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Post-Pandemic Exploratory Analysis of the Romanian Public Administration Digitalization Level in Comparison to the Most Digitally Developed States of the European Union

Rodica Pripoaie *, George-Cristian Schin and Andreea-Elena Matic

Faculty of Law and Administrative Sciences, Dunărea de Jos University of Galati, 800008 Galați, Romania; george.schin@ugal.ro (G.-C.S.); andreea.matic@ugal.ro (A.-E.M.)
* Correspondence: rodica.pripoaie@ugal.ro

Abstract: This study aims to carry out a comparative analysis between the level of digitization of the Romanian public administration compared to that existing in the most digitally developed states at the European level. Our study identifies the extent to which Romanian citizens have access to non-bureaucratic and transparent public services that support social inclusion and non-discrimination, compared to European citizens from states with the best digitalization of public services. Also, our research studies the relationship between the level of digitalization quantified by the DESI indicator and the level of income for the states considered in the analysis, as well as the relationship between digitalization and bureaucracy, the corruption index, and the digital skills of citizens. Based on the 486 statistical data collected and centralized on the corruption index (CPI), as well as the values for DESI and GNI per capita, for the period 2017–2022 for the 27 EU member states, we performed a statistical analysis using SPSS 28 regarding the existence of a DESI relationship and level of income (GNI per capita) and/or CPI (Corruption Perceptions Index). Our study is on a current issue, as it addresses the issue of digitalization of public administration, in the new post-pandemic and geostrategic context. It has theoretical applicability, by determining a model that can be used to study the relationship between digitalization and the standard of living and corruption, and also practical application, because it can contribute to the awareness of the government in taking measures and adopting strategies to reduce gaps as compared to the most developed digital states.

Keywords: e-government; digitalization of public administration; the Digital Economy and Society Index; Corruption Perceptions Index; gross national income per capita

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1. Introduction

Our study presents a comparative analysis of the digitalization level of the existing public administration in Romania compared to the most digitally developed European states in the current, post-pandemic period and begins with a review of the literature on e-government and its implications for the quality of public services offered to citizens. Firstly, the specialized literature review covers numerous studies that address the issue of digitalization of public administration.

In the last years, the digitalization of Romanian public administration has made significant progress compared to the previous period, in the sense of doubling the value of most indicators. However, it remains in the negative rank at the European level, which reflects the need to continue the implementation of the digitalization strategy and maintain or even increase the pace in order to reduce the gap with other more digitally developed European states.

The digital public administration in Romania faces a series of problems, because public information systems are not interoperable, basic digital skills are deficient, and the number of ITC specialists is insufficient. Thus, Romania's low level of digitalization also influences the effectiveness of the public administration, which is far below the European Union average.

2. Literature Review

2.1. Theoretical Framework—The Concept of Digitalization

In this study, we propose to analyze a model that can be used to study the relationship between digitalization and the standard of living and corruption. Our study can contribute to the awareness of governments in taking measures and adopting strategies to reduce gaps as compared to the most developed digital states. Also, the knowledge of these interdependencies is useful for anticipating the need for specialists in the ITC field.

Digital transformation is usually a buzzword hinting at e-government [1], and the increasing use of Artificial Intelligence (AI) is triggering several opportunities for governments worldwide [2].

2.2. Empirical Findings—The Digitalization of Public Administration

The digitalization level of public administration in a country quantifies the extent to which citizens in that state have access to accessible, non-bureaucratic, and transparent public services that ensure increased social inclusion and non-discrimination.

E-governance generally increases the efficiency and quality of public services [3] and EGSC (e-government service capability) [4].

While local governments document greater obstacles to e-government [5], some authors consider that governments must pay greater attention to elements such as e-commerce, e-business, and virtual public services [6].

A few authors consider that e-government has several virtues, specifically "Improved public services; improved administrative efficiency; Open Government (OG) capabilities; improved ethical behavior and professionalism; improved trust and confidence in government; and improved social value and well-being" [7].

The digitalization of public services changes the way that interactions between authorities and citizens take place but also the skills they need [8].

AI in public administration must be transparent, to ensure citizens' trust of AI [2] such that, depending on the service quality, residents intend to reuse on-line public services [9].

The following describes some empirical studies that have been published in the last few years (see Table 1) in the field of digitalization of public administration.

Table 1. Empirical studies about the digitalization of public administration.

Authors, Title, and Year	Method Used	Focus	Period Examined	Variables Used and Conclusions
Zidkova, Hana; Arltova, Marketa; Joskova, Katerina, Does the level of e-government affect value-added tax collection? A study conducted among the European Union Member States, 2024 [10]	A dynamic panel regression model	digitalization of tax collection and its effect on tax evasion	2003–2020	e-government level, the VAT share in tax revenues, final consumption of households, and the standard rate
Savchenko, Nataliia; Fedirko, Oleksandr; Muravytska, Hanna; Fedirko, Nataliia; Nemyrovska, Oksana, Digital Transformations of Public Administration in the Context of the COVID-19 Pandemic: EU Countries Case Study, 2024 [11]	Cluster analysis method	homogeneity and pace of digital transformation of public administration	2009–2021	five clusters of level of public administration digitalization

Table 1. *Cont.*

Authors, Title, and Year	Method Used	Focus	Period Examined	Variables Used and Conclusions
Qi, Yong; Tang, Yanan; Bai, Tingting, Impact of smart city pilot policy on heterogeneous green innovation: micro-evidence from Chinese listed enterprises, 2024 [12]	Smart city pilot policy (SCPP) as a quasi-natural experiment based on the panel data and the difference-in-differences method	smart city construction represents an innovative approach to promoting economic growth and environmental protection	2007–2021	SCPP can promote enterprise green innovation (EGI) by increasing enterprise digitalization
Pauluzzo, Rubens; Fedele, Paolo; Dokalskaya, Irina; Garlatti, Andrea, The role of digital technologies in public sector coproduction and co-creation: A structured literature review, 2024 [13]	Investigating method	reviews and critiques the literature on digitalization and coproduction/co-creation in public administration	published until 2022	128 records
Jia, Kaiwei; Zhang, Yu, Bank digitalization and corporate green innovation: empowering or negative? 2024 [14]	research sample of listed enterprises	the impact and mechanism of bank digital transformation on corporate green innovation	2010–2021	digital transformation can promote corporate green innovation by inhibiting corporate financialization and alleviating corporate financing constraints; regulation and media attention have a positive moderating effect on the relationship between banks' digital transformation and enterprises' green innovation
Aristovnik, Aleksander; Ravselj, Dejan; Murko, Eva, Decoding the Digital Landscape: An Empirically Validated Model for Assessing Digitalisation across Public Administration Levels, 2024 [15]	adaptation of Leavitt's diamond model	comprehensive questionnaire administered to Slovenian public administration organizations	questionnaire encompasses five key organizational elements (2023)	processes, people, structure, culture, and technology
Chatterji, Tathagata; Mukkai, Aravindan R., Driving Urban Digitalisation through a National Mission—a multilevel governance perspective of India's data smart cities strategy, 2024 [16]	analyzes the Data Smart Cities Strategy in India	how a national government-driven urban digitalization agenda is being implemented in a federal political system where urban development responsibilities are shared between different tiers	2015–present	100 Smart Cities Mission
Noennig, Jorg Rainer; Rose, Filipe Mello; Stadelhofer, Paul; Jannack, Anja; Kulashri, Swati, Agile development for urban digitalisation: insights from the creation of Dresden's smart city strategy, 2024 [17]	Agile development in public sector innovation	practical avenues for adapting agile development to the needs of public sector organizations	case study, review the collaborative elaboration of Dresden's smart city strategy as a critical case study	agile development and quadruple-helix innovation
Berman, Alexander; Licht, Karl de Fine; Carlsson, Vanja, Trustworthy AI in the public sector: An empirical analysis of a Swedish labor market decision-support system, 2024 [18]	Institutional Theory, the Resource-Based View (RBV), and Ambidexterity Theory	the deployment of Artificial Intelligence (AI) in the Swedish Public Employment Service (PES), focusing on the concept of trustworthy AI in public decision making	A case-study research design 2020–2021	7 Criteria for evaluating trustworthy AI: Performance, Calibration, Interpretability and Explainability, Intelligibility and Availability, Equal and Fair Treatment, Legality, Negotiation, and Appeal and Accountability and Human Oversight

Table 1. *Cont.*

Authors, Title, and Year	Method Used	Focus	Period Examined	Variables Used and Conclusions
Sanchez-Graells, Albert, Resh(AI)ping Good Administration: Addressing the Mass Effects of Public Sector Digitalisation, 2024 [19]	Analyze the Mass Effects of the Digitalization of Public Sector Decisions	the need to adapt good administration guarantees to a the collective dimension through an extension and a broadening of the public sector's good administration duties: that is, through an extended ex ante control of organizational risk-taking, and a broader ex post duty of automated redress	A case study—Making as the Crucial Challenge	legal modifications should be urgently implemented
Chevalier, Emiliem, Eva Ma Menéndez Sebastián, Digitalisation and Good Administration Principles, 2022 [20]	Analyze the links and the mutual impact of simultaneous developments	In the context of digitalization, the exercise of the administration's discretionary power is subject to certain pressures	from the beginning of the 21st century, of good administration and of the process of digitalization	technological disruption is transforming our lives, also from the perspective of the relationship between authorities and citizens
Dabbous, Amal; Barakat, Karine Aoun; Kraus, Sascha, The impact of digitalization on entrepreneurial activity and sustainable competitiveness: A panel data analysis, 2023 [21]	Quantitative panel method for evaluating the effect of digitalization on entrepreneurial activity and sustainable competitiveness	twin transitions—complementarity between digital and green transitions	Annual secondary data for an unbalanced panel of 34 countries from 2015 to 2018	digitalization as a major disruptive factor; it positively affects entrepreneurial activity and sustainable competitiveness, and entrepreneurial activities drive sustainable competitiveness
Fülöp, Melinda Timea; Breaz, Teodora Odett; He, Xiaofei; Ionescu, Constantin Aurelian; Cordos, George Silviu; Stanescu, Sorina Geanina, The role of universities' sustainability, teachers' wellbeing, and attitudes toward e-learning during COVID-19, 2022 [22]	questionnaire method based on the literature	an X-ray of the status and challenges faced in adopting e-learning	A questionnaire was sent to teachers	the technology acceptance model; it is essential to realize that we must take care of our wellbeing amid chaos
Mergel, Ines; Edelmann, Noella; Haug, Nathalie, Defining digital transformation: Results from expert interviews, 2019 [1]	expert interviews method	provide an empirically-based definition of digital transformation	40 experts from 12 countries were interviewed	definition of digital transformation and development of a conceptual framework
Lindgren, Ida; Madsen, Christian Ostergaard; Hofmann, Sara; Melin, Ulf, Close encounters of the digital kind: A research agenda for the digitalization of public services, 2019 [8]	a review and discussion on the digitalization of public services	discussion on how the digitalization of public services has affected the interaction between citizens and government	qualitative and hermeneutic approach	Summary of how digitalization of public services affects the public encounter: Nature and purpose of encounter, Communication form and setting, Central actors involved, Initiation, duration, and scope

Source: authors.

Some of the limitations that researchers may face when analyzing the evolution of e-government are related to the rapid changes in the field of the digitalization of public administration. Also, political and economic factors as well as cultural and social aspects can be important for impact analysis of the speed of digitalization of citizens' services in different countries.

3. Materials and Methods

3.1. Methodology

This study considers the annual data of the Corruption Perceptions Index, Digital Economy and Society Index, and gross national income per capita, in the period 2017–2022, for the 27 EU member states for linear regression analysis.

On base of SPSS and linear regression with the dependent variable DESI and the independent variables GNI per capita and CPI, we studied whether these independent variables can be considered as determinants for DESI. The justification for choosing those variables is that they can influence the value of DESI.

We analyzed the normality of the DESI, CPI, and GNI per capita series with the assistance of PP Plots.

In our study, we collected 486 statistical data on the corruption index (CPI), as well as the values for DESI and GNI per capita (USD), for the period 2017–2022 for all 27 states within the European Union. The data were centralized based on the official reports of the European Commission on DESI in the period 2017–2022 as well as the Transparency International Reports on the Corruption Perceptions Index from the period 2017–2022 and the official reports of The World Bank for the same period. We also processed the data related to EGDI level, level of income, and DESI provided by the United Nations, Department of Economic and Social Affairs, Division for Public Institutions and Digital Government.

The economic variables that could have an impact on the level of digitization in a country are numerous, but among the most important identified by us following the study conducted on the digitalization process of administration are the following:

- Corruption Perceptions Index (CPI);
- Gross National Income per capita (GNI per capita).

There are also other variables that are difficult to quantify, such as the factor that influences the success of an e-government service as prioritized by the authors of [23]: "being user satisfaction".

Several authors have tried to adapt a series of recognized models, such as UTAUT (unified theory of acceptance and use of technology), to which they added a series of influencing factors, such as trust.

The importance of digital transformation is also the basic idea of the study of Ha, L.T., who believes that the digitalization of public administration "is an essential factor in driving access to financial markets" [7].

Some studies report that digitalization of public administration "has affected, and continues to affect, the interaction between citizens and public authorities" [8] but also that the suppression of this interaction leads to the reduction of bureaucracy and corruption among public officials.

DESI and EGDI represent indicators by which the degree of digitalization can be measured at the European and international levels, respectively.

DESI (the Digital Economy and Society Index) summarized "indicators on Europe's digital performance and tracked the progress of EU countries" [24]

EGDI (E-Government Development Index) "presents the state of E-Government Development of the United Nations Member States" [25].

The CPI (Corruption Perceptions Index) "ranks 180 countries and territories around the world by their perceived levels of public sector corruption" [26].

3.2. The Algorithm of the Analysis of the Digitalization Process of the Public Administration in a State

In order to obtain the model for the level of the digitalization process of the public administration in a state, we used the following algorithm for this study, based on the methodology specified in the following Figure (see Figure 1).

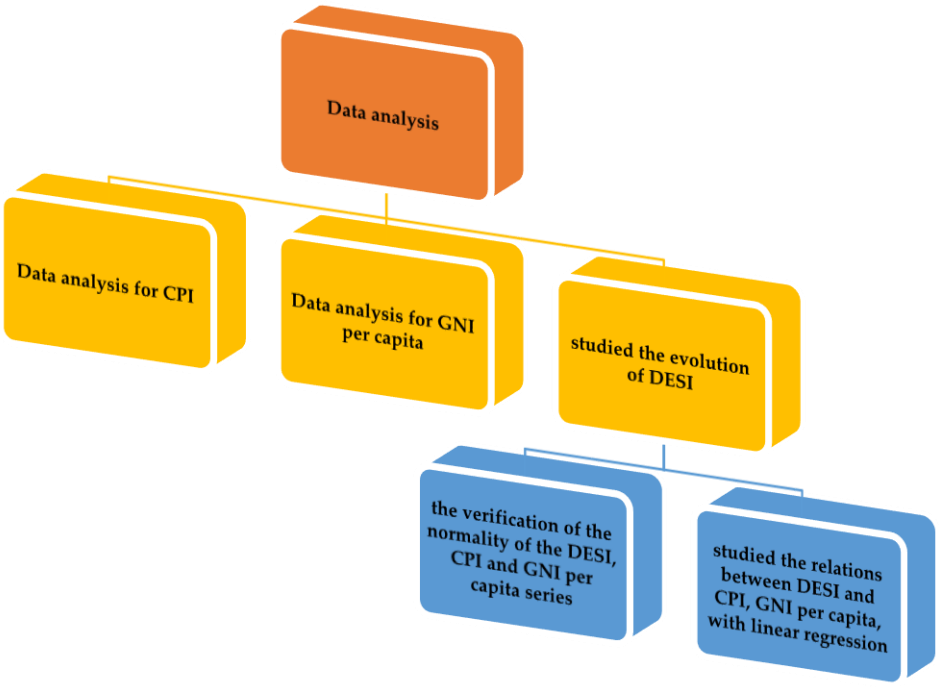

Figure 1. Flow chart of the study. Source: Drafted by the authors.

Our study is structured in two large parts, namely the following:

1. A comparative analysis of the current level of digitalization of the public administration in Romania compared to the existing level in the most digitally developed countries in the European Union according to DESI 2023 as well as compared to the EU average.
2. An SPSS analysis of the relationship between the digitalization level of a country quantified through the DESI index and the level of income for the 27 EU member states considered in the analysis (GNI per capita) and CPI (Corruption Perceptions Index) (see Figure 2).

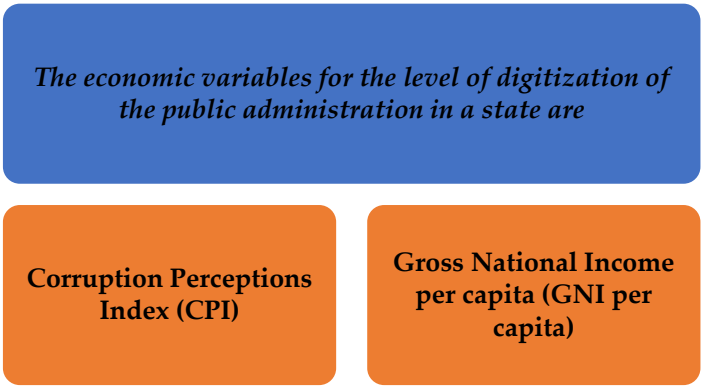

Figure 2. The economic variables for the level of digitization of the public administration. Source: Drafted by the authors.

4. Results

4.1. Comparative Analysis of the Current Level of Digitalization of the Public Administration in Romania Compared to the Existing Level in the Most Digitally Developed Countries in the European Union According to DESI 2023 as Well as Compared to the EU Average

The comparative analysis was carried out from the perspective of comparing the level of digitalization of the public administration in Romania to that existing in the most digitally developed countries at the level of the European Union according to DESI 2022

(top three) to which we added Estonia; although it is in the seventh place, it leads in digitized public services, and from the perspective of public administration, this indicator has a greater importance than the others, which is a priority from the point of view of our study. Thus, the group of digitized countries considered in the analysis consists of Denmark, Estonia, Finland, Netherlands, and Romania.

4.1.1. Comparative Analysis Regarding the Digital Infrastructure

In Figure 3, we can observe the scatterplot chart of the digitalization of public services for citizens in 2023.

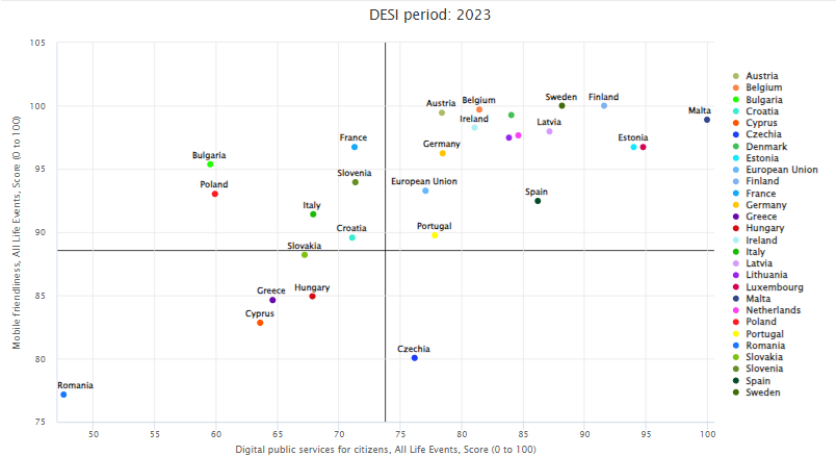

Figure 3. Source: https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts/compare-two-indicators?indicatorX=desi_4a2&indicatorY=desi_4a7&breakdownX=all_egov_le&breakdownY=all_egov_le&unitX=egov_score&unitY=egov_score&periodX=desi_2023, accessed on 10 February 2024.

Figure 4 and in Appendix A (Figures A1–A4) details the existing digital infrastructure in Romania as compared to the European average and that of digitally developed countries at the end of 2023, as follows:

- The digital infrastructure in Romania is superior to the EU average in terms of Fixed Very High-Capacity Network (VHCN) coverage (see Figure 1); Romania is in third place compared to the group of digitized countries at the EU level considered in the analysis (see Figure 2).

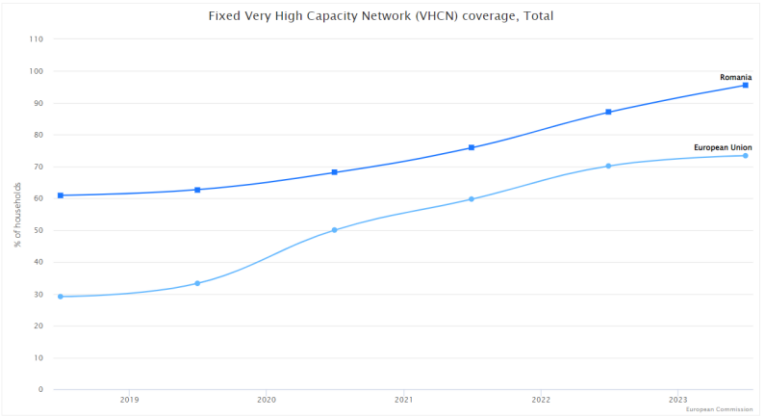

Figure 4. Source: Processed with the help of https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts/compare-countries-progress accessed on 10 February 2024.

4.1.2. Comparative Analysis of Digital Skills

As shown in Figure 5 and Appendix A (Figures A5–A11), Romania is below the EU average, as well as below the values recorded by the group of the most digitized EU countries considered in our study, for almost all indicators, except for the digital skills indicator regarding the percentage of ICT graduates, Female ICT specialists, and Female ICT graduates (see Appendix A, Figures A8–A10). Although Romania is at the top of the digital skills list for the ICT graduates indicator (%), it is in last place in the digital skills average, which means that a significant share of the population does not have basic digital skills.

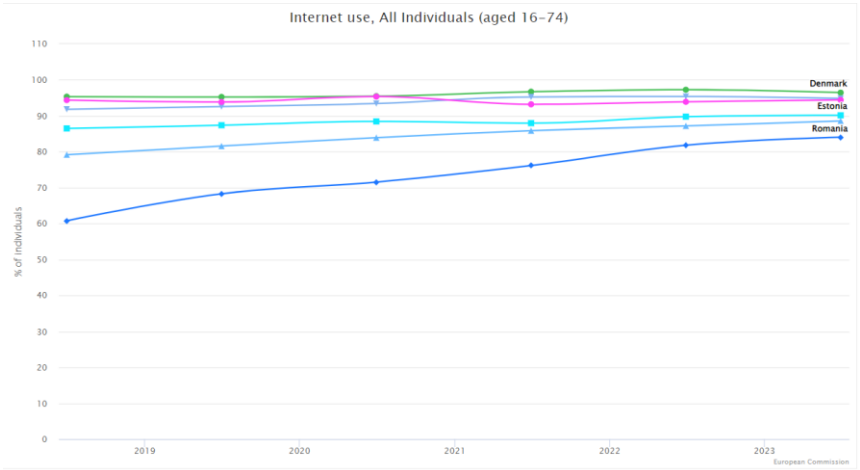

Figure 5. Source: Processed with the help of https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts/compare-countries-progress accessed on 10 February 2024.

4.1.3. Comparative Analysis Regarding the Digital Transformation of Business

In Appendix A, Figures A12–A16, it can be seen that Romania ranks last compared to the EU average and compared to the values recorded by the group of countries considered in the analysis for all indicators regarding the digital transformation of business.

However, in recent years, the digitalization of the public administration in Romania has made significant progress, which must be continued in the medium and long term, in a sustained way, to reduce the gap with the group of countries considered in our study. These efforts to emphasize digitalization can be supported, since the ITC has an increasingly significant weight in the GDP in recent years, considerably higher than most EU member states (see Figure 6 and Table 2).

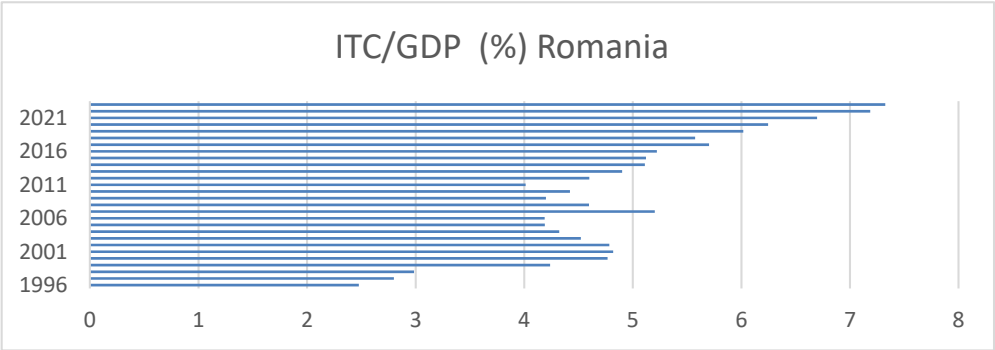

Figure 6. The evolution of the share of the ITC sector in Romania's GDP. Source: Processed with the help of SPSS.

Table 2. Gross value added (%). Source: https://ec.europa.eu/eurostat/statistics-explained/images/a/a7/Gross_value_added_at_current_basic_prices,_2005_and_2022_(%25_share_of_total_gross_value_added)_NA2023.png accessed on 15 January 2024.

	Agriculture, Forestry and Fishing		Industry		Construction		Distributive Trades, Transport, Accomodation and Food Services		Information and Communication		Financial and Insurance Activities		Real estate Activities		Professional, Scientific, Technical, Admnistrative and Suport Services		Public Admnistration, Defence, Education, Human Health and Social Work Activities		Art, Entertainment and Recreation; Other Services	
	2005	2022	2005	2022	2005	2022	2005	2022	2005	2022	2005	2022	2005	2022	2005	2022	2005	2022	2005	2022
EU	2.0	1.9	21.0	20.5	6.0	5.6	19.4	19.4	4.7	5.3	5.1	4.3	10.2	10.4	9.9	11.2	18.3	18.4	3.4	3.0
Belgium	0.9	0.7	20.4	17.7	4.9	5.4	21.2	18.3	4.1	4.5	5.6	6.2	8.3	8.8	12.1	15.5	20.3	20.8	2.2	2.0
Bulgaria	8.6	5.0	22.4	26.0	6.1	3.5	21.8	21.4	3.8	7.3	5.8	6.0	10.4	8.2	4.3	6.3	14.8	14.8	2.0	1.5
Czechia	2.5	2.3	30.5	28.1	6.7	5.7	20.6	17.9	4.8	6.8	3.1	3.9	8.1	9.6	6.7	7.4	14.7	16.1	2.3	2.1
Denmark	1.3	0.9	20.8	17.9	5.4	5.8	20.2	26.2	4.3	4.4	5.2	4.7	9.6	9.7	7.7	9.0	22.1	18.8	3.4	2.7
Germany	0.8	1.2	25.2	23.5	3.9	6.0	16.3	17.0	4.6	4.8	5.5	3.6	11.0	10.0	10.8	11.5	17.4	18.8	4.3	3.6
Estonia	3.7	2.9	21.1	20.4	8.5	6.9	24.6	19.9	4.7	8.0	4.1	4.6	9.6	10.0	7.5	9.6	13.3	15.2	2.8	2.6
Ireland	1.2	1.1	24.4	41.4	9.8	2.3	15.8	8.9	6.8	17.0	9.8	4.2	6.7	5.8	8.1	9.7	15.2	8.6	2.1	1.1
Greece	4.8	4.5	13.5	17.0	6.4	2.2	25.8	27.9	3.9	3.2	4.7	4.5	11.6	13.9	5.7	5.3	19.5	17.9	4.2	3.7
Spain	3.1	2.6	18.4	17.6	11.9	5.2	22.6	24.4	4.4	3.9	4.5	4.4	8.2	1.8	6.8	8.9	16.1	17.7	4.1	4.4
France	1.9	2.1	16.4	13.3	5.4	5.5	18.1	18.6	6.3	5.5	3.8	3.7	12.2	12.5	12.4	14.0	21.4	22.2	3.0	2.6
Croatia	4.6	3.0	21.0	17.7	7.2	5.7	22.2	24.0	4.9	5.7	5.9	4.6	8.6	9.5	6.6	8.1	16.2	18.4	2.8	3.3
Italy	2.3	2.2	19.9	20.5	5.9	5.2	20.7	21.1	4.4	3.6	5.2	4.7	11.7	13.4	9.5	9.8	16.8	16.4	3.7	3.5
Cyprus	3.1	1.9	10.1	9.4	10.4	6.0	24.8	21.9	3.9	9.0	7.1	10.2	7.9	8.6	7.9	11.1	20.7	18.5	4.0	3.5
Latvia	4.2	5.8	15.9	18.7	6.8	5.0	30.5	23.6	4.6	6.1	4.4	3.2	9.5	9.9	6.0	8.6	15.2	16.7	2.9	2.5
Lithuania	4.8	4.4	25.0	22.9	7.8	7.1	28.2	29.1	4.1	3.9	2.2	3.2	6.3	6.3	5.1	6.8	14.3	14.3	2.3	1.9
Luxembourg	0.4	0.3	10.6	7.0	5.7	6.4	15.7	17.1	6.0	4.0	25.9	25.2	9.7	7.2	8.5	14.7	15.5	16.4	1.9	1.6
Hungary	4.3	3.2	25.8	24.0	5.7	6.4	17.4	17.9	5.1	4.9	4.2	3.6	7.9	10.8	8.2	10.0	18.4	16.5	2.9	2.7
Malta	2.1	1.0	16.6	9.1	7.6	4.3	23.7	18.3	5.5	8.8	6.8	8.8	6.4	5.8	8.1	15.7	18.6	16.7	4.7	11.4
Netherlands	2.1	1.9	18.1	16.4	5.4	4.7	19.8	20.5	5.0	5.2	7.2	5.2	7.2	8.2	13.1	14.9	19.7	20.9	2.4	2.1
Austria	1.4	1.5	23.4	21.6	7.0	7.6	22.8	22.2	3.6	3.7	4.9	4.1	9.1	9.6	8.0	9.9	17.0	17.3	2.8	2.5
Poland	3.3	2.4	25.0	27.6	7.6	6.1	25.6	23.1	4.4	4.5	4.0	5.0	6.0	5.7	6.4	9.2	15.4	14.6	2.3	1.8
Portugal	2.7	2.2	17.7	17.5	6.9	4.6	22.3	23.7	3.9	4.5	6.6	5.0	8.7	12.3	6.4	8.6	22.3	19.3	2.5	2.4
Romania	9.6	4.9	28.5	24.8	7.9	7.0	21.2	20.5	4.5	7.3	2.3	2.9	8.5	8.1	3.4	7.8	11.7	13.9	2.4	2.9
Slovenia	2.8	1.9	27.4	25.7	6.5	7.1	19.2	21.5	4.0	4.2	4.5	3.9	7.6	7.4	8.3	9.9	16.7	16.2	3.0	2.2
Slovakia	1.8	2.5	29.7	25.4	6.5	6.7	22.3	18.6	4.2	5.2	3.8	2.2	8.4	12.2	6.6	8.6	13.9	15.9	2.7	2.8
Finland	2.6	2.7	27.0	22.2	6.4	6.7	17.1	14.5	5.0	6.4	2.9	3.1	10.2	12.3	6.6	9.2	19.5	20.1	2.7	2.8
Sweden	1.4	1.6	23.2	20.3	4.9	6.6	17.8	17.0	6.7	8.5	4.5	4.4	8.7	7.7	9.1	11.4	20.8	19.9	2.8	2.6

4.2. SPSS Analysis of the Relationship between the Digitalization Level of a Country Quantified through the DESI Index and the Level of Income for the 27 EU Member States Considered in the Analysis (GNI per capita) and CPI (Corruption Perceptions Index)

Based on the 486 statistical data collected and centralized in the corruption index (CPI) as well as the values for DESI and GNI per capita (US dollars) for the period 2017–2022 for the 27 EU member states, we performed statistical analysis with the help of SPSS regarding the existence of a relationship between DESI and level of income (GNI per capita) and/or CPI (Corruption Perceptions Index).

We also processed the data related to EGDI level, level of income, and DESI; the cross-tabulation distribution regarding EGDI level and level of income for the 27 EU member states can be found in Figure 7, and the distribution according to EGDI level, level of income, and GNI per capita is shown in Figure 8.

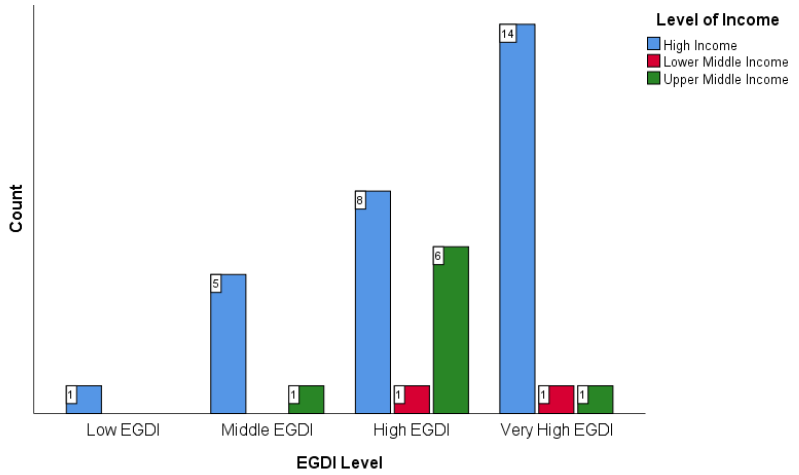

Figure 7. Distribution of EGDI level according to level of income. Source: SPSS processing.

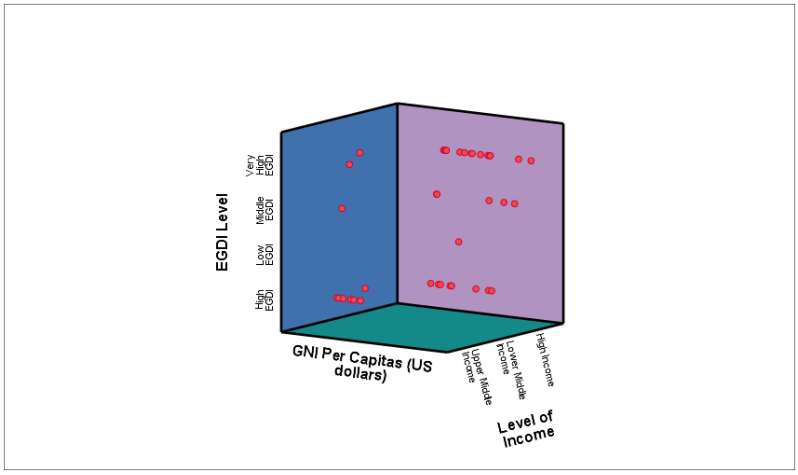

Figure 8. Distribution according to EGDI level, level of income, and GNI per capita. Source: SPSS processing.

Using SPSS to conduct linear regression with the dependent variable DESI and the independent variables GNI per capita and CPI, we studied whether the independent variables can be considered as determinants of DESI.

The verification of the normality of the DESI, CPI, and GNI per capita series is reflected with the help of PP Plots (See Figures A20–A22 in Appendix B).

The statistical data for 27 countries from the EU were processed with SPSS; analyzing Model 1 for 27 EU member states considered in the analysis, and considering the fact that Sig. from the ANOVA table is 0.002, a value of less than 0.05 shows that Model 1 is statistically relevant, and the parameters in the respective regression equation differ significantly from 0 (See Tables 3–6).

Table 3. Variables entered/removed. Source: Processed with the help of SPSS.

Model	Variables Entered	Variables Removed	Method
1	CPI, GNI per capita	.-	enteritis

Dependent variable: DESI.

Table 4. Model summary. Source: Processed with the help of SPSS.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.860 [a]	0.740	0.718	5.05218

[a] Predictors: (constant), CPI, GNI per capita.

Table 5. ANOVA [a]. Source: Processed with the help of SPSS.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1743.281	2	871.640	34.149	0.000
	Residual	612.588	24	25.524		
	Total	2355.868	26			

[a] Dependent variable: DESI; Predictors: (constant), CPI, GNI per capita.

Table 6. Coefficients for dependent variable DESI. Source: Processed with the help of SPSS.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	17.057	5.216		3270	0.003
	GNI per capita	0.000	0.000	0.225	1500	0.014
	ICC	0.470	0.103	0.684	4552	0.000

Based on the data in Table 6 for Model 1 analyzed for the 27 EU member states, the Sig. afferent for the constant and the independent variable CPI and DESI is <0.05; thus, we can validate the model because these coefficients are statistically relevant. Thus, there is a direct relationship between digitalization and standard of living, but also between digitalization and CPI, which means the reduction of corruption.

Through the analysis carried out on the evolution of CPI in the last decade at the level of all EU member states based on the data collected and processed from the official reports of Transparency International on the Corruption Perceptions Index, it can be found based on Tables 7 and 8 that in the case of the majority of European countries, the way in which corruption is perceived has improved, with the exception of Hungary and Cyprus, which recorded a decrease in CPI of 12 and 13 points, respectively, in the last 10 years.

Table 7. Score changes in trends for Corruption Perceptions Index. Source: Processed according to the Corruption Perceptions Index, 2021, https://www.transparency.org/en/cpi/2021 accessed on 30 September 2023.

Country/ Territory	CPI Score 2021	1-Year Trend		5-Year Trend		10-Year Trend	
		CPI Score 2020	Change Since 2020	CPI Score 2017	Change Since 2017	CPI SCORE 2012	Change Since 2012
Austria	74	76	↓ −2	75	↓ −1	69	↑ 5
Belgium	73	76	↓ −3	75	↓ −2	75	↓ −2
Bulgaria	42	44	↓ −2	43	↓ −1	41	↑ 1
Cyprus	53	57	↓ −4	57	↓ −4	66	↓ −13
Croatia	47	47	0	49	↓ −2	46	↑ 1
Czechia	54	54	0	57	↓ −3	49	↑ 5
Denmark	88	88	0	88	0	90	↓ −2
Estonia	74	75	↓ −1	71	↑ 3	64	↑ 10
Finland	88	85	↑ 3	85	↑ 3	90	↓ −2
France	71	69	↑ 2	70	↑ 1	71	0
Germany	80	80	0	81	↓ −1	79	↑ 1
Greece	49	50	↓ −1	48	↑ 1	36	↑ 13

Table 7. *Cont.*

Country/ Territory	CPI Score 2021	1-Year Trend		5-Year Trend		10-Year Trend	
		CPI Score 2020	Change Since 2020	CPI Score 2017	Change Since 2017	CPI SCORE 2012	Change Since 2012
Hungary	43	44	↓ −1	45	↓ −2	55	↓ −12
Ireland	74	72	↑ 2	74	0	69	↑ 5
Italy	56	53	↑ 3	50	↑ 6	42	↑ 14
Latvia	59	57	↑ 2	58	↑ 1	49	↑ 10
Lithuania	61	60	↑ 1	59	↑ 2	54	↑ 7
Luxembourg	81	80	1	82	↓ −1	80	↑ 1
Malta	54	53	↑ 1	56	↓ −2	57	↓ −3
Netherlands	82	82	0	82	0	84	↓ −2
Norway	85	84	↑ 1	85	0	85	0
Poland	56	56	0	60	↓ −4	58	↓ −2
Portugal	62	61	↑ 1	63	↓ −1	63	↓ −1
Romania	45	44	↑ 1	48	↓ −3	44	↑ 1
bondage	38	38	0	41	↓ −3	39	↓ −1
Slovakia	52	49	↑ 3	50	↑ 2	46	↑ 6
Slovenia	57	60	↓ −3	61	↓ −4	61	↓ −4
Spain	61	62	↓ −1	57	↑ 4	65	↓ −4
Sweden	85	85	0	84	↑ 1	88	↓ −3

Table 8. Corruption Perceptions Index 2021: Statistically significant changes (2012–2021). Source: processed according to the Corruption Perceptions Index, 2021, https://www.transparency.org/en/cpi/2021 accessed on 30 September 2023.

Country/Territory	ICC 2021	ICC 2012	Score Change
Austria	74	69	↑ 5
Estonia	74	64	↑ 10
Greece	49	36	↑ 13
Hungary	43	55	↓ −12
Italy	56	42	↑ 14
Latvia	59	49	↑ 10
Cyprus	53	66	↓ −13

It can thus be stated, once again, that the emphasis on the level of digitalization within the EU member states, especially in the post-pandemic period, has also led to a reduction in the level of bureaucracy, which is also reflected in the reduction in the level of corruption perceived by citizens.

5. Discussion

In the specialized literature, some authors considered that citizens are willing to use "the e-government services" to a greater extent [27], which is why the development of digital skills of all citizens is extremely important to facilitate access to digitized public services. This can be achieved through digital education, which can be achieved through lifelong learning programs and by including in school programs subjects that ensure the development of digital skills and competences in accordance with the age of the students.

Scheerder et al. state that we must focus on the "third-level digital divide in which the tangible outcomes of Internet use are highlighted" [28].

In public administration "digital transformation contributes to increasing accessibility, transparency, and efficiency and reducing bureaucracy and corruption. There is a direct correlation between digitalization and efficiency" [29].

Romania "aimed at speeding up digitalization even before the pandemic period, which in a necessary way boosted this process in all sectors of the Romanian economy, and especially in education, online trade and online payments" [30].

E-government "refers to the use of information and communication technology (ICT) applications to deliver various government services" [31].

The digital infrastructure in Romania is second best, after Spain, regarding the indicator of at least 100 Mbps fixed broadband take-up and leads the group of the most digitized countries (see Appendix A, Figures A1 and A2).

The digital infrastructure in Romania is third best, after France and Hungary, regarding other indicators and leads compared to the group of the most digitized countries (see Appendix A, Figures A2 and A3).

Also, Romania is in first place compared to the group of the most digitized countries considered in the analysis for the Fiber to the Premises (FTTP) coverage indicator (see Appendix A, Figure A3), but Romania ranks last compared to the group of countries considered in the analysis regarding the indicators related to mobile broadband take-up, Overall 5G coverage, and 5G spectrum (see Appendix A, Figure A4).

The PNRR national recovery and resilience plan states that "the digitalization of public administration also follows a sectorial approach through measures related to e-health, the digitalization of the justice system, the environment, employment and social protection and the implementation of electronic forms for public procurement" [25].

"Romania is making some progress in the digitalization of tax administration, which contributes to reducing tax arrears and increasing tax collection. Although tax arrears fell by 1.4 percentage points to 43% of total net revenues, they remain consistently higher than the EU-27 average. Electronic filing rates have increased considerably in recent years, along with VAT simplifications and the relatively low level of administration required for the single rate; however, tax collection and predictability should improve" [25].

But, for digitized public services to be accessed by an increasingly significant share of citizens, digital skills are particularly important, and this can only be achieved through digital education. In this sense, reforms must aim at "early education and care, reducing early school leaving, creating a full vocational route for dual education and digitizing vocational education and training" [25].

"The implementation of digitalization projects such as SAF-T, the electronic invoice and the interconnection of cash registers will bring progressive benefits by reducing the administrative burden, reducing the fiscal gap, especially in the VAT area, they will contribute to combating tax evasion and will implicitly lead to the improvement of collecting money" [32].

One of the barriers to digitalization in Romania is the interoperability of public administration IT systems and databases. Also, it is essential to ensure the cyber security of the data at every stage of the public services offered to citizens to ensure both the protection of personal data and the security of the transactions carried out, so as to increase the confidence of the citizens in these e-government solutions.

6. Conclusions

6.1. General Conclusions

Our study aimed at carrying out a quantitative and qualitative analysis of the level of digitalization of the 27 EU member states based on 486 statistical data collected and centralized for the period 2017–2022, including standard of living and corruption index. The research started with the comparative analysis of the Romanian public administration compared to that existing in the most digitally developed states at the European level, the countries located in the top 3 regarding the DESI index, to which we added Estonia, which is considered the most digitized state from the point of view of public services offered to citizens.

The comparative analysis between Romania's digitalization level and the group of the most digitally developed states sought to identify the extent to which Romanian citizens have access to accessible, non-bureaucratic, and transparent public services that allow them social inclusion and non-discrimination, compared to other European citizens. Unfortunately, although visible and important progress has been made at the level of the Romanian economy and public administration from the perspective of digitalization, Romania remains at the bottom of the list of European nations for almost all indicators, apart from the indicators that target the digital infrastructure and the share of ICT graduates and female ICT graduates and specialists. All this shows that citizens' access to digital, transparent, and non-discriminatory public services has improved, but sustained efforts are still needed to maintain and even accelerate the trend so as to reduce the discrepancies compared to the EU average.

Also, our research studies the link between the level of digitalization quantified by the DESI indicator and the level of income and CPI for the states considered in the analysis. Thus, there is a direct relationship between digitalization and the standard of living, but also between digitalization and CPI, which means the reduction of corruption.

Because the degree of digitalization of electronic payments also influences the underground economy in that state and therefore the efficiency of revenue collection, all governments should be interested in accelerating the digitalization of all public and fiscal services.

6.2. The Limitations of the Research and Future Lines of Research

Our study is on a current issue, as it addresses the issue of digitalization of public administration in the new post-pandemic and geostrategic context. It has theoretical applicability, by determining a model that can be used to study the relationship between digitalization and the standard of living and corruption, and also practical application, because it can contribute to the awareness of the government in taking measures and adopting strategies to reduce the gaps compared to the most developed digital states. Also, the knowledge of these interdependencies is useful for anticipating the need for specialists in the ITC field. Another vital aspect of the governance of any state is the one that refers to the connection between the degree of digitalization of electronic payments and the level of the underground economy and therefore the efficiency of revenue collection. Thus, in Romania, in addition to the electronic platform for payment of taxes and fines, www.ghiseul.ro (accessed on 28 January 2024) which currently has over 1,955,400 active users, representing approximately 10% of the total population of Romania, shows a high degree of digitalization at the level of ANAF (National Fiscal Administration Agency). There are several digitalization projects underway, among which the newest is the one related to the mandatory use of e-invoices to all legal entities, which will lead to the reduction of tax evasion and, implicitly, the underground economy.

Also, the fact that in Romania the ITC sector has a large share of the GDP, combined with the high share of ITC graduates, represents a series of favorable premises for accelerating the digitalization of the economy and public administration in the next digital decade.

Our study will be continued in articles that will focus on the connection between digitalization and the efficiency of public administration, as well as between digitalization, the reduction of the underground economy, and the increase of efficiency regarding the

collection of budget revenues. We will also continue research from the perspective of citizens' access to accessible, non-bureaucratic, and transparent public services that support social inclusion and non-discrimination, also from the perspective of digitalization and cyber security.

Author Contributions: Conceptualization, R.P., G.-C.S. and A.-E.M.; Methodology, software, formal analysis and validation, R.P.; Investigation, R.P., G.-C.S. and A.-E.M.; Resources, R.P., G.-C.S. and A.-E.M.; Data curation, R.P., G.-C.S. and A.-E.M.; Writing—original draft preparation, writing—review and editing, visualization and supervision, R.P. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Note: Figures A1–A19 are processed with the help of https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts/compare-countries-progress accessed on 15 January 2024.

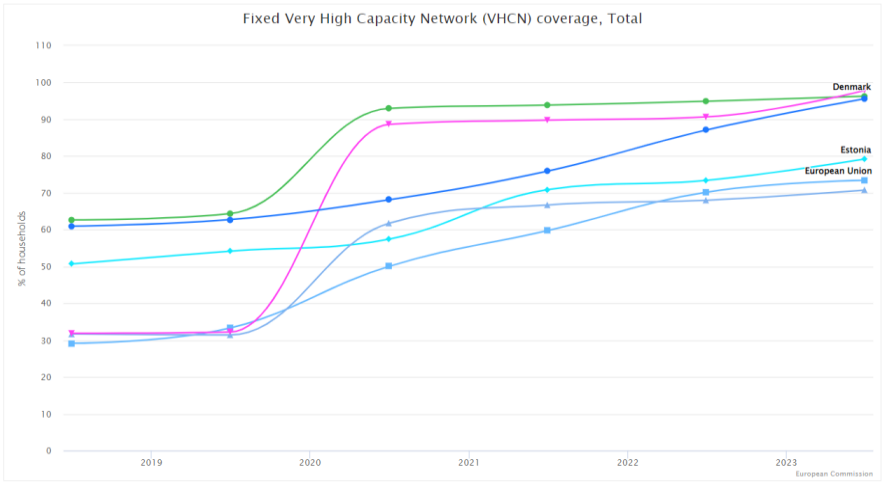

Figure A1. Fixed Very high Capacity Network (VHCN) coverage, Total.

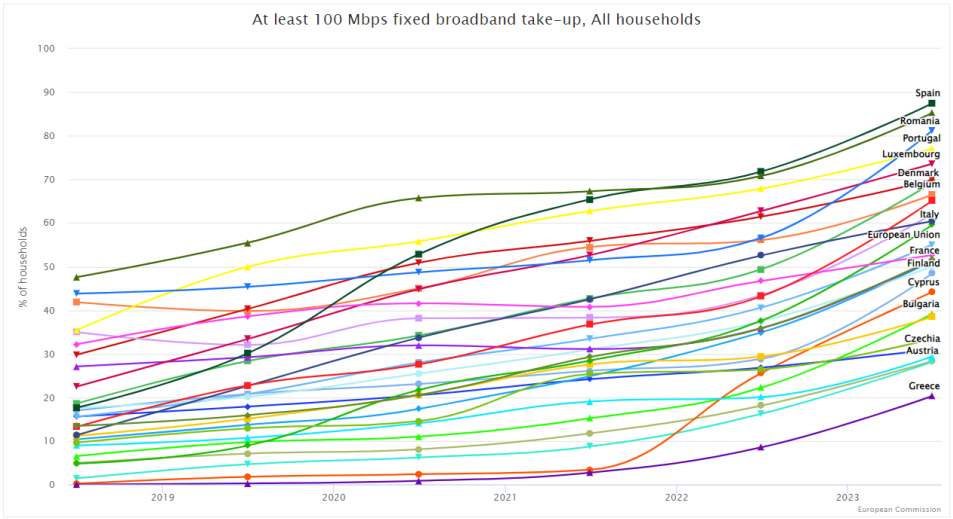

Figure A2. At least 100 Mbps fixed broadband take-up, All households.

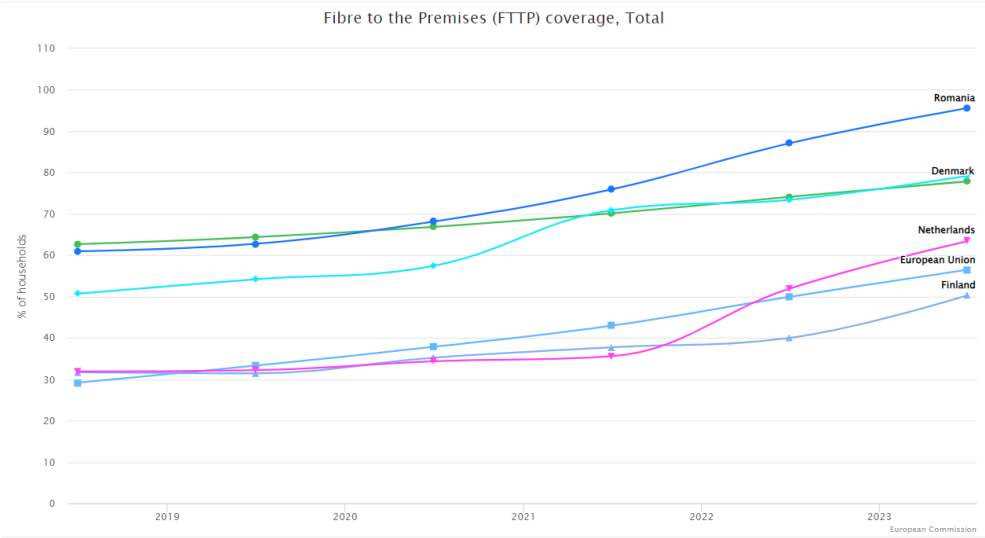

Figure A3. Fibre to the Premises (FTTP) coverage, Total.

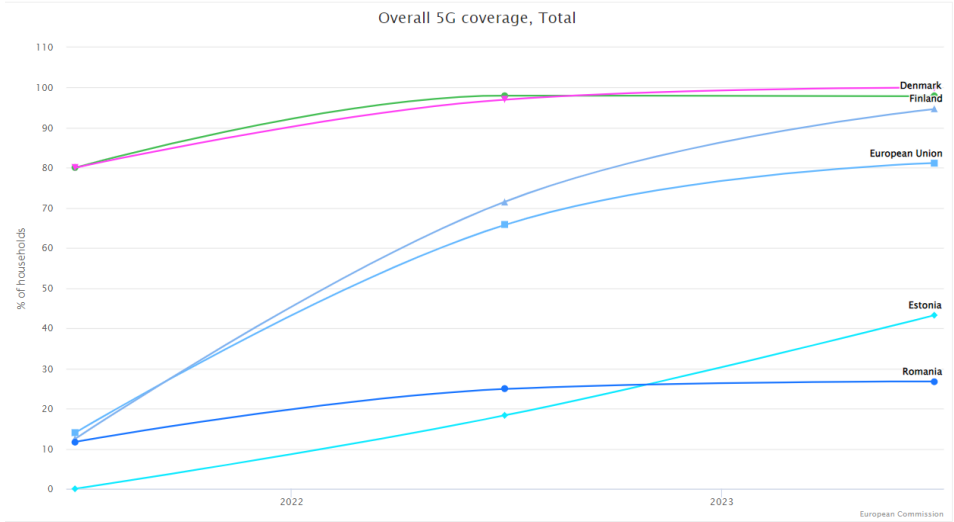

Figure A4. Overall 5G coverage, Total.

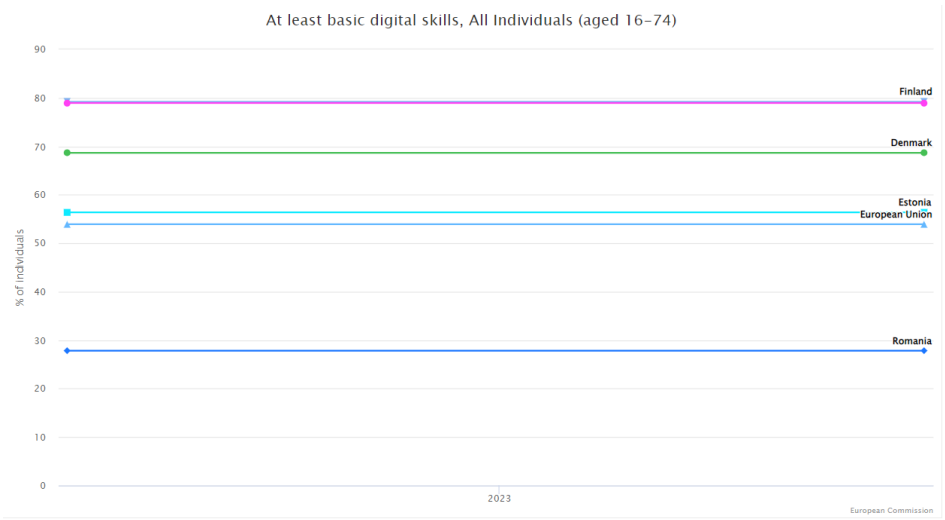

Figure A5. At least basic digital skills, All Individuals (aged 16–74).

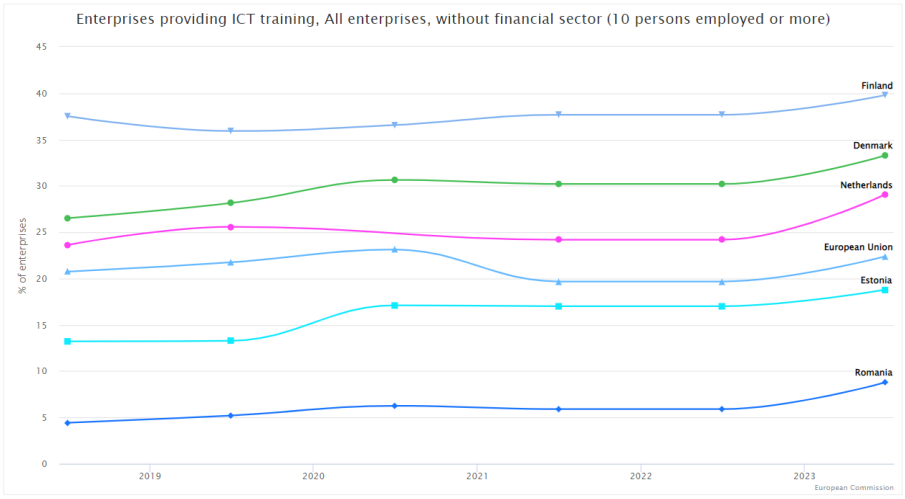

Figure A6. Enterprises Providing ICT training, All enterprises, without financial sector (10 persons employed or more).

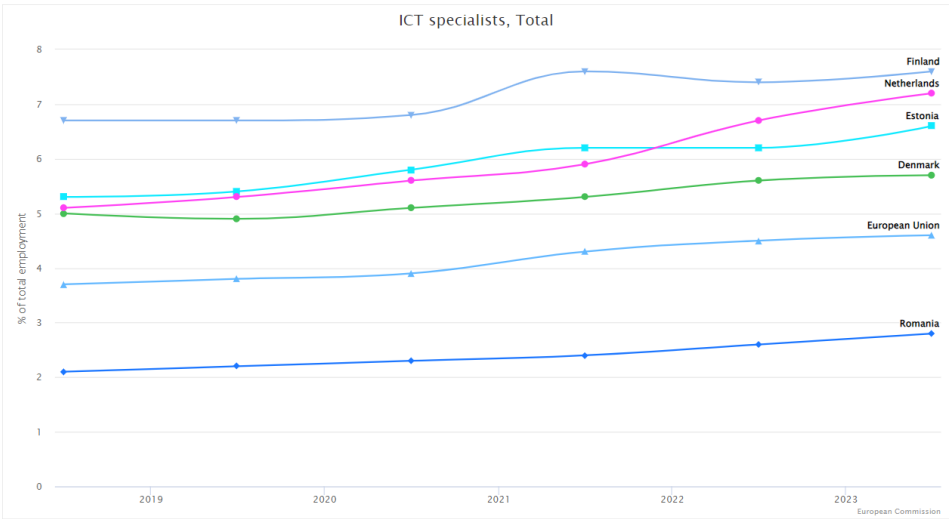

Figure A7. ICT specialists, Total.

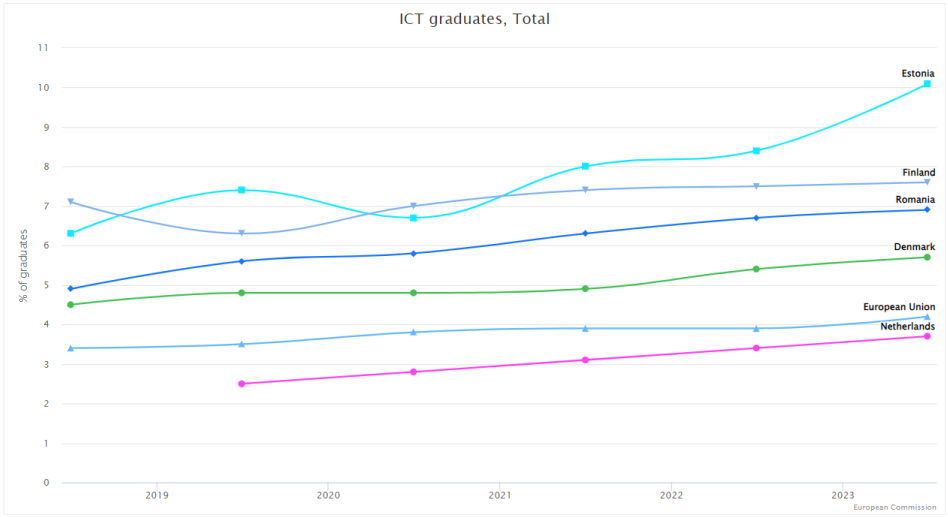

Figure A8. ICT graduates, Total.

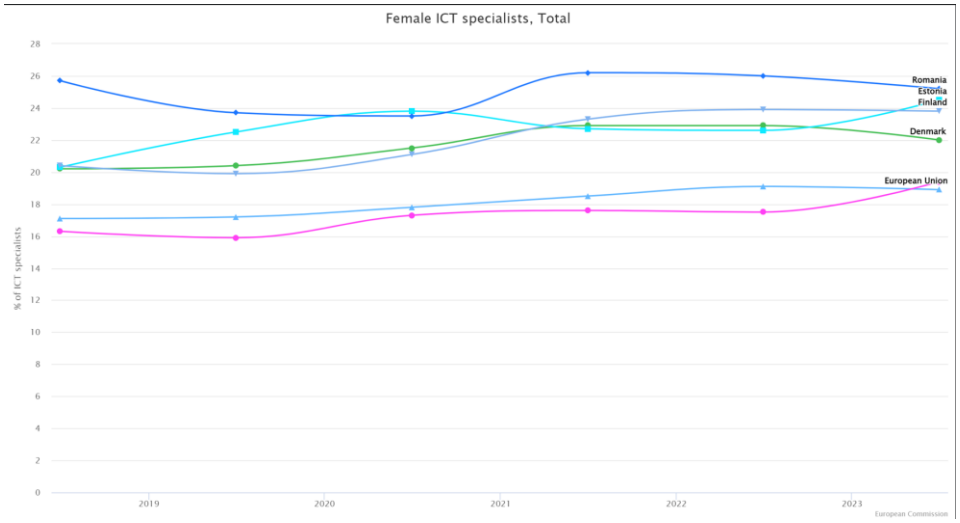

Figure A9. Female ICT specialists, Total.

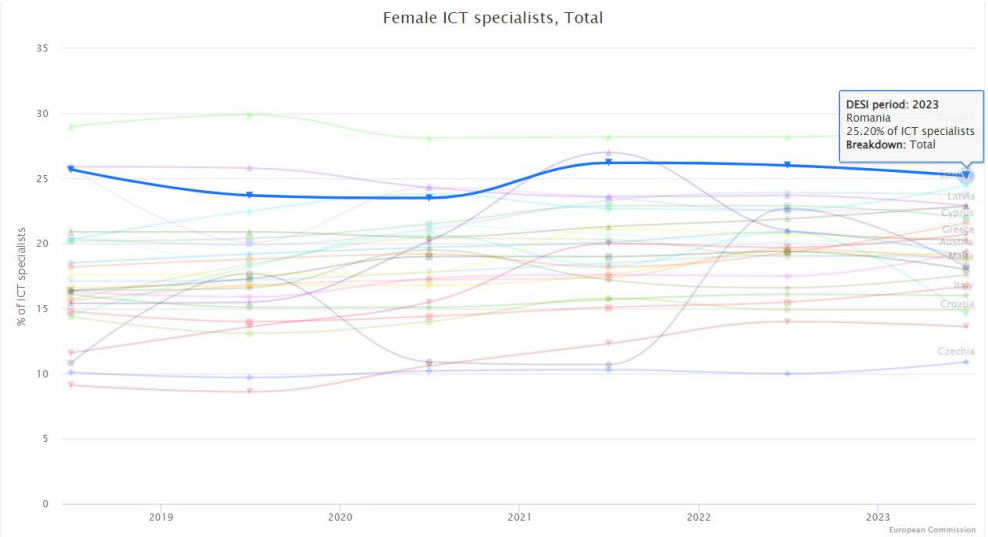

Figure A10. Female ICT specialists, Total.

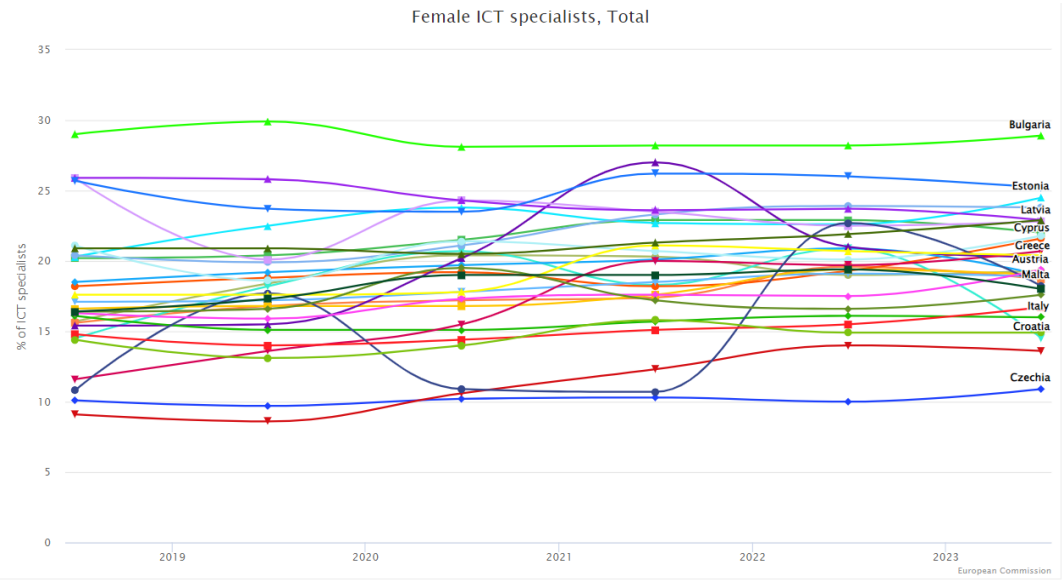

Figure A11. Female ICT specialists, Total.

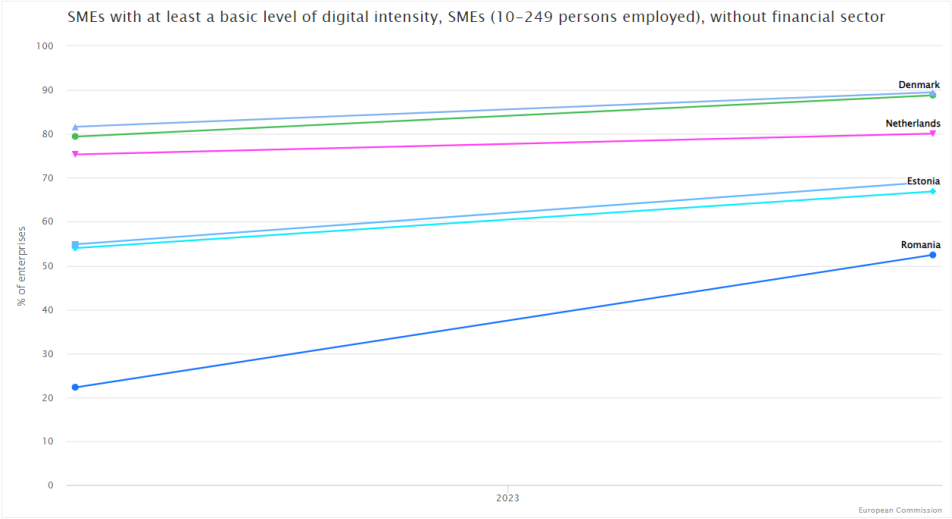

Figure A12. SMEs with at least a basic level of digital intensity, SMEs (10–249 persons employed), without financial sector.

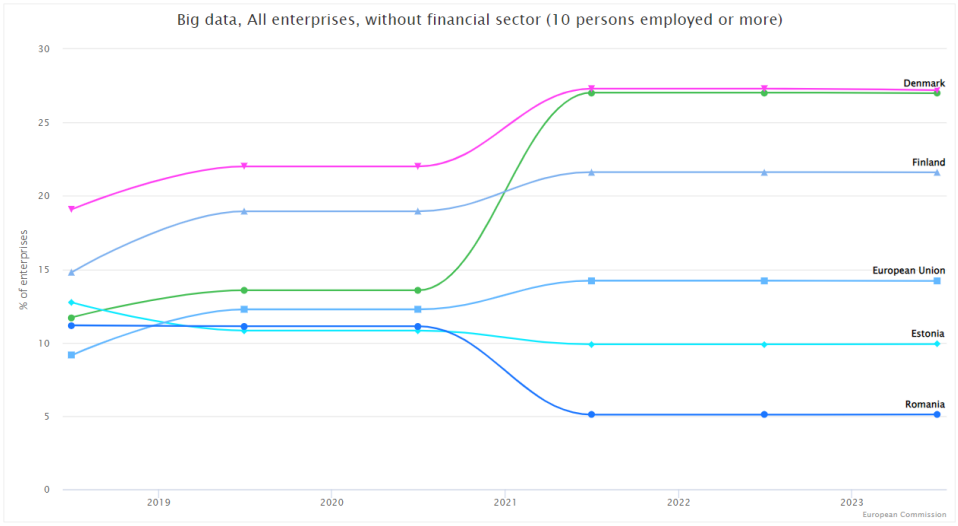

Figure A13. Big date, All enterprises, without financial sector (10 persons employed or more).

Figure A14. e-Invoices, All enterprises, without financial sector (10 persons employed or more).

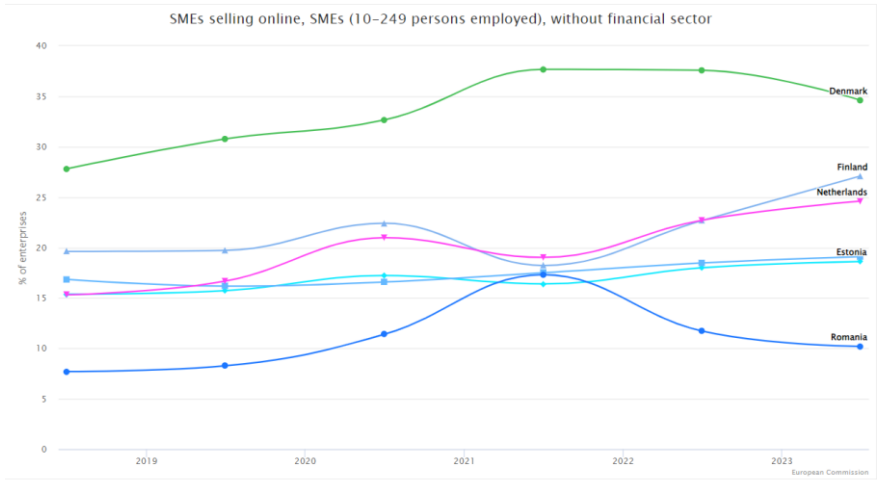

Figure A15. SMEs selling online, SMEs (10–249 persons employed), without financial sector.

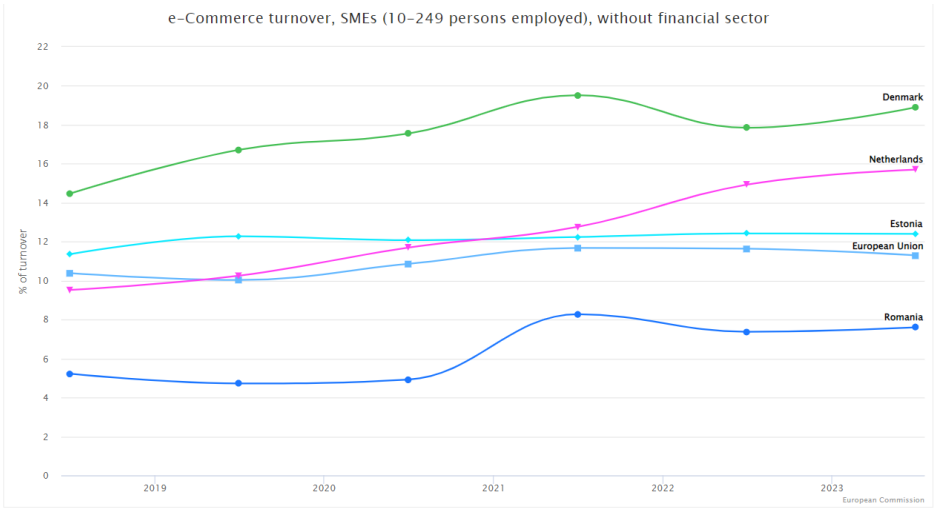

Figure A16. e-Commerce turnover, SMEs (10–249 persons employed), without financial sector.

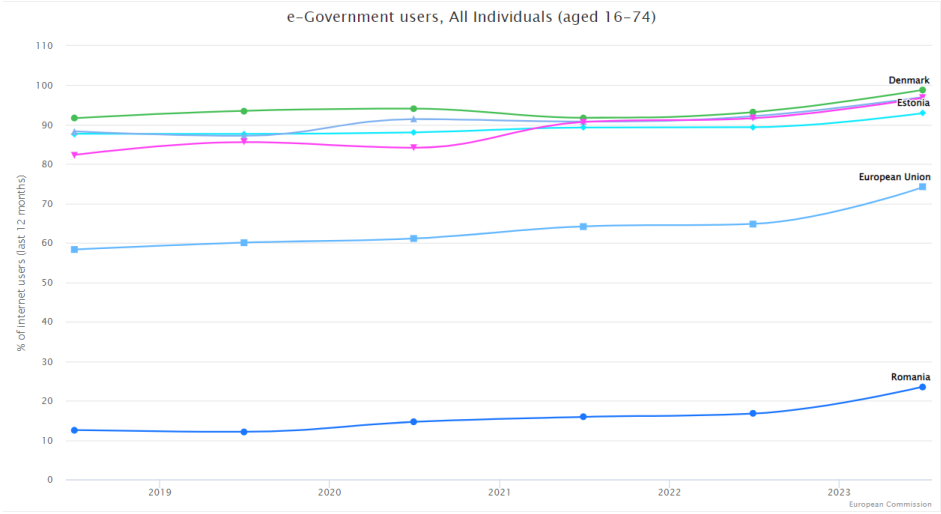

Figure A17. e-Government users, All individuals (aged 16–74).

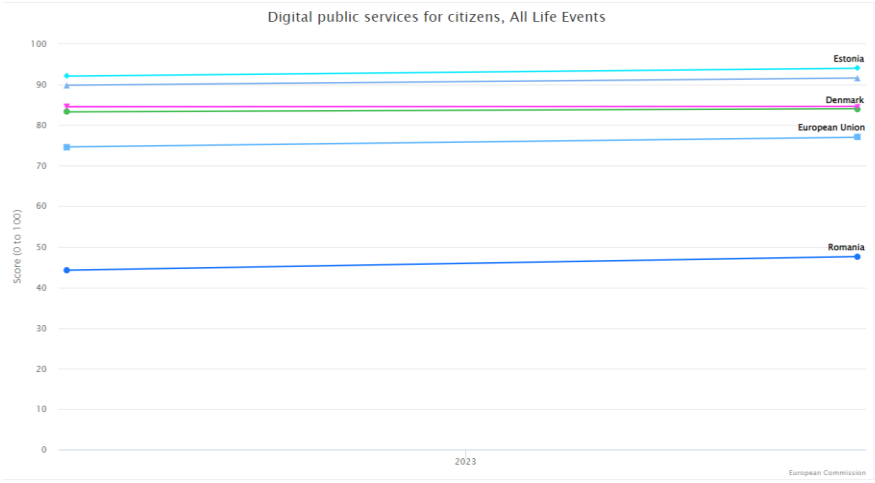

Figure A18. Digital public services for citizens, All life events.

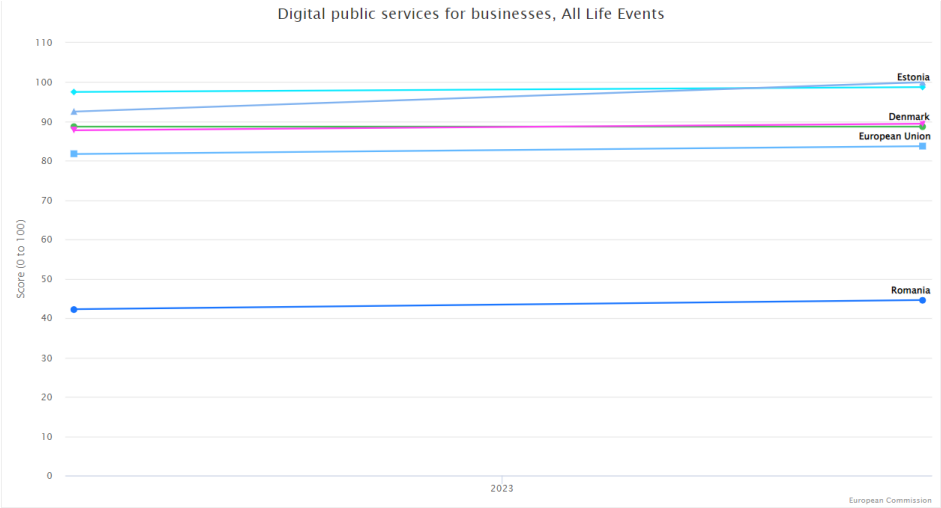

Figure A19. Digital public services for businesses, All life events.

Appendix B

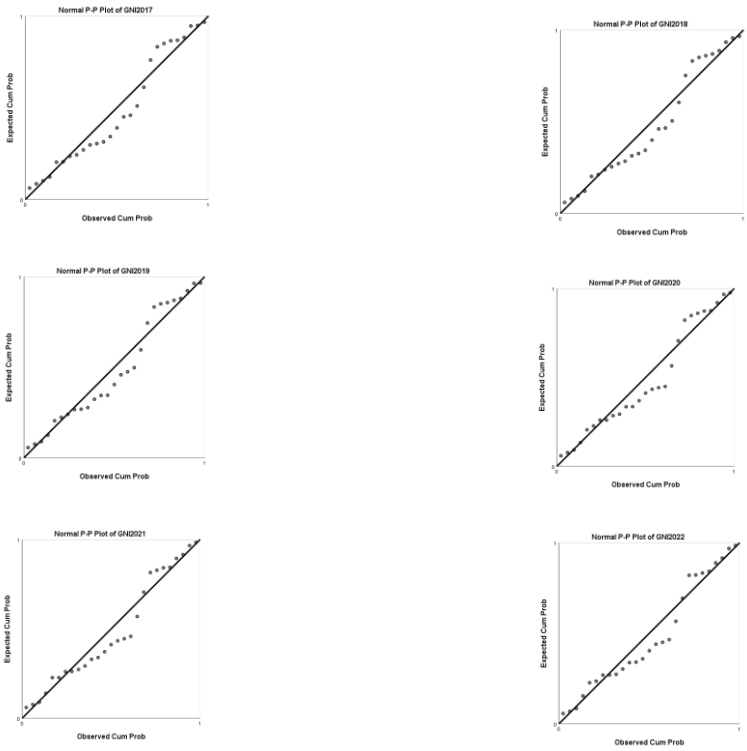

Figure A20. PP Plot of GNI per capita. Source: SPSS processing.

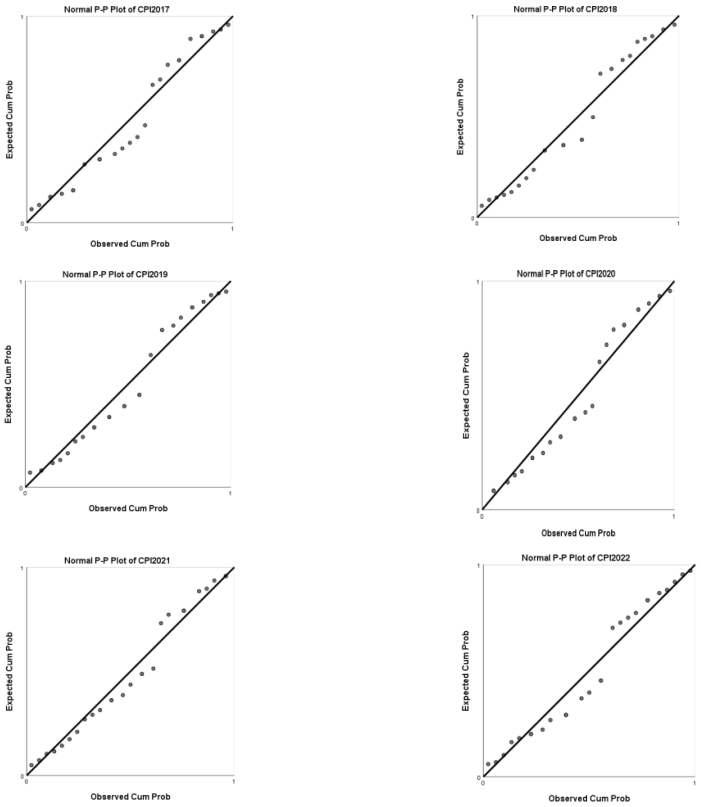

Figure A21. PP Plot of CPI. Source: SPSS processing.

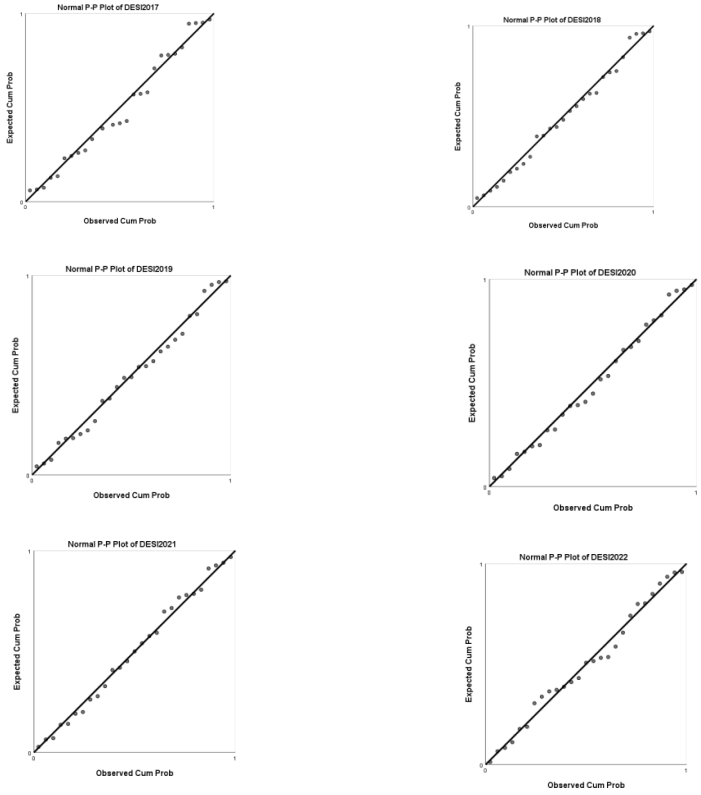

Figure A22. PP Plot of DESI. Source: SPSS processing.

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