation and structural analysis, divides the states into clusters according to their similar characteristics. The main findings of the article are summarized in the conclusion.

1 Theoretical background

E-government represents the use of ICT in public administration Grönlund (2010). This is the provision of services via the Internet Huysmans (2007). E-government is used by local and state authorities to support the government itself, to involve citizens in the public space, or to provide government services through ICT (Palvia and Sharma 2007). E-government services can be provided to citizens both through the Internet and other technologies Maclean and Titah, 2021. According to Lechner (2013), e-government represents the transformation process of internal and external relations of public administration, through ICT, the goal of which is to optimize internal processes. The original idea of e-government involvement was to replace the traditional provision of government services with fast online processes (Fan et al. 2022).

According to Malodia (2021), the development of e-government research can be structured into five stages. In the first two stages, e-government was focused on the exchange and dissemination of various types of data and information. The third stage dealt with research on technology and as a tool for public administration reforms and a tool for ensuring convenience in the exchange and dissemination of data. The fourth and final phase focused on technology adoption and citizen perceptions by examining technology adoption issues.

E-government includes several interactions, namely: provision of information, effective communication with citizens and other entities; digital transactions; integration of government organizations; participation of citizens and other subjects (Moon 2002). E-government includes a general process aimed at digitizing the entire public sector. It includes network infrastructure as well as offices. E-Government can ensure the use of a whole range of wider public services and reduce the level of bureaucracy. E-government can be used for a more efficient, transparent, and administrative system Androniceanu and Georgescu (2021).

The successful implementation of e-government depends on the attitudes and behaviour of the entities that will use it (Shareff et al. 2011). According to Mensah, Vera and Mi (2018), perceived ease, quality, trust, and language are important determinants of e-government

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adoption. Other important factors include recommendations from other citizens and trust in the government Mensah, Zeng and Luo (2020). At the same time, the digitalization of public services ensures a higher quality of public services offered, but under several conditions, such as suitable legislation and infrastructure or the already mentioned trust of citizens in the government (Ívić et al. 2022).

According to Pérez-morote, Pontones-rosa, and Núñez-chicharro (2020), governments should invest in e-government and at the same time increase citizens' trust in their political actions and proposals. According to Nimer et al. (2022), the use of e-government affects reducing tax evasion. Investing in e-government can create so-called public value for entities that participate in the e-government process. According to Srivastava and Teo (2007), there is a positive relationship between the level of e-government and the effectiveness of public administration. According to Zheng (2016), e-government can lead to reducing corruption in the country. The use of ICT creates a more transparent system and can increase the accountability of the government and the public administration.

The use of Cloud Computing in e-government was discussed, for example, by Abied, Ibrahim, and Kama, 2021. Blockchain application can contribute to more transparent and robust e-government services (Likidis, Drosatos and Rantos 2021).

2 Methodology

In the article, the theoretical background is based on research focused on e-government. The empirical part uses data and indicators from the United Nations (see Table 1) for the period 2020 and 2022.

The selected set consists of 27 countries of the European Union, that is, Austria; Belgium; Bulgaria; Croatia; Cyprus; Czechia; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Romania; Spain; Slovakia; Slovenia; Sweden.

Table 1: Definition of variables

Indicators	Definition	Unit	Source
E-Government Development Index (EGDI)	It represents the status of the e-government level including online service delivery, telecommunication connectivity, and human capacity	Index (0 – 1)	United Nations
E-participation index (EPI)	It is focused on electronic information (provision of public information), electronic consultation (involvement of citizens in considerations of public services), and E-decision-making (position of citizens in the design of policy options	Index (0 – 1)	United Nations
Online service index (OSI)	It is focused on e-government, portals, and websites of public administration	Index (0 – 1)	United Nations
Telecommunication Infrastructure Index (TII)	It is focused on the availability and quality of the Internet connection	Index (0 – 1)	United Nations
Human capital index (HCI)	It is focused on literacy and education of citizens	Index (0 – 1)	United Nations

Source: United Unions (2023), own processing

The evaluation of selected indicators in EU countries for the period 2020-2022 is carried out using correlation analysis and hierarchical cluster analysis.

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Correlation analysis is used to assess the degree of relationship between the selected indices, see formula (1):

$$r = \frac{\sum_{i=1}^{n}(x_i - x)\,(y_i - y)}{\sqrt{\sum_{i=1}^{n}(x_i - x)^2 \;\sum_{i=1}^{n}(y_i - y)^2}} \tag{1}$$

where: r represents Pearson's correlation coefficient, x_i a y_i represent the values of x and y for the ith individual (Mukaka 2012). The significance level is chosen at 5 %.

Employing cluster analysis, the grouping of multiple objects into groups (clusters) takes place. The individual clusters are then more similar and at the same time different from other clusters. The goal of cluster analysis is to find similar groups. Cluster analysis methods include hierarchical and non-hierarchical clustering. The hierarchical method used in the article divides individual objects into smaller subsets in a hierarchical approach. Within this method, it is not necessary to know the number of clusters in advance; on the other hand, the resulting clusters are dependent on the method used to determine the distance. The Euclidean distance is used to measure the distance. Individual clusters are graphically expressed in a so-called dendrogram (Govender and Sivakumar 2019; Bulivou, Reddy and Khan 2022). Among the hierarchical techniques, Ward's method was chosen, which is defined as the smallest increase in the sum of squares within a cluster, as a result of joining two clusters, and is given by relation (2):

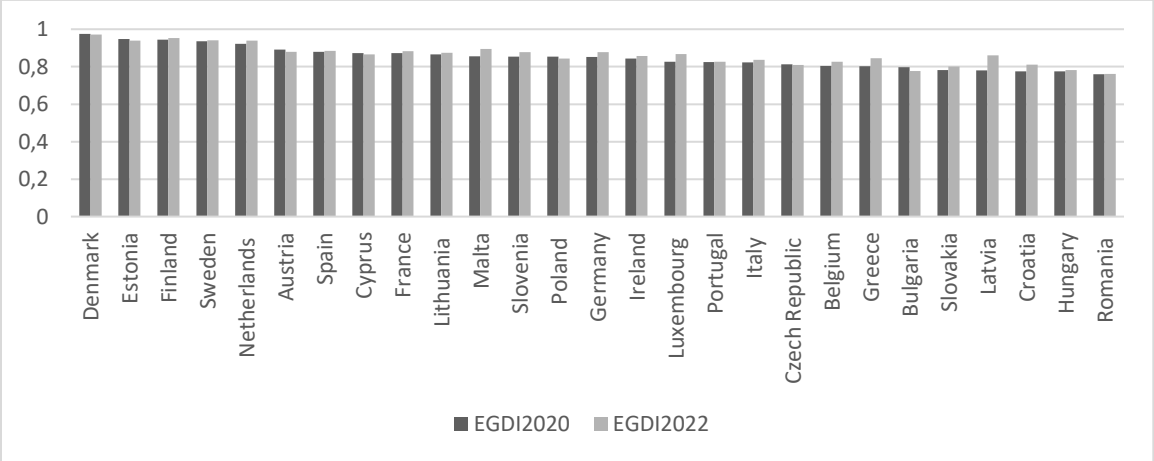
$$d\,(A,B) = \frac{d(a,b)^2}{n_A^{-1} + n_B^{-1}}, \tag{2}$$

where: a, b represent the centroids of clusters A, B (Govender and Sivakumar, 2019).

3 Empirical results

Figure 1 shows the year on-year change of the EGDI in 2020 and 2022 in the EU countries.

Figure 1: Year on-year change of the EGDI indicator in 2020 and 2022 in the EU countries



Source: United Unions (2023), own processing

The average EGDI value increased by approximately 2% between 2020 and 2022. The average in 2020 was 0.849 and in 2022 it was 0.863. Overall, it can be said that between these years the variation range of the countries decreased by approximately 2.3%. Although there are differences between states, the gap between the best and worst states has narrowed. Countries that do not reach average values are mainly from southern, eastern, and central Europe. In contrast, states that achieve higher than average values are primarily states in the north and west of the European Union.

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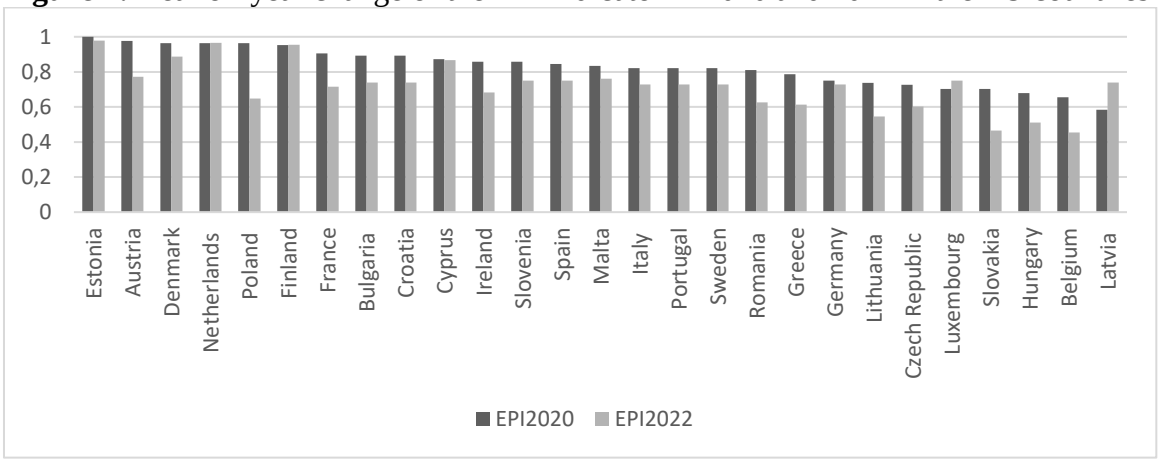
Figure 2 shows the year on-year change of the EPI in 2020 and 2022 in the EU countries.

Figure 2: Year on-year change of the EPI indicator in 2020 and 2022 in the EU countries

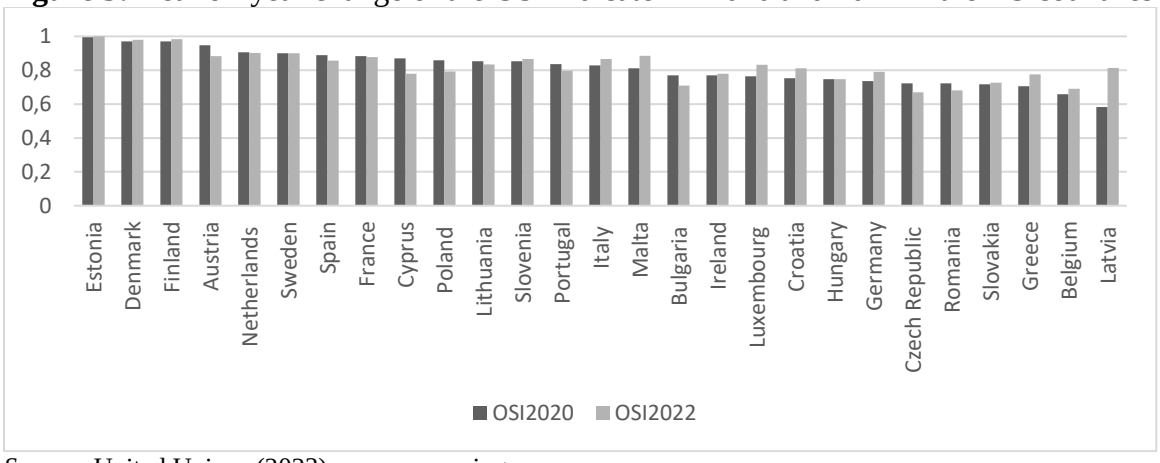


Source: United Unions (2023), own processing

Compared to the EGDI indicator, the EPI varies more from year to year, and in 2022 there was an approximately 13% decrease compared to the previous year. The average value in 2020 was 0.83 and in 2022 it was 0.72. Compared to the previous one, there was an increase of about 24% in the range of variation between countries. Similar to the previous case, the average values are not reached by the states mainly from southern, eastern, and central Europe. On the contrary, states that achieve higher than average values are primarily states in the north and west of the European Union.

Figure 3 shows the year on-year change of the OSI in 2020 and 2022 in the EU countries.

Figure 3: Year on-year change of the OSI indicator in 2020 and 2022 in the EU countries



Source: United Unions (2023), own processing

The average value of the OSI increased by about 1% between 2020 and 2022. The average in 2020 was 0.815 and in 2022 it was 0.826. The biggest change took place in Latvia, where the value of the indicator increased by approximately 40% in 2022.

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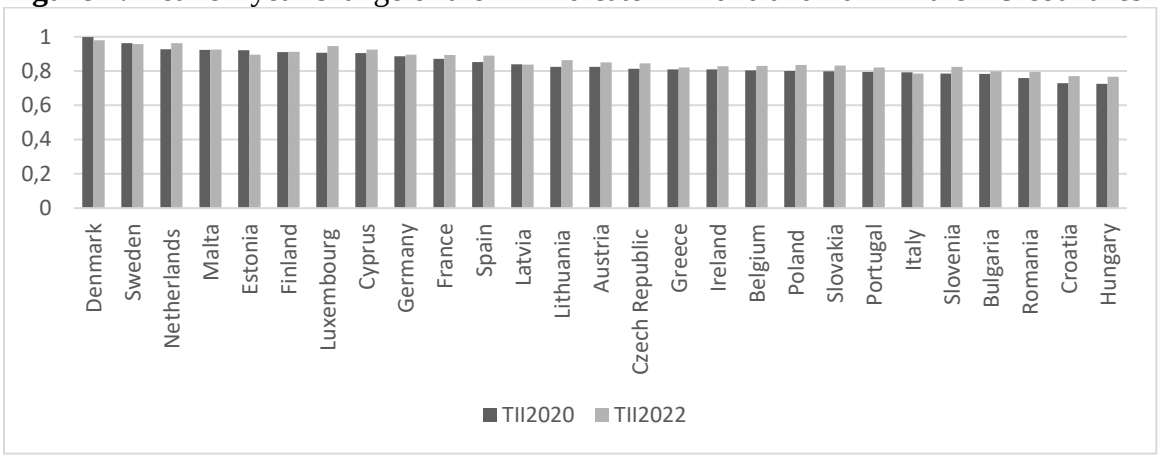
Figure 4 shows the year on-year change of the TII in 2020 and 2022 in the EU countries.

Figure 4: Year on-year change of the TII indicator in 2020 and 2022 in the EU countries

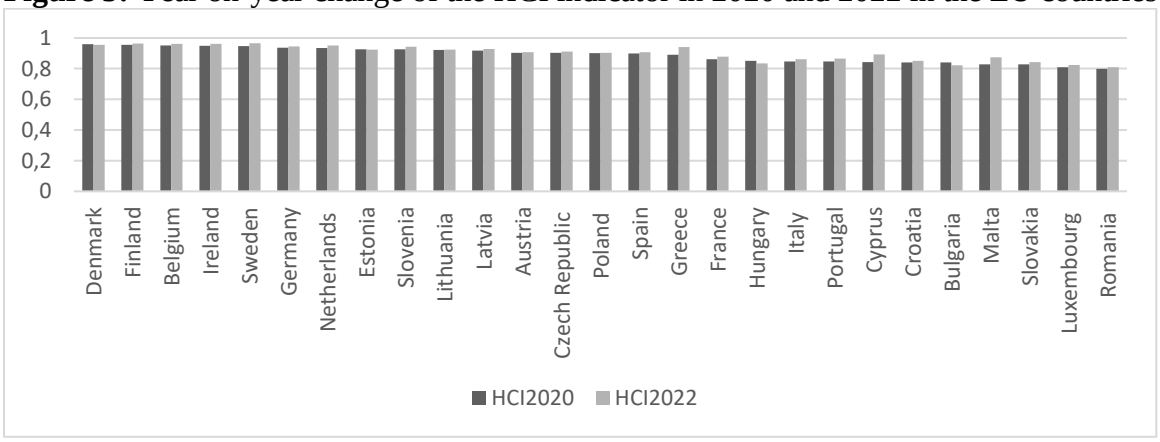


Source: United Unions (2023), own processing

The average TII value increased by approximately 2% between 2020 and 2022. The average in 2020 was 0.843 and in 2022 it was 0.863. Overall, there were no significant changes within the countries.

Figure 5 shows the year on-year change of the HCI in 2020 and 2022 in the EU countries.

Figure 5: Year on-year change of the HCI indicator in 2020 and 2022 in the EU countries



Source: United Unions (2023), own processing

The average HCI value increased by about 1.5% between 2020 and 2022. The average in 2020 was 0.890 and in 2022 it was 0.902. Overall, there were no significant changes within the countries.

3.1 Evaluation of the similarities of EU countries using hierarchical cluster analysis

The results of the correlation analysis for 2020 can be seen in Table 2.

Table 2: Correlation analysis between EGDI, EPI, OSI, TII, and HIC in 2020

	EGDI	EPI	OSI	TII	HIC
EGDI	1	0,658	0,874	0,823	0,607
EPI	0,658	1	0,833	0,322	0,180
OSI	0,874	0,833	1	0,544	0,292
TII	0,823	0,322	0,544	1	0,401
HCI	0,607	0,180	0,292	0,401	1

Source: own processing

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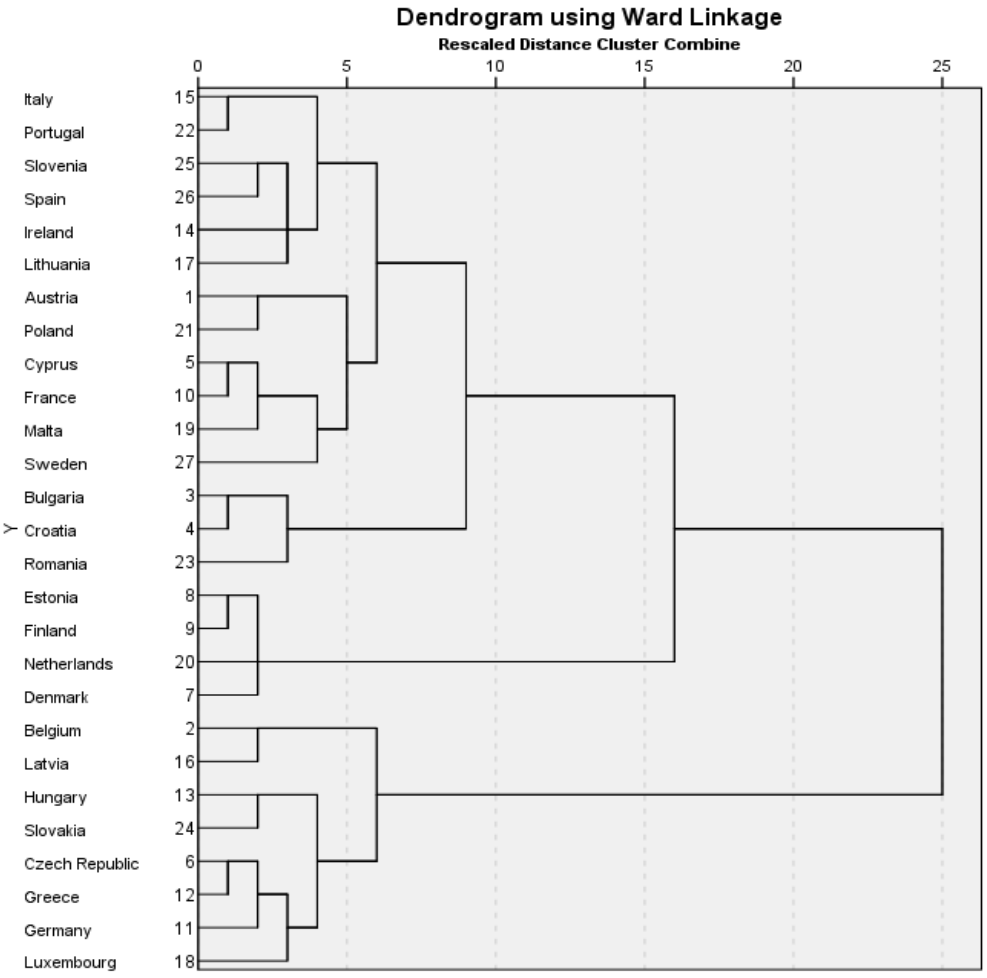
The strongest correlation is between EGDI and OSI and TII, and the smallest is between EPI and TII and HCI. Although there is a low correlation between some indicators, all indicators are still part of this analysis.

The result of the hierarchical clustering process is displayed in 2020 through a dendrogram; see Figure 6. The dendrogram shows the possible division of states into six clusters.

Figure 6: Dendrogram of Similarities in EU Countries in 2020



Source: own processing

Cluster 1 comprises six countries (Austria, Cyprus, France, Malta, Poland, and Sweden). These are the countries of central (Austria and Poland), southern (Cyprus and Malta), western (France), and northern (Sweden) Europe. Based on average values, this is the second best cluster. According to the EGDI indicator, Sweden significantly exceeds other countries and the rest of the countries are at a similar level. According to the EPI indicator, Austria and Poland exceed the other countries, and the greatest similarities are between France and Cyprus and Malta and Sweden. Within the OSI, Austria, and Sweden achieve the best values, and there are also the greatest similarities between Cyprus, France, and Poland. Within the TII, Sweden shows above-average values and the greatest similarities are between Cyprus, France, and Malta, as well as Austria and Poland. Within the framework of the HCI, Sweden again surpasses the other countries, and there are also the greatest similarities between Poland and Austria, as well as Cyprus, France, and Malta. It should be noted that Sweden belongs to this group only due to its low EPI value.

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Cluster 2 comprises two countries (Belgium and Latvia). These are the states of western (Belgium) and eastern (Latvia) Europe. It is rather a worse cluster, especially from the point of view of EPI and OSI, on the contrary, according to the TII it is the second-best cluster.

Cluster 3 comprises three countries (Bulgaria, Croatia, and Romania). These are the states of eastern (Bulgaria and Romania) and southern (Croatia) Europe. Within the EGDI, this is the worst cluster. All states are at a similar level for each indicator. The exception is the EPI indicator, where Bulgaria and Croatia achieve above-average values.

Cluster 4 comprises six countries (Czech Republic, Germany, Greece, Hungary, Luxembourg, and Slovakia). These are central (Czech Republic, Germany, Hungary, and Slovakia), southern (Greece), and western (Luxembourg) states. It is the 3 best clusters within the EGDI, and in other indicators, it is rather a below-average cluster. Within the framework of the EGDI, the greatest similarities are between the Czech Republic, Greece, Luxembourg, and also between Slovakia and Hungary. In the EPI, Greece slightly surpasses the other countries, and there are also the greatest similarities between the Czech Republic and Germany, and also between Luxembourg and Slovakia. Within the OSI, Luxembourg slightly exceeds the other states and the other states are at a similar level. Within the TII, Germany, and Luxembourg achieve above-average values, while Hungary, on the other hand, is characterized by below-average values. Germany achieves the best values in the HCI, and there are also the greatest similarities between the Czech Republic and Greece, and then between Luxembourg and Slovakia.

Cluster 5 comprises four countries (Denmark, Estonia, Finland, and the Netherlands). These are the states of western (Denmark and the Netherlands), northern (Finland), and eastern (Estonia) Europe. In terms of average values, this is the best cluster, which is characterized by very similar values for all. The exception is the TII indicator, where Denmark exceeds other countries.

Cluster 6 comprises six countries (Ireland, Italy, Lithuania, Portugal, Slovenia, and Spain). These are the western (Ireland), southern (Italy, Portugal, and Spain), and eastern (Slovenia) states. These are states that are in the third place according to the EGDI, and from the point of view of other indicators, these are rather below-average states. Within the EGDI, the greatest similarities are between Lithuania, Slovenia, and Spain, and then Italy and Portugal. Within the EPI, there are the greatest similarities between all states, except Lithuania, which achieves below-average values. Within the OSI, Spain achieves slightly above-average values and the greatest similarity between Slovenia and Lithuania, followed by Italy and Portugal. Within the TII, all countries are very similar except for Spain, which surpasses the others. Within the HCI, Ireland, Lithuania, Slovenia, and Spain achieve above-average values.

Table 3 shows the average values of individual clusters.

Table 3: Average cluster values in 2020

Cluster	EGDI	EPI	OSI	TII	HCI
1. cluster	0,880100	0,895517	0,878450	0,881300	0,880583
2. cluster	0,792250	0,619050	0,620600	0,821600	0,934650
3. cluster	0,777667	0,865100	0,749000	0,756833	0,827233
4. cluster	0,808567	0,724217	0,732350	0,823517	0,869817
5. cluster	0,947775	0,970250	0,960300	0,939200	0,943800
6. cluster	0,848850	0,823383	0,838217	0,810217	0,898100

Source: own processing

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The results of the correlation analysis for 2022 can be seen in Table 4.

Table 4: Correlation analysis between EGDI, EPI, OSI, TII, and HIC in 2022

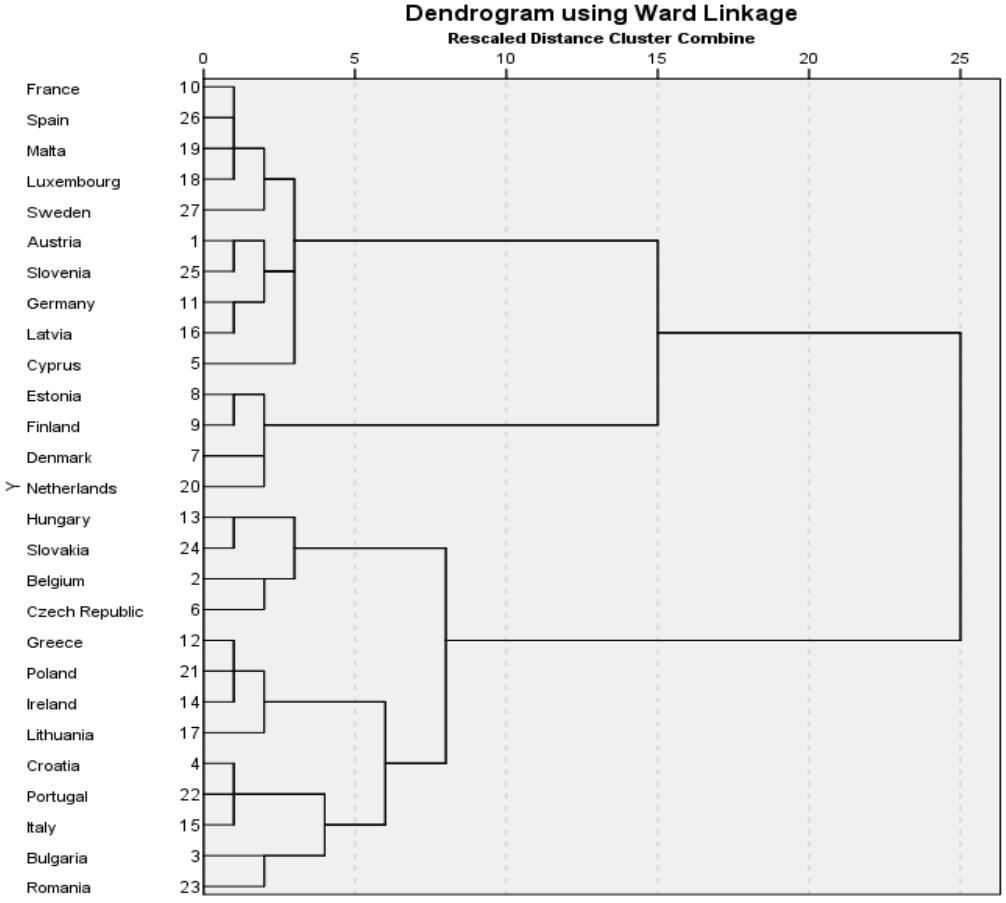
	EGDI	EPI	OSI	TII	HIC
EGDI	1	0,709	0,894	0,831	0,687
EPI	0,709	1	0,761	0,582	0,265
OSI	0,894	0,761	1	0,609	0,415
TII	0,831	0,582	0,609	1	0,435
HCI	0,687	0,265	0,415	0,435	1

Source: own processing

The strongest correlation is between EGDI and EPI, OSI and TII, on the other hand, the smallest is between EPI and HIC and HCI. Although there is a low correlation between some indicators, all indicators are still part of this analysis.

The result of the hierarchical clustering process is displayed in 2020 through a dendrogram; see Figure 7. The dendrogram shows the possible division of states into six clusters.

Figure 7: Dendrogram of Similarities in EU Countries in 2022



Source: own processing

Cluster 1 comprises ten countries (Austria, Cyprus, France, **Germany**, **Latvia**, **Lithuania**, Malta, **Slovenia**, **Spain,** and Sweden). These are the countries of central (Austria and Germany), southern (Cyprus, Malta, and Spain), western (France), northern (Sweden), and eastern (Latvia, Lithuania, and Slovenia) Europe. This is a very heterogeneous cluster, which according to the average values, achieves the second-best values. According to the EGDI indicator, Sweden significantly exceeds other countries and the rest of the countries are at a

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similar level. According to the EPI indicator, Cyprus significantly exceeds other countries, and the greatest similarities are between Austria, Luxembourg, Malta, Slovenia, and Spain, and also France, Germany, Latvia, and Sweden. Within the OSI, Sweden achieves the best values, followed by Austria and Malta, and the greatest similarities between France, Slovenia, and Spain, and between Germany, Latvia, and Luxembourg. Within the TII, Cyprus, Luxembourg, Malta, and especially Sweden achieve above-average values. The greatest similarities are also between France, Germany, and Spain, and also between Latvia and Slovenia. Within the HCI, Germany, Latvia, Slovenia, and Sweden show above-average values. The greatest similarities are further between France and Malta. Again, it should be mentioned that Sweden belongs to this group only because of the low EPI value.

Cluster 2 comprises four countries (Belgium, **Czech Republic, Hungary,** and **Slovakia**). These are the states of Western (Belgium) and Central (Czech Republic, Hungary, and Slovakia) Europe. It is rather a worse cluster, especially from the point of view of EGDI, EPI, and OSI. According to the EGDI, all states are at almost the same level. In the EPI framework, it is rather heterogeneous states, the best of which is the Czech Republic and the worst is Slovakia. According to the OSI, Belgium, and the Czech Republic are the most similar, followed by Hungary and Slovakia. Within the TII, Belgium, the Czech Republic and Slovakia are most similar. According to the HCI, the greatest similarities are reported between Belgium and the Czech Republic and then Hungary and Slovakia.

Cluster 3 comprises two countries (Bulgaria and Romania). These are the states of eastern Europe (Bulgaria and Romania). This is the worst cluster except for the EPI, where it is in 5th place. All countries are at a similar level for each indicator, except for the EPI, where Bulgaria achieves better values.

Cluster 4 comprises three countries (**Croatia**, **Italy,** and **Portugal**). These are the southern states (Croatia, Italy, and Portugal) of Europe. This is a slightly below-average cluster. All states are at a similar level for each indicator, except for the OSI, where Italy achieves better values than the others.

Cluster 5 comprises four countries (Denmark, Estonia, Finland, and the Netherlands). These are the states of western (Denmark and the Netherlands), northern (Finland), and eastern (Estonia) Europe within EGDI and HCI. Within the EPI, Estonia, Finland, and the Netherlands are most similar. Within the OSI, the greatest similarities are between Denmark, Estonia, and Finland. Denmark, Finland, and the Netherlands are most similar in the TII.

Cluster 6 comprises four countries (**Greece**, Ireland, Lithuania, and **Poland**). These are the states of western (Ireland), southern (Greece), eastern (Lithuania), and central (Poland) Europe. These are states that are in the third place according to the EGDI, and from the point of view of other indicators, these are rather below-average states except for TII and HCI. Within the EGDI, there are the greatest similarities between all states. Within the EPI, there are the greatest similarities between all states, except Lithuania, which achieves below-average values. Within the OSI, Lithuania achieves slightly above-average values, and the other states are at a very similar level. Within the TII, all states are very similar except for Lithuania, which slightly exceeds the others. Within the HCI, Ireland and Greece achieve above-average values, and there are other similarities between Lithuania and Poland.

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Table 5 shows the average values of individual clusters.

Table 5: Average cluster values in 2022

Cluster	EGDI	EPI	OSI	TII	HCI
1. cluster	0,883130	0,755920	0,848220	0,894580	0,906570
2. cluster	0,804800	0,508525	0,707925	0,818725	0,887725
3. cluster	0,769250	0,681800	0,695300	0,796900	0,815550
4. cluster	0,825133	0,731067	0,824033	0,792400	0,859033
5. cluster	0,950675	0,946025	0,966400	0,937275	0,948400
6. cluster	0,855100	0,622150	0,795625	0,836925	0,932675

Source: own processing

4 Discussion

Based on the cluster analysis, the EU states were divided into 6 clusters according to their similarities. Overall, it can be said that countries within the framework of e-government did not change much in the monitored years and their level remained practically the same, which may also be influenced by the selected period. However, the level of digitization of the EU countries is uneven, although it should be noted that this digital divide is narrowing slightly.

Most of the western, northern, and also some southern states are faring much better at the level of e-government than the eastern states. An exception is, for example, Estonia, which is in the east of Europe, and which started the intensive development of e-government far earlier than other states in the east of Europe. In both years, Bulgaria and Romania are worst off. Similar results were achieved, for example, in (Ardielli and Vavrek 2019; Androniceanu, Kinnunen and Georgescu 2020). In these countries, citizens do not use the internet much to interact with public administration, according to (Eurostat 2023), less than 30% use it in 2021. Lower values (below 50%) are also recorded in Croatia, Italy, Poland, and Portugal. Conversely, more than 80% of citizens use the internet to communicate with public administration in Denmark, Ireland, Estonia, France, the Netherlands, Finland, and Sweden. In the vast majority of states, this share grows over time. The biggest changes in 2021 compared to 2020 occurred in Ireland, Luxembourg, Hungary, and Malta. For example, the decline occurred in Germany. The average value in the EU is 58%. In Bulgaria and Romania, citizens use the internet to a small extent even for sending forms (under 15% of citizens). Low values (below 50%) are also reached in Germany, Greece, Croatia, Italy, Malta, Poland, Portugal, Slovenia, and Slovakia. Higher values (over 70%) are recorded in Estonia, France, the Netherlands, Finland, and Sweden. Again, in most states, this share grows over time. The biggest changes in 2021 compared to 2020 occurred in the Czech Republic, Ireland, Greece, and Hungary. The decline occurred again in Germany, which does not reach a high level in the digitization of public administration, as is the case in the northern states or some western EU states. The average value in the EU is 44%. Similar results are also achieved, for example, in the area of downloading forms or obtaining information from the websites of public authorities. According to data (World Bank 2019) from 2019, the Czech Republic, Croatia, Romania, Slovakia, Cyprus, Slovenia, and Hungary are among the countries where access to building permits issued by public authorities is very lengthy and difficult. On the contrary, processing a building permit is easier in Denmark, Lithuania, Luxembourg, Estonia, Germany, Sweden, and Poland.

However, it should be noted, based on the above-mentioned selected areas, that each country is unique in its level of e-government and it should be taken into account that although a given country appeared in a given cluster, it does not mean that it is at the same level of e- government like the other countries in this cluster, so the states must be approached individually. Most countries have problems with the use of experts in information and communication

technologies, but also with low digital skills of citizens or with internet coverage. Some countries started implementing e-government earlier and some later. In some countries, the implementation of e-government procedures is slow. Differences between countries can also stem from political, financial, or distrust of the government (European Commission 2023).

Conclusion

E-government has attracted a lot of attention in recent years. There are many definitions of e-government, but in principle, it can be said that it represents the provision of public services through information and communication technologies. E-government affects the efficiency and quality of public services or the government itself, or under certain conditions, it can reduce corruption in a given country. For EU countries, it is necessary to constantly invest in e-government, deepen it, and offer new digital services for their citizens that will meet expectations, as not all established digital services are successful. At the same time, there are considerable differences in the level of e-government between EU states, for that reason, it is appropriate to focus on these differences so that these differences do not deepen in the future.

According to the EGDI indicator in 2020 and 2022, the level of the countries did not change much, overall, it increased by only 2% on average. On the contrary, from the perspective of the EPI, there were much larger changes in countries and even an average decrease of more than 10%. In general, it can be said that in these indicators the countries of Northern and Western Europe achieve better values, and, on the contrary, the countries of Eastern, Southern, and Central Europe achieve worse values. The exception is Estonia, which ranks among above-average countries. In most indicators, there was a slight improvement of approximately 1-2% in 2022. The exception is the EPI indicator, in which countries experienced a deterioration.

Through cluster analysis, a total of six clusters of EU countries were created in 2020 and 2022. In general, it can be said that most of the countries that were in the given cluster in 2020 were also in it in 2022. Among the best countries in e-government are Denmark, Estonia, Finland, the Netherlands, and Sweden. These are the countries of Northern and Western Europe and, in the case of Estonia, Eastern Europe. On the contrary, the worst countries include, for example, Bulgaria and Romania.

Future research could focus on factors that influence countries and their level of e-government or could use more indicators for the analysis that evaluate the level of e-government.

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