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Analysis of E-government and Digital Society Indicators in Selected Countries

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– Definition and development of the terms e-government and digital society
– Identification and comparison of relevant indicators
– Analysis of indicators in selected countries
– Results and discussion

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Falk, S., Römmele, A., & Silverman, M. (Eds.). (2017). Digital Government: Leveraging Innovation to Improve Public Sector Performance and Outcomes for Citizens. Cham: Springer. ISBN 978-3-319--38795-6.
Chen, H. et al. (Eds.). (2007). Digital government: E-government research, case studies, and implementation, Vol. 17. Springer Science & Business Media. ISBN 978-0-387-71611-4.
Nardo, M. et al. (2008). Handbook on Constructing Composite Indicators: Methodology and user Guide. Paris: OECD Publishing. ISBN 978-92-64-04345-9.
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ANNOTATION

This thesis deals with the analysis of indicators of e-government and digital society in the EU countries. First, the ICT topic and the conditions for the development of digital societies in the public administration context are described. The following are definitions of e-government and digital society, and above all a description of existing indices, rankings, and reports evaluating these areas. After comparing selected indices and related indicators and their structure and development, statistical and cluster analyses of the data for the EGDI and DESI in the EU countries are performed.

KEYWORDS

e-government, digital society, development, indicators, comparison, cluster analysis

NÁZEV

Analýza indikátorů e-governmentu a digitální společnosti ve vybraných zemích

ANOTACE

Tato práce se zabývá analýzou indikátorů e-governmentu a digitální společnosti v zemích EU. Nejdříve je popsána problematika ICT a podmínky pro rozvoj digitálních společností ve veřejné správě. Následují definice e-governmentu a digitální společnosti, a především popis existujících indexů, pořadí a zpráv hodnotících tyto oblasti. Po porovnání vybraných indexů a souvisejících indikátorů a jejich struktury a vývoje jsou provedeny statistická a shluková analýza získaných dat pro EGDI a DESI v zemích EU.

KLÍČOVÁ SLOVA

e-government, digitální společnost, vývoj, indikátory, porovnání, shluková analýza

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
DESI	Digital Economy and Society Index
EGDI	E-government Development Index
EPI	E-participation Index
EU	European Union
GIS	Geographic Information System
ICT	Information and Communications Technologies
IDI	ICT Development Index
IoT	Internet of Things
ITU	International Telecommunications Union

NRI	Network Readiness Index
OECD	Organisation for Economic Co-operation and Development
SDGs	Sustainable Development Goals
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WEF	World Economic Forum

INTRODUCTION

Information and Communications Technologies (ICT) enabled delivery of public services to more people in an efficient and flexible way. Thus, digital technologies have come as a way of removing the barrier that has been posed by distances in communication and interaction. ICT play a crucial role in both individual and work settings. There has been a technological evolution amongst individuals with a dynamic shift from pen and paper to screen and emails. This shift in communication has opened other channels which are fast, smart, convenient, and traceable for everyone to engage with.

The digital age has grown to remove barriers to personal growth and development of the business and social side of life (Alexopoulos et al., 2018; Dwivedi et al., 2011). Digitalisation and technological advances have made the world accessible to everyone and in this regard, a surge of communication through broadband and Wi-Fi has been realised as people transact form one part of the world to the next. On the other hand, evidence from Perriam and Carter (2021) demonstrated that the introduction of digitalisation, has also helped people interact across all domains of life, in a fast and convenient way.

E-government cannot be disputed as one of the most advanced approaches to provision of digital public services to citizens and businesses as well as making the processes in public sector agencies and institutions more efficient and effective that have been improvised in the 21st century. Since the first global assessment of e-government efforts (United Nations, 2002), the success of e-government initiatives has allowed for significant progress in delivery of digital public services to citizens and businesses (United Nations, 2022). With the emergence of the pandemic, it can be noted that e-government played a crucial role in the advancement of the public sector during the pandemic (Burlacu et al., 2021). Digitalisation of health-related public services remains one of the over month enforcements that came with the pandemic. The disclosure of pandemic-related datasets under open data licenses is one of the services that supports the reuse of these data and improves improve trust in data (Kobayashi et al., 2021)

E-government and digital society indicators have been observed as diverse and within their diversity they have opened the window to an understanding and appreciation of digitalisation at various levels. According to Cenfetelli (2004), benchmarking progress in e-government and the digital society is one of the more complex aspects of digitalisation and ranking of ICT use. Over the years, various benchmarks and indices were introduced to compare groups of countries such as the E-government Development Index (EGDI), the ICT Development Index (IDI), the

Network Readiness Index (NRI), the Waseda University World Digital Government Ranking, or the eGovernment Benchmark by the European Union (EU) (Heeks, 2008; Skargren, 2020).

However, according to Beynon-Davies (2007), digitalisation does not occur over night. As such, evidence from Russo (2020) illustrated that indicators such as the Digital Economy and Society Index (DESI) by the EU was put in place to ensure that, digitalisation and the rate at which it is being accepted and received across Member States is noted and assessed for. The evidence suggests that evaluations and assessments of digitalisation of society are indexed through aspects such as Connectivity, Human capital, Use of the Internet, Digital Public Services, and Integration of Digital Society. Thus, because each of the above-mentioned indices consists of different indicators that focus on different aspects of digitalisation and ICT use by the public sector, it is crucial to know by which indicators are the indices are composed before a complex analysis of countries can be performed.

The aim of this thesis is to analyse e-government and digital society indicators in selected countries. The first section deals with theoretical background of the research. It focuses on ICT and the society, ICT in public administration, digital public services for citizens and business, and open government, transparency, and participation of involved stakeholders. The second section investigates issues of e-government, the digital society as well as benchmarking and evaluation reports and how it has been defined across selected countries. The purpose of this section is to shade insights and an understanding towards how e-government systems are built and how they are currently operating.

The third section focuses on identification and cross comparisons of the relevant established indicators. In this area, indices such as the EGDI and DESI are cross examined against each other in the context of their development over the years. This will facilitate the identification of relevant indicators of e-government and digital society development that cut across. Hence, the fourth chapter provides the analyses and presentation of the relevant indicators in the selected countries and how they help understand digitalization and e-government. The last chapter includes the results and discussions. This will also further cascade into conclusions from the thesis based on the analysis and cross examination with theoretical background and literature.

1 THEORETICAL BACKGROUND

This provides an overview of the most important concepts that form the theoretical background of this thesis.

1.1 SOCIO-TECHNICAL THEORY

The socio-technical theory has been identified as one theory that stipulates on the relationships existing between individuals, society, and the Internet. The theory utilises some aspects of Kramer's framework which was basically influenced by the motion that true knowledge can only be achieved by falsification (Lu et al., 2011). The socio-technical system theory as at its core the idea that the design and performance of any organisation is governed by the utilisation of social and technical aspects of the engagements. These aspects according to the theory should be brought together and treated as independent parts of a complex system in the organisation.

Therefore, according to the socio-technical systems theory, it is important to treat each index that brings forth an understanding of how digitalisation has shaped as an independent aspect. Evidence from Sony and Naik (2020) suggests that IDI, EGDI, NRI, Waseda index, E-government Benchmark, DESI, and other indices are all part of a complex systems interaction that enable us to understand and acknowledge the role of people participation as indicated by these indicators. However, these indicators operate independent of each other and each of them resembles a significant dimension that is not closely related to the other but demonstrating similar evidence on digitalisation of society (Sony and Naik, 2020).

Thus, as these indicators are understood of their role and function in the digital society, failure to consider both the social and technological aspects may hinder the ability to effectively change within the organisation (Lu et al., 2011). The theory provides and critical analysis on the importance of organisational work designs and the interaction between people and technology within places of work. Thus, the interaction between coherent systems of human relations, cybernetic process, and technical objects as part of a larger and complex structure informs on how these interactions sharp the appreciation and adoption of digital technologies and how they are used within complex systems as proposed by Sony and Naik (2020). Therefore, social systems and technical systems will, then formulate what constitutes the socio-technical systems framework.

The level of interrelatedness and interconnectedness that exists between the individuals and the open data networks plays a huge and significant role in determining the general outcomes of

interaction. These interactions are general divided into principles and the first one forwards the position that interaction of social and technical conditions creates an environment that allows for successful organisational performance (Fuenfschilling and Binz, 2018). The interaction can be linear with a causal effect relationship, between the digital society indicators and aspects of e-government. The approach further cascades into an understanding that relationships that are normally designed from a nonlinear complex system usually prove unpredictable and these interactions may be use if well studied and understood of how they influence acceptance and reasonable accommodation (Cherp et al., 2018).

On the other hand, theory further proposes that optimisation of each aspect of the socio-technical systems theory increases not only the quality of unpredictable relationships but rather disbars those relationships that may prove to be dangerous towards the system (Fuenfschilling and Binz, 2018). The theory hence forth, brings forth the viewpoint that it is basically directed towards joint optimisation and the designing for social and technical systems that further accountability and transparency in the relationships and communications existing between individual, individual to organisation administration, administration to administration and further on (Cherp et al., 2018). These levels of interaction and the evidence of the interrelatedness and interconnectedness proves that these socio-technical approaches are variant and define interactions.

The theory further proposes differently and varying means of achieving joint optimisation. It states towards designing of different kinds of organisations, with ones having relationships between the socio and technical aspects forwarding productivity and wellbeing rather than more inclined towards full technological advancements. Therefore, this interaction may shape the general outcomes aligned with the introduction of new technologies, the level of acceptance and the ability of the technology to meet the expectations of the designers and the users within which the technology is directed for use towards (Fuenfschilling and Binz, 2018). Thus, according to e-government and the development of digitalised societies, when human elements and the technical systems are put together, they bring forth opportunities for new possibilities and even pave way for the technological developments and change orientation needed within this interaction (Cherp et al., 2018).

1.2 ICT IN SOCIETY

The 21st century has been described as a millennium of transformation and technovation on the digital front. Evidence states that most of the activities that are being done at individual,

organisational and society level are now heavily depended on information technologies and systems. In the working environment, ICT has contributed significantly to minimisation of mobility in the physical domain. That is almost every document is now being transferred using ICT. As such, services such as internal email, websites to communicate with external service users and processing of data (Dwivedi et al., 2011; Falk et al., 2017; Sekgweleo et al, 2017). The digital society has managed to transform the industrial economy into a network economy. This transformation has brought forth digital democracy, thus the expediting of interaction between the government and the people it served through modes observed as trustworthy, transparent, and responsive to the needs and demands citizens and businesses (Chen et al., 2007; Sekgweleo et al., 2017).

The existence of the Internet has opened other areas of social existence that most people would take for granted and take lightly. Thus, according to Dwivedi et al. (2011), governance of the Internet plays a critical role in management and preservation of the law. On the other hand, legislation and law enforcement has triggered indicators that can be used to understand how people have adopted to change. Dwivedi et al. (2011) also introduced the theory of change that stipulates on how and why people need to be governed on the Internet as they interact at individual and organizational levels.

There was also a notable transformation in the job industry where individual and organizations have transformed physical work into online work. At this point, the work from home concept has triggered and fast tracked the adoptions of Internet methods and methodologies of work which have cut across the globe (Dwivedi et al., 2011). It is important to understand that most of the work has been transformed and transferred to online platforms and this greatly demands strong Internet skills and abilities on the part of every individual (Falk et al., 2017). Legislation governing the use and adoption of the Internet is still improving and being adjusted to suite the ever growing and not stagnant Internet demands (Venkatesh et al., 2003).

1.3 ICT IN PUBLIC ADMINISTATION

ICT play a significant and crucial role in public administration. The role of ICT in public administration has been categorised into three aspects. These have been placed as internal administration, planning and decision making, and lastly service delivery. In internal administration, ICT brought about change through the use of electronic transformation in areas that had been previously governed as traditional pen and paper (Laxmikant, 2011). The

availability of information to the masses allows for the use of ICT in areas that people have not fully invested in.

According to Sony and Naik (2020), in internal administration, ICT promotes centralised storage of files and data, this comes with the reduction of unnecessary effort and lessening of security threats. Furthermore, cloud storage of important files implies that these can be accessed by the authorised personal from across the globe. In that regard, there is no need to carry files across and move around with them in person (Laxmikant, 2011). On the other hand, file access and use are monitored electronically in case of misuse and unauthorised access during unconventional times. Evidence further stipulates that during the Covid 19 pandemic, these advanced technologies allowed for document interchanging without physical contact and this lessened the chances of viral transmissions (Burlacu et al., 2021).

On the other hand, the approach shaped the internal environment within which business is being conducted. This has also allowed for other skills development initiatives to be brought forward through training and development of the administrative staff. There has been a significant amount of learning and training with organisations as the need to adapt to change is still rife. Amongst some of the delegated duties, machine learning and automation has also come in as a factor to enhance the quality of experiences individual go through as they interact with technology (Laxmikant, 2011). Some of the occupations have become fully automated and reducing human associated costs in business.

On the other hand, Fadia and Fadia (2018) believe that ICT in public administration also play a critical role in planning and decision making. That is, the role of ICT is to gather as much information as possible, manage the information using services such as Geographic Information System (GIS), which tell governments' departments of planning on the geography of areas and currently established developments. Thus, computerisation of all these aspects of work within the government becomes helpful. As such, ICT has also facilitated connectivity between and within government services (Laxmikant, 2011). Thus, allowing public sector agencies and institutions to share files without too much mobility in the physical, and these file transfers are done on time without major delays (Fadia and Fadia, 2018).

The last aspect of administration is service delivery, at this level the public will receive services through information technology portals and outlets without physically visiting the service providers. Further evidence demonstrates that in other ministries that handle public land and

state land allocations, maintaining of these records has been electrified and as such the information can be accessed readily without challenges (Laxmikant, 2011).

1.4 DIGITAL PUBLIC SERVICES FOR CITIZENS AND BUSINESSES

The online services aspect, more precisely the Online Service Index (OSI), of the EGDI forms a composite index that speaks towards the measurement and use of ICT services by the government to deliver public services. These services are then deployed at nation and local levels through the adopted strategies and approaches untiled by the government to manage the governance of these established services and approaches. Thus, based on a survey that was conducted by Stanimirovic (2013), across the UN's Member States, observations were made that most countries have gone digital and they participation in international meetings through digital platforms is a strong indicator of acceptance and acknowledgement of e-government as a strategic and meaningful approach to management of society.

The E-government Benchmark evaluates delivery of over 100 digital public services for citizens and businesses across Europe in at least 35 countries. It looks at how government websites and portals for citizens and businesses continue to improve over the years (European Commission, 2022b).

1.5 OPEN GOVERNMENT, TRANSPARENCY, PARTICIPATION

As reported by European Commission (2022a), the open data approach and the use of the digital society has not been great, they believed that integrating the clients is a blind side that has not been taken into consideration and as such, these technologies may not be able to enhance and increase the amount of money that people would make out of their adoption. On the other hand, innovation, and enhanced participation of citizens in government activities remains an important aspect of e-government (European Commission, 2022b). European Commission (2022a) further elaborated that open data use could refer to the activities that people engage with reference to provide data to understand or change events within a particular system.

The use and acceptance of data requires a unified approach and linkages between data scientists, data collectors, up loaders, analysers, and interpreters to make sense of the information. This value chain in data management requires that at each stage of data managements, the information provided should be in synchrony and providing relevant details for extraction and usage of the data in the public domain (Martin, 2014). Thus, according to the theory of acceptance in data management, most of the data available to the global communities may not be evaluated and assessed of its truthfulness, accountability, and transparency for mass usage.

As such, despite the introduction of hackathons, workshops, and conferences, currently not much is known about the predictors that influences the willingness of individuals to be involved in activities. Further evidence from Jupp et al. (2014) demonstrated that not much is also known about which predictors influence the ability and intention to use open data technologies, as such it was observed that systematic data with proper investigatory power on the usage and adoption of data technologies in understanding the public domain is lacking. With the rapid growth in digitalization and development of digital societies, if governments want to ensure entrepreneurs and researchers use open data technologies, they a great need to monitor and assess which conditions influence the nature of the data and type of data these individuals would target as primary to them (Martin, 2014).

Open government

The concept of open government is an important aspect of how the digital society is developed. It has been defined as reliance of government on open economies, open societies which subsequently lead to open governments. In this regard, it builds from transparency and accountability to the public in terms of data provisions and open access to information. Thus, Jupp et al. (2014) further acknowledges that open government speaks towards the way the government responds to the needs of its citizens, the values and the level of participation, experience and the knowledge indecision making. It rides on the modern and emerging technologies to the structure of governance.

Furthermore, open government further operates across the culture of governance. In this regard, this culture is usually built around principles of integrity, transparency, stakeholder participation and accountability (Martin, 2014). These building blocks in governance play a significant but pivotal role towards improving the outcomes in electronic governance and accountability of the digital society. The concept of e government is strongly adopted in the form of open government. This constitutes the application of digital technologies to the provision of better public service provisions to its citizens (United Nations, 2020; United Nations, 2022).

According to the Open Data Charter, the core principles in open data gained international visibility during the 2015 United Nations General Assembly after the global consultation. Thus, open data was established within the six basic facets, to which this form of data was supposed to be open by default to all users without restrictions. Evidence from OECD (2019) supposed that among 150 governments, cities, local authorities, and organisations believed in open data.

Furthermore, the objection across the open data charter were also met with rejections directed towards open data partnerships and the international efforts to deal with issues such as climate change failed. Thus, according to the OECD, open data should thus be closely related to and forming an integral part of the open data government agenda (Matasick et al., 2020).

Transparency

This aspect of open government has been strongly aligned with disclosure of information and data that help citizens in making decisions on their own lives. This further involves conducting of business and an understanding of how public authorities make decisions and spend public funds in a transparent state and providing information and data to the public through methods everyone can simply relate with, access, understand, implement, and reuse (Harrison, and Sayogo, 2014). These involves opening of government and information on areas such as public spending, lobbying activities, and government contracts, the development and impact of policy and public services.

Transparency was further evolved into three dimensions, to which access to information formulated the first point of endowment. Under this motion, it is believed that people have the right and freedom to access information, and as such individual and organisations reserve the right to request the information that they need from the government unless there is an exemption from the law. Good records management also form a pillar that informs and ensures that information is accessible, comprehensive, and reliable. This comes with the underpinning towards access to information and open data. This also speaks towards the capacity of these sources to be reviewed quickly and easily by the public in a safe and secure manner (Harrison, and Sayogo, 2014).

Participation

Participation in open data use and open government has not been taken as a factor that requires analysis only and individual level. The concept of participation has been strongly aligned with Sustainable Development Goals (SDGs) as proposed by the UN. In that regard, participation through open government was levelled as the enforcement of non-discriminatory laws and policies. These laws would be implemented utilising the principles of open government which seek to accomplish transparency and citizen participation at its best level. This approach speaks towards ensuring that all individual from all parts of the community or society are involved and included in each level of engagement with open governance and digitalisation of society (Falk et al., 2017; Harrison, and Sayogo, 2014).

Furthermore, the level of engagement may also ensure that people everywhere have relevant information and awareness for sustainable development through encouragement and promotion of effective, public, and private society partnerships. Thus, the government would then bear the responsibility of ensuring enhanced capacity building support for developing countries, and an increase in significant and available high quality, timely and reliable data. Thus, engaging citizens at all stages of policy and service delivery through close involvement in areas such as implementation and evaluation ensure that policies and services aimed at achieving all the SDGs are effective and meets the actual needs that are perceived as legitimate (United Nations, 2022).

2 DEFINITION AND DEVELOPMENT OF E-GOVERNMENT AND DIGITAL SOCIETY

This chapter provides definitions for the key terms of this thesis and their developments in time and summarizes the most important benchmarking and evaluation reports, indices and rankings, and respective indicators.

2.1 E-GOVERNMENT

2.1.1 Definition

The role of the e-government is to codify electronic communication and make sure the form and nature of communication between business and public authorities is attained within the working scope of the government. On the other hand, Caldow (1999) proposed that the E-government Act establishes the power of the public to communicate with each other and with businesspersons electronically without impediments but within the scope of the law of governance. In this regard, the concept of e-government is related to informalisation of public administration. E-government has become a form of government administration through information and communication and such technologies help facilitate the understanding resting within the day to day running of governments (Ojo et al., 2007). E-government is basically understood as administration done using ICT tools and tools specifically relating to Internet to improve public service for citizens, entrepreneurs, and the whole society (Chen et al., 2007).

E-government is not a universal applicable principle cutting across the national spectrum but rather is fragmented to address the specific branches and aspects of government legislation required of the approach. Thus, the e-government approach according to Beynon-Davies (2007) branches into 5 aspects that are directed towards addressing the issues raised by the Internet between the government, citizens, and businesses. The integration of the traditional and the technological aspects has led to an invisible line between and separation of services within the government and e-government. The idea of e-government has also expanded to encompass the use of ICT for a variety of interactions between stakeholders as well as the use of open government data and ICT to support innovation in governance (United Nations, 2022).

Therefore, e-government has been observed as a measure directed towards defining the level of access and leverage that governments, businesses and individuals have within each other (Lixăndroiu, 2018). Beynon-Davies (2007) highlighted that removing the human face especially for social services were people need to report or seek advice on more intimate and

intricate issues allows for more information seeking and self-help behaviours to be administered. On the other hand, Ojo et al. (2007) was of the view that e-government reduced the costs of transport and logistics for citizens and business owners as they sort to interact with public administration.

2.1.2 Development

A global development of e-government can be described by using 12 reports published between 2002 and 2022 by the UN. These reports are widely recognized as an important source of information on e-government development among more than 190 Member States of the UN (Falk et al., 2017). In 2002, a country's progress in e-government closely relates to its social, political, or economic composition. Nation e-government development remains desultory and unsynchronized. Online service delivery should be thought of as complementary. There was considerable lack of public awareness campaigns (United Nations, 2002). For the 2003 edition, governments are becoming increasingly cognizant of the significance of utilizing e-government and e-governance to enhance the dissemination of public services to citizens. The efficacy of e-government in promoting development is reliant on three fundamental prerequisites, namely: an adequate level of technological infrastructure, a sufficient pool of human capital, and universal e-connectivity. One of the primary challenges facing e-government's role in development pertains to the question of its accomplishment (United Nations, 2003).

The next year, the key findings include the widening disparities in ICT availability and access to digital public services. This report examines several aspects of the global disparity in access to ICT and demonstrates how the prompt advancement of ICT for development can enhance accessibility and opportunities for both nations and individuals (United Nations, 2004). This topic was also in the focus on the next reports. Evidence suggests that there is prevalence of a great danger where unequal diffusion of technology can be a trigger for exclusion of others in the digital front. The approach toward inclusivity in digitalisation should defer from reinforcing the traditional patterns of economic and social inequalities which will in turn lead to the weakening and deterioration of social bonds and cultural organisations. E-inclusion formulates that basis for a socially inclusive government, and this goes beyond e-government (United Nations, 2005).

The next report was published in 2008, i.e., after 3 years, when subsequent reports then always evaluated a two-year period, primarily for the purpose of obtaining all relevant data for all countries. The 2008 report focuses on improving the efficiency through the integration of back-

offline functions. Though successful implementation of such initiatives would certainly yield benefits for citizens, the foremost objective of these endeavours is to enhance the efficacy of government and its affiliated entities. The delivery of back-office integration is contingent upon several key variables, namely the personnel, processes, and technological resources that are involved (United Nations, 2008). In 2010, the impact of ongoing financial and economic crisis across the globe on e-government was addressed. As such evidence suggest that public trust plays an important role on facilitating growth and develop with the help of the people. Thus, public trust that is gained through transparency can further be enhanced through free sharing of government data based on open standards. Evidence further articulates that technology cannot be used as a substitute for good policy but can be a powerful tool for citizens to question the actions and regulations in a systematic manner. Thus, governance in times of crisis can add agility to public service delivery to help governments respond to an extended and expanded set of demands that may even include revenue (United Nations, 2010).

The 2012 report emphasises the institutional framework for e-government and ascertains that the existence of a national coordinating authority can potentially surmount internal barriers and facilitate a concerted effort towards addressing the needs of citizens. Thus, governments should identify efficient means of communication that align with domestic circumstances, simultaneously devising measures to enhance the prevalence of online and mobile service utilization, thereby enabling maximal advantageous outcomes to be attained by citizens (United Nations, 2012). The publication from 2014 is focused on the sustainable development and its promotion using modern ICT. This development and related goals should help in the creation of superior prospects for all, the curtailment of disparities, the elevation of fundamental living standards, the cultivation of impartial social development and incorporation, and the fostering of integrated and sustainable methods for managing natural resources and ecosystems (United Nations, 2014).

At similar lines, the report from 2016 elaborates the topic of sustainable development into several recommendations such as providing public services online through one-stop platforms; making public sector agencies and institutions more inclusive, effective, accountable, and transparent; supporting participatory decision-making towards sustainable development goals, providing services for mobile devices etc. (United Nations, 2016). The utilization of digital technologies by governments is progressively becoming prevalent in enhancing disaster response and fostering community resilience. Within the context of the current information society, it behoves stakeholders to shift towards an approach whereby the incorporation of

building resilience, sustainable development, and ensuring an equitable distribution of opportunities in e-government development is prioritized (United Nations, 2018).

The 2020 report highlights importance of the provision of efficient, transparent, and equitable digital services that cater to all individuals, whilst simultaneously working towards bridging existing disparities to uphold the fundamental principle of inclusive development. The impact of the Covid-19 pandemic is also discussed in this report because it has renewed emphasis on the significance of e-government, encompassing conventional provisions of digital services and contemporary inventive approaches in managing the crisis. Simultaneously, the pandemic has revealed various challenges and differing types of digital disparities, particularly among the financially disadvantaged and the most susceptible cohorts (United Nations, 2020). The latest report also includes the recommendations towards using digital government tools to overcome the global health crisis by providing viable solutions and facilitating the efficient distribution of digital public services. It also elaborates other relevant topics contributing to the future of digital government such as barriers relating to access, affordability, and ability; the integrated roles of data, design, and delivery in shaping inclusive e-government; cybersecurity, privacy, and data protection issues; cloud computing technology etc. (United Nations, 2022).

2.2 DIGITAL SOCIETY

2.2.1 Definition

The digital society speaks towards the introduction of appliances and gadgets that have access to the Internet and can be used in facilitating communication over the Internet through open data sources (Perriam and Carter, 2021; European Commission, 2022a). Thus, the increasing number of users who were searching for products or services via their smartphones and computers can be used to under a decrease or increase in the use of Internet service and how these have impacted in either positive or negative approaches. These numbers of Internet adoptions have varied insignificantly amongst countries (OECD, 2019; United Nations, 2022). Therefore, communication between providers and consumers is usually observed through optimized service provisions where the Internet through Artificial Intelligence (AI) narrows the individualized and personalized searches to facilitate how the experience of the Internet is mentioned by an individual (OECD, 2019; Perriam and Carter, 2021).

Evidence from Crahay (2022) highlighted that the Berlin Declaration on digital society and value should be based on democratic values and principles. The declaration saw union within European countries with the effort directed towards digital transformation that allowed citizens

and businesses within the country and the EU to harness the benefits and opportunities offered by modern digital technologies. Participation in the declaration has seen value based digital transformation increasing and with the target of addressing and strengthening digital participation and digital inclusion in European countries. Therefore, in this regard, digital society has been identified through growth of a wide web network for individuals with the intention of unifying both private and public administered business as proposed by Crahay (2022).

The development and definition if digitalisation and digital society is understood through embracing of AI, platform thinking, and crowd-based action as proposed by Elliott et al. (2021). Based on their comprehension, the digital society is transformation of activities of daily living that were physical to be done through "code". Thus, society is now running on code that can be altered, updated, fixed, hacked, stored, and analysed without making physical changes to the machine from which users interact from (Elliott et al., 2021. The digital society has been observed as the implementation of digital technologies which in their primary form have become entangled in the structures of society at complex levels and even contradictory to many laws and regulation (OECD, 2019). In essence, digital networks and platforms have become the currency through which digital society run on. The presence of technology in almost every part of everyday living realises the transformation of ideas, thoughts and feeling into digitalised visual stimuli that people understand as if it were physical (United Nations, 2022).

Evidence further suggests that the digital society is self-evolutionary and people are forced to suite within its demands without their consent taken in consideration. This has been observed through the radical implementation of some aspects of service even at government and private level into digital technology (McAfee and Brynjolfsson, 2017). These transformations are done without consideration of the illiterate, to which the transformation is built on the belief that community members will help each other manoeuvre and develop into the society eventually. Thus, the interface between the physical and the digital world is understood through digi-grasping (Dwivedi et al., 2011; McAfee and Brynjolfsson, 2017).

2.2.2 Development

The availability of data has become a norm and governments to some degrees have accepted the existence of a digital society (McAfee and Brynjolfsson, 2017). Access to information through the web and Internet services has changes the spectrum of digitalization and growth of digital societies. As such, government have also been train formed into electronic governments

and this has triggered the initiation of e-government through policy formulation and policy regulations on the use, adaptation, implementation, and monitoring of existing systems (European Commission, 2022a).

One of the most profound indicators of digital social was observed as performance expectancy, which was noted as the ability or the degree to which individuals believes that the systems that they are using is enabling and helping them to achieve their intended goals and aspirations (OECD, 2019; Venkatesh et al., 2003). In this regard, performance expectance and its related indicators are a strong predictor of behavioural intention. As such, when there is an intention and a very strong one, it becomes easy to note that the involvement of persons into digital technologies is influenced and inspired by the core existence with other that share the same point of view or rather perspectives (Falk et al., 2017; Venkatesh et al., 2003). Furthermore, Hunnius and Krieger (2014) argued that interfaces that are not user friendly within the Internet have a strong deterring effect on how the Internet and digital technologies are adopted and utilized by the masses. Thus, they recorded mass discrepancies and differences with regards to contents and the shape of data use within the different classes of persons involved in open data use.

We can conclude that the development of digital societies is shaped by the penetration of digital technologies among citizens and businesses. In contrast to e-government, in which public sector agencies and institutions provide legislatively mandated services to their customers, i.e., citizens and businesses, digital societies are more affected by technologies and approaches that are usually developed by the private sector. After that, governments recognize their importance and include them in their strategic development documents and then into digital public services. This is also one of the main reasons why frameworks and tools that are developed to measure and benchmark the state of digital societies in selected countries are constantly updated and weights of indicators modified based on the importance of these technologies. The DESI and related reports are the most important sources of information of digital societies in the EU. It has been published every year since 2014 (European Commission, 2022a). The other indices that appeared after 2000 are for example World Digital Competitiveness Ranking or Digital Adoption Index by the World Bank.

2.3 BENCHMARKING AND EVALUATION REPORTS

2.3.1 Overview of reports

The following Table 1 provides an overview of indices and rankings that appeared since 2000 and benchmarked countries in ICT use, e-government development, digital society, and other indicators. Five of them are still active and reports are available. Based on the analysis of reports presented in Table 1 we can argue that the methodology of each active index, i.e., that the latest report was published in 2022, changed over the years. These changes can be attributed to advances in ICT and channels through which people communicate and receive information.

Table 1. Overview of e-government and digital society indices and rankings. Source: own processing.

Index	Publisher	First report	Last report	No. of reports
DESI	EU	2014	2022	8
EGDI	UN	2001	2022	12
eGov. Benchmark	EU	2001	2022	20
EIU index	The Economist	2000	2010	11
IDI	ITU	2009	2018	10
NRI	WEF, Portulans Institute	2002	2022	21
TBR index	Brown University	2001	2007	7
Waseda index	Waseda University	2005	2022	17

2.3.2 Indices and rankings

This section is focused on the description of the active e-government and digital society indices, i.e., DESI, EGDI, eGovernment Benchmark, NRI, and Waseda index.

The **DESI** was firstly introduced in 2014, this indicator has been monitored by the European Commission, with evaluations central to its Member State. The results and corresponding analyses such as country profiles are published annually since 2014. Each indicator is aligned with strategies that are set out in the commission proposal for a decision path to the digital goals such as Digital Decade Targets. Several improvements have been made on the DESI over the years to better reflect the required digital competencies of citizens as well as businesses. Improvements have also been made with the introduction of the female ICT specialist

indicators, where connectivity, the fibre to the coverage indicator has been added, this allows for a more comprehensive analysis of gigabyte connectivity (European Commission, 2022a).

The **EGDI** presents the state of e-government development of the UN's Member States. Since its second edition from 2003, it consists of three sub-indices. It is a composite measure of three important dimensions of e-government: provision of online services, telecommunication connectivity, and human capacity (United Nations, 2022). The EGDI is a composite index that is based on the weighted average of three normalised indices. The composite is dived into three, were pone third is derived from Telecommunications Infrastructure Index (TII), which is based on the data provided for by the International Telecommunications Union (ITU). Another indicator is derived from the Human Capital Index (HCI) which is based on data acquired from United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the last third is derived from the Online Service Index (OSI). These are independent online services. These data sets are collected from across 193 United Nations member states through completion of a Member State Questionnaire.

eGovernment Benchmark by the EU has been published since 2001 with 20 reports that are based on comparisons of how governments across Europe deliver digital public services. Thus, the benchmarking evaluates provisions and delivery of the services in 35 countries with 27 being EU Member States. The e-government benchmark uses life event to capture the landscape of public services. The eGovernment method paper was originally released in July 2012 and has been updated to remain relevant and internationally recognised. There has been a series of these benchmarks, starting from 2011, the 2015 edition, and the 2020 to 2023 edition. The eGovernment method connects its indicators with events. Thus, it uses two types of data collection to set its grounding. Thus, the Mystery Shopping being the most prominent one and supported by the automated tools for selection of indicators. Thus, the Mystery Methods further details itself through areas such as user centricity, transparency, cross border mobility and key enablers (European Commission, 2022b).

The **NRI** has been published since 2002. Until the 2016 edition by World Economic Forum (WEF), Cornell University, and INSEAD, and since 2019 by Portulans Institute. Following its relocation to the Portulans Institute, the NRI has accorded significant emphasis to matters of direct relevance to the youth demographic. These areas include, but are not limited to, sustainability, inclusivity, governance, and trust. The list of indicators of this index was consistently updated through the years, the last update of the methodology was done in 2019. The NRI 2022 ranks 131 economies across the various components of digital readiness. The

NRI is a multidimensional concept which is built from a composite index constructed with four pillars: technology, people, governance, and impact. Each of these pillars also consist of dimensions which then consist of indicators. The first pillar consists of the technology, which builds on access, content and future technologies. The second pillar is people, which is made up of individuals, business, and governments. The third pillar is governance which is built on trust, regulation and inclusion and the last pillar is impact which is built on economy, quality of life, and SDGs. In the current reports, evidence suggest that inclusion of countries and indicators relied on the double threshold approach. That is, all countries that provided data for at least 70% of all indicators were included in the current NRI. Thus, the 2022 NRI focuses on the young generation in leading the world into an information age. Thus, evidence suggest that NRI will heavily rely on three major currencies which are, data, talent, and learning. The NRI has become a significant aspect of organisational decision making as it possesses the receptive power for business modelling. This NRI marks the level at which an organisation is at as it finds it footing in the digitalised world (Dutta and Lanvin, 2022).

Digital Government Rankings by Waseda University has been on the record since 2005. It shows important trends in the use of new digital technologies in government activities. The digital governance analysis under this indicator is based ranking a group of indicators to evaluate the overall digital government development. This ranges will include information on policy development and e-services implementation to manage optimisation and digital government promotion. Thus, in 2010 there was the introduction of the e-participation indicator and later in 2014, open government and cyber-security were added to the ranking. In 2017, usage of emergence ICT technologies to make it a total of 10 main indicators for evaluation was made. Lastly in 2022 (the 17th edition of this index), there was the introduction of the digital transformation and innovation indicators. Thus, the Waseda index is a composite index that is built from 10 indicators in 2022: Network Infrastructure Preparedness, Management Optimization, Online Services, National Portal, Government Chief Information Officer, Digital Government Promotion, E-Participation, Open Government Data & Digital Transformation, Cybersecurity, and the emerging technology in Digital government.

2.3.3 Indicators

Therefore, we can conclude that there are different indices and rankings, usually accompanied by analyses in form of reports, that consist of sub-indices, dimensions, pillars etc. which then consist of indicators. An indicator is a specific and measurable characteristic, and it is the lowest level that is considered by the index. For the context of e-government and digital society, it

allows for cross comparisons to be made against the digitalisation and digital performance of a country. Thus, according to Saltelli (2007), indicators are useful as they can be used to identify common trends across performance in digital areas of a country. Thus, the quality as well as the soundness of an indicator does not only depend on the methodology used but rather extends to the quality of the framework and the data used in its construction. Thus, an indicator based on a weak theoretical background or soft data containing large measurements errors can lead to disputable policy messages. As such, according to Nardo et al. (2008), it is important to have transparency and the guiding principle for the entire exercise to make and take shape.

Table 2 shows an overview of indices that could be used to compare selected countries. They are composed of several levels and respective indicators that can be also used as a measure to compare and analyse countries. All the latest editions in the table were published in 2022. It can be also seen from the table that each index covers different number of countries.

Table 2. Overview of the latest editions of e-government and digital society indices. Source: own processing.

Index	**Countries covered by the last report**	**No. of sub-indices / dimensions**	**No. of indicators in the last report**
DESI	27	4 (10 sub-dimensions)	32
EGDI	193	3	13
eGov. Benchmark	35	4 (14)	48
NRI	131	4 (12 sub-pillars)	58
Waseda index	64	10	36

3 IDENTIFICATION AND COMPARISON OF RELEVANT INDICATORS

This chapter deals with the identification and comparison of the indicators, as well as sub-indices, dimensions, pillars etc., relevant for the e-government development and digital society context. We aim to provide an overview of existing indicators and how publishers of respective indices and reports include modern technologies in their frameworks. We also decompose the most representative indices and discuss changes in the sets of indicators that were used by these indices over the years. Finally, the results presented in this chapter should help in the selection of the most suitable countries for the analysis.

3.1 CURRENT LISTS OF INDICATORS AND THEIR COMPARISON

We decomposed the latest editions of indices and reports discussed in the previous chapter to get a clear picture of indicators that are currently used to evaluate the state and development of e-government and digital society efforts in different countries. Because of the high number of indicators for the DESI, eGovernment Benchmark, and NRI, we listed only sub-levels for these indices in Table 3. We can conclude that there are some similarities in indicators across all indices. Each index includes indicators that measures human capital and how users, or concrete stakeholders such as citizens, businesses, and governments, consume and interact with online services. It is important to know competencies and capabilities of users to be able to develop concrete online services that will suit them most. It is obvious that countries with low levels for these indicators cannot provide advanced online services because users could have problems to us them.

This is closely related to levels of ICT and digital infrastructures and integration of digital technology among stakeholders in respective countries. This dimension is covered by indicators such as connectivity and broadband users, mobile subscriptions etc. Some of the indices include only these general indicators while the others, such as the NRI and Waseda index, focus also on future technologies, such as cybersecurity, cloud, Internet of Things (IoT), and big data utilization. The last dimension that is common to all indices is dealing with the digital public services that are provided online. There are quite a bit differences between indices in their lists of services because some of them focus only on services provided by websites, i.e., if the respective information can be found online and if a user can complete all the steps online or using a web or mobile application for this purpose. The other indicators evaluate also if these

transactions are secure, usable etc. Finally, the dimensions that are not covered by all indices and are affected by the purpose of the index are related to impacts, transparency and openness, sustainability, and sustainable development goals etc.

Based on the lists of indicators included in each index, the number of countries covered, changes in the methodology, comparability of data over years, and the availability of the input data, we decided that we will focus more closely on the EGDI and DESI and their indicators in the next sections.

Table 3. Decomposition of e-government and digital society indices and rankings from 2022. Source: own processing.

Index	**Indicators**	
	1st level	**2nd level**
DESI	Connectivity	Mobile broadband, broadband price index, fixed broadband take-up, fixed broadband coverage
	Human Capital	Internet user skills, advanced skills and development
	Integration of Digital Technology	Digital technologies for businesses, ecommerce, digital intensity
	Digital Public Services	eGovernment
EGDI	Online service index	Institutional framework, service provision, content provision, technology, e-participation
	Telecommunication infrastructure index	Internet users (% of population), mobile-cellular subscriptions per 100 inhabitants, fixed broadband subscriptions per 100 inhabitants, active mobile-broadband subscriptions per 100 inhabitants
	Human capital index	Adult literacy rate, the combined gross enrolment ratio, expected years of schooling, mean years of schooling
eGov. Benchmark	User centricity	Online availability, user support, mobile friendliness
	Transparency	Transparency of service delivery, transparency of service design, transparency of personal data
	Key enablers	eID, eDocuments, authentic sources, digital post, security
	Cross-border services	cCoss-border online availability, cross-border user support, cross-border eID, cross-border eDocuments
NRI	Technology	Access, content, future technologies
	People	Individuals, business, governments
	Governance	Trust, regulation, inclusion

Index	Indicators	
	1st level	**2nd level**
	Impact	Economy, quality of life, SDG contribution
Waseda index	Network infrastructure preparedness	Internet subscribers, broadband users, digital mobile phone subscribers
	Management optimization	Optimization progress, integrated enterprise architecture model, administrative budget system
	Online services	Electronic bidding system, electronic tax payment, electronic payment/customs clearance system, ehealth system, one-stop service
	National portal	Navigation function, two-way dialogue, interface, technical convenience
	Government Chief Information Officer (CIO)	Introduction of CIO, CIO authority, CIO organization, CIO human resources development plan
	Digital government promotion	Legal response, effective promotion business, support mechanism, evaluation mechanism
	E-participation	Information sharing mechanism, exchange/discussion, participation in decision making
	Open government data and digital transformation	Legal response, society, organization, activity
	Cybersecurity	Legal response, cybercrime measures, internet security organization
	The emerging technology in digital government	Cloud utilization, IoT utilization, big data utilization

3.2 E-GOVERNMENT DEVELOPMENT INDEX

The UN Public Administration Programme led by the Department of Economic and Social Affairs, Division for Public Institutions and Digital Government, has published the reports of e-government development assessments and benchmarking since 2002. The first report covered the year 2001. The latest report is from 2022. We analysed all the reports published, i.e., 12 reports, and listed all the indicators that were used over the years. Table 4 shows the structure of sub-indices and indicators, their coverage, and weights over the years. It should be noted that

the OSI consists of a list of questions that changed over the years as well as their allocation to different sub-indices and indicators.

We can conclude that the structure in terms of three sub-indices and their weights, i.e., OSI, TII, and HCI, did not change since 2002. However, the indicators from which are these sub-indices comprised evolved through the years. For the OSI, which was partially based on the e-government development stages between 2002 and 2020, the presence represents different levels of governments' ability to provide digital public services fully online. The emerging presence is characterised by availability of information on websites only, including forms that can be downloaded. The connected presence is usually represented by the existence of the central a-government portal through which all digital public services are available fully online. In 2022, the structure of the OSI was completely reworked, including weights of indicators.

How has the significance and benefits of various technologies and infrastructures for citizens, businesses, and governments changed over the years is the best represented by indicators of the TII. From on-line population, PCs and TVs per 1000 persons, and fixed telephone lines, now, the most important indicators are fixed and active mobile-broadband subscriptions. It should be also noted that Internet users and mobile telephones are measured from 2002 till now. Finally, the HCI did not change much over the years, only indicators measuring expected years of schooling and mean years of schooling were added in 2014.

Table 4: Indicators of the EGDI over the years. Source: own processing.

Structure of sub-indices and indicators	**Coverage**	**Weight**
1. Web Measure/Online Service Index (OSI)	2002–2022	33%
Emerging presence	2002–2020	20% (2002–2008), 25% (2010–2020)
Enhanced presence	2002–2020	20% (2002–2008), 25% (2010–2020)
Interactive presence	2002–2008	20%
Transactional presence	2002–2020	20% (2002–2008), 25% (2010–2020)
Networked presence	2002–2010	20% (2002–2008), 25% (2010)
Connected presence	2012–2020	25% (2012–2020)
Institutional framework	2022	10%
Service provision	2022	45%

Structure of sub-indices and indicators	Coverage	Weight
Content provision	2022	5%
Technology	2022	5%
E-participation	2022	35%
2. Technological/Telecommunication Infrastructure Index (TII)	2002–2022	33%
PCs per 1000 persons/100 inhabitants	2002–2010	20%
Internet users per 1000 persons/100 inhabitants Internet users (% of population)	2002–2022	20% (2003–2018), 25% (2020–2022)
Fixed telephone lines (subscriptions) per 1000 persons/100 inhabitants	2002–2018	20%
Mobile telephones (cellular subscriptions) per 1,000 persons/100 inhabitants	2002–2022	10% (2002–2005), 20% (2008–2018), 25% (2020–2022)
On-line population per 1000 persons	2002–2005	20%
TVs per 1000 persons	2002–2005	10%
Fixed broadband subscriptions per 100 inhabitants	2008–2022	20% (2008–2018), 25% (2020–2022)
Fixed Internet subscriptions per 100 inhabitants	2012	20%
Wireless broadband subscriptions per 100 inhabitants	2014–2016	20%
Active mobile-broadband subscriptions per 100 inhabitants	2018–2022	20% (2018), 25% (2020–2022)
3. Human Capital Index (HCI)	2002–2022	33%
Adult literacy rate	2002–2022	66% (2002–2012), 33% (2014–2022)
The combined gross enrolment ratio	2002–2022	33% (2002–2012), 22% (2/9) (2014–2022)
Expected years of schooling	2014–2022	22% (2/9)
Mean years of schooling	2014–2022	22% (2/9)

3.3 DIGITAL ECONOMY AND SOCIETY INDEX

The DESI 2022 provides with four dimensions of assessment that can be utilized in establishing how digital technologies have been adopted for use in the economy and society. To improve the methodology and consider the latest technological developments, several changes were made in the 2019. Some bigger changes were also made in 2018 and 2020. Since 2021, the

indicators are now structured around the four main areas in the Digital Compass, replacing the previous five-dimension structure. Table 5 below gives a general overview of the structure of this index over the years. The weights are available only for the first and second level of the DESI structure.

The DESI structure has gradually improved over time with aspects such as measurement of 5G readiness, coverage and spectrum added that did not exist in the previous ratings. This has also been advanced by the introduction of sub aspects of mearing fast broadband, fast broadband take-up, ultrafast broadband coverage, ultrafast take-up, broadband price index amongst other aspects in the connectivity dimension. Furthermore, in terms of human capital, improvements were made by the introduction of aspects such as at least basic digital skills, at least basic software skills, at least basic digital content creation skills, female ICT specialists, and enterprises providing ICT training. These additional measurements were meant to initiate a close look into the aspects of the DESI that fostered development on that domain. More so, in terms of internet use, additional dimensions such as online consultations and voting, purchase online products were added. On the other hand, the DESI improvements for integration of digital technology involved changes in areas such as AI, ICT for environmental sustainability, digital intensity, and online presence. Lastly, the DESI structural changes also cascaded into areas such as digital public services where notifiable change were in areas such as transactional services, connected services, digital public services for citizens, medical data exchange and e-prescription. We can conclude that the structure of the DESI changed significantly over the years in terms of indicators' relevance to e-government and digital society trends valid in the given years.

Table 5: Indicators of the DESI over the years. Source: own processing.

Main dimensions/Sub-dimensions/Indicators	**Coverage**	**Weight**
1. Connectivity	2014-2022	25% (2014–2022)
Fixed Broadband	2014-2019	33% (2014–2017), 20% (2018)
Fixed Broadband Coverage	2014-2019	-
Fixed Broadband Subscriptions (Take-Up)	2014-2019	-
Mobile Broadband	2014-2022	22% (2014–2017), 30% (2018–2019), 35% (2020), 40% (2021–2022)
Mobile Broadband Subscriptions (Take-Up)	2014-2022	-
3G Coverage	2014-2015	-

Main dimensions/Sub-dimensions/Indicators	Coverage	Weight
Spectrum	2016-2017	-
4G Coverage	2017-2021	-
5G Readiness	2019-2021	-
5G Coverage	2021-2022	-
5G Spectrum	2022	-
Speed	2014-2017	33% (2014–2017)
Average Connection Speed	2014-2015	-
Subscriptions to Fast Broadband	2014-2017	-
NGA Coverage	2016-2017	-
Affordability	2014-2017	11% (2014–2017)
Fixed BB Subscription charge (Price)	2014-2017	-
Fast Broadband	2018-2019	20% (2018–2019)
Fast Broadband (NGA) Coverage	2018*-2019	-
Fast Broadband Take-up	2018-2019	-
Ultrafast Broadband	2018-2019	20% (2018–2019)
Ultrafast Broadband Coverage	2018-2019	-
Ultrafast Broadband Take-up	2018-2019	-
Broadband Price Index / Prices	2018-2022	10% (2018–2019, 2021–2022), 15% (2020)
Broadband Price Index	2018-2022	-
Fixed Broadband Take-up	2020-2022	25% (2020–2022)
Overall fixed broadband take-up	2020*-2022	-
At least 100 Mbps fixed broadband take-up	2020-2022	-
At least 1 Gbps take-up	2021-2022	-
Fixed Broadband Coverage	2020-2022	25% (2020–2022)
Fast broadband (NGA) coverage	2020*-2022	-
Fixed Very High Capacity Network (VHCN) coverage	2020-2022	-
2. Human Capital / Digital Skills	2014-2022	25% (2014–2022)
Basic Skills and Usage / Internet User Skills	2014-2022	50% (2014–2022)
Daily Internet Users	2014-2015	-
(Regular) Internet Users	2014-2018	-
At Least Basic Digital Skills	2016-2022	-
Above Basic Digital Skills	2019-2022	-

Main dimensions/Sub-dimensions/Indicators	Coverage	Weight
At Least Basic Software Skills	2019-2021	-
At Least Basic Digital Content Creation Skills	2022	
Advanced Skills and Development	2014-2022	50% (2014–2022)
ICT Specialists	2014-2022	-
STEM Graduates	2014-2018	-
Female ICT Specialists	2019-2022	-
ICT Graduates	2019-2022	-
Enterprises providing ICT training	2021-2022	-
3. Use of Internet (Services)	2014-2020	15% (2014–2020)
Content / Activities online	2014-2020	33% (2014–2018), 50% (2019–2020)
(Reading News Online) News	2014-2020	-
Music, Videos and Games	2014-2020	-
Video on Demand	2015-2020	-
Video Calls	2019*-2020	-
Social Networks	2019*-2020	-
Professional Social Networks	2019	-
Doing an Online Course	2019-2020	-
Online Consultations and Voting	2019	-
Communication	2014-2018	33% (2014–2018)
Social Networks	2014-2018	-
Video Calls	2016-2018	-
Transactions	2014-2020	33% (2014–2018), 25% (2019–2020)
(Online) Banking	2014-2020	-
(Purchase online products) Shopping	2014-2020	-
Selling Online	2019-2020	-
Internet use	2019-2020	25% (2019–2020)
People who never used the Internet	2019-2020	-
Internet users	2019*-2020	-
4. Integration of Digital Technology	2014-2022	20% (2014–2020), 25% (2021–2022)
Business digitization / Digital technologies for businesses	2014-2022	60% (2014–2020), 70% (2021–2022)
Electronic Information Sharing	2015-2022	-

Main dimensions/Sub-dimensions/Indicators	Coverage	Weight
RFID	2015-2018	-
Social Media	2015-2022	-
Online Presence	2014-2015	-
Cloud (Services)	2015-2022	-
eInvoices	2016-2018, 2021-2022	-
Big Data	2019-2022	-
AI	2021-2022	-
ICT for environmental sustainability	2021-2022	-
eCommerce	2014-2022	40% (2014–2020), 15% (2021–2022)
SMEs Selling Online	2014-2022	-
eCommerce Turnover	2014-2022	-
Selling Online Cross-border	2016-2022	-
Digital intensity	2021-2022	15% (2021–2022)
SMEs with at least a basic level of digital intensity	2021-2022	-
5. Digital Public Services	2014-2022	15% (2014–2020), 25% (2021–2022)
eGovernment	2014-2022	100% (2014–2017, 2020–2022), 80% (2018–2019)
eGovernment Users	2014-2022	-
Transactional Services	2014-2015	-
Connected Services	2014-2015	-
Open Data	2014-2022	-
Pre-filled Forms	2016-2022	-
Online Service Completion	2016-2020	-
Digital Public Services for Businesses	2018-2022	-
Digital Public Services for Citizens	2021-2022	-
eHealth	2018-2019	20% (2018–2019)
eHealth Services	2018-2019	-
Medical Data Exchange	2019	-
e-Prescription	2019	-

** means that the indicator appeared in the previous editions of the DESI*

4 ANALYSIS OF INDICATORS IN SELECTED COUNTRIES

This chapter deals with the analysis of e-government and digital society indicators in the EU Member States.

4.1 RESEARCH METHODOLOGY AND DESIGN

The different indicators are essential as they give insights on the nature and form of digital integration that is assigned to the countries under study. These indicators give the details required to make sense of the digital data on digitalisation and Internet integration. The level of digitization is also draw through a cross examination of these factors. As such these factors lay the foundation from which composite indicators can be drawn and develop. They also lay the foundation for methodological computations as they open opportunities for factor analysis to establish the most suitable factors towards understanding the level of digital integration (Nardo et al, 2008).

4.1.1 Research instrument and data collection

As described in the previous sections, there are a lot of indicators that can be used to analyse the development of e-government and digital society. However, as we found in our comparisons of the structures and respective indicators included in these indices, they changed several times for each index over the years. Therefore, it can be difficult to get any relevant insights because of the comparability of these indices over the years. Based on these findings, we decided to analyse only the main components, i.e., sub-indices and dimensions, which remained the same over the years. For this purpose, for our analysis we selected the EGDI and DESI. Finally, because of the availability of the input data, we selected the EU Member States as a sample of countries for which we will analyse the indicators.

The data for the EGDI were gathered from the e-Government Knowledgebase available at https://publicadministration.un.org/egovkb/data-center. The data period covers 2003-2022. The data for the DESI were collected directly from the official website of the European Commission which can be accessed at https://digital-agenda-data.eu/datasets/desi/ and the respective reports then at https://digital-strategy.ec.europa.eu/en/library. The data period consisted of 2017-2022 years. The data were analysed using the Microsoft Excel and SPSS Statistics software.

4.1.2 Objectives of the analysis and methods used

Based on findings in our previous sections and the data that we collected, our objectives are:

1. To analyse the progress of selected sub-indices and dimensions of the EGDI and DESI in the EU Member States over the years.
2. Find similarities and identify groups of the EU Member States for the EGDI and DESI over the years.

To fulfil these objectives, statistical analysis that is drawn towards understanding the level of progress and trends over the years for the composite indices against the sample countries is used. Thus, simple linear regression analysis is carried out. This assessment will allow for the identification of trends for the sample of Member States as well as the progress of individual countries by observing the development. Furthermore, zooming in to pinpoint the sub-indices and dimensions where Member States performance could be improved based on the exploitation of similarities and differences between the countries, we apply the cluster analysis. Cluster analysis techniques can be hierarchical if the clusters are nested together. Thus, a cluster tree to the effect of adoption of the composite indicators, i.e., sub-indices and dimensions, paves way towards more intimate understanding of how digitalisation and e-government has been embraced within the sample countries over the years. Therefore, cluster analysis provides evidence through squared Euclidean distances and countries with similarities are noticed by the decrease in these distances. We used joining (tree clustering) and K-means clustering. Although cluster analysis will be computed, evidence also suggests that these clusters may prove useful or otherwise in classification of objects and this may depend upon the objectives of the analysis (Rencher and Christensen, 2012).

4.2 STATISTICAL ANALYSIS

This section deals with the first objective and discusses the findings for the sample of all EU Member States for the EGDI and DESI.

4.2.1 E-government development index

First, Table 6 shows top 5 best performing countries for the EGDI in each year for the sample of 27 countries. Sweden and Denmark are among the top performers in each year. We can state that the Nordic countries have the most developed e-government systems in Europe. Figure 1 then shows the progress of the EGDI in the EU Member States over the years. The countries are ranked according to the average value for the entire period covered and the main purpose

of this chart is to compare the performance of individual countries, i.e., how the differences between countries have developed over the years and which countries have improved the most.

We can conclude that countries such as Cyprus, Croatia or Latvia improved the most, while countries such as Belgium and Germany show continuous improvements over the years. It should be also noted that some countries, and their levels oof e-government development, were affected by various internal and external pressures, which, however, would require a more detailed analysis of individual countries. Among the external pressures by which most of the countries were affected, we can mention the global financial crisis 2008/2009 which resulted in decline in values for the 2010 edition of the index. Also, the global Covid-19 pandemic slightly affected the results from 2022, depending on how much countries prioritised and invested in delivery of digital public services fully online, especially for the health domain.

Table 6. Top 5 best performing countries for the EGDI from 2003 to 2022. Source: own processing.

Year/Rank	**1.**	**2.**	**3.**	**4.**	**5.**
2003	Sweden	Denmark	Germany	Finland	Netherlands
2004	Denmark	Sweden	Finland	Netherlands	Germany
2005	Denmark	Sweden	Finland	Germany	Netherlands
2008	Sweden	Denmark	Netherlands	France	Estonia
2010	Netherlands	Denmark	Spain	France	Sweden
2012	Netherlands	Denmark	France	Sweden	Finland
2014	France	Netherlands	Finland	Spain	Sweden
2016	Finland	Sweden	Netherlands	Denmark	France
2018	Denmark	Sweden	Finland	France	Germany
2020	Denmark	Estonia	Finland	Sweden	Netherlands
2022	Denmark	Finland	Sweden	Estonia	Netherlands

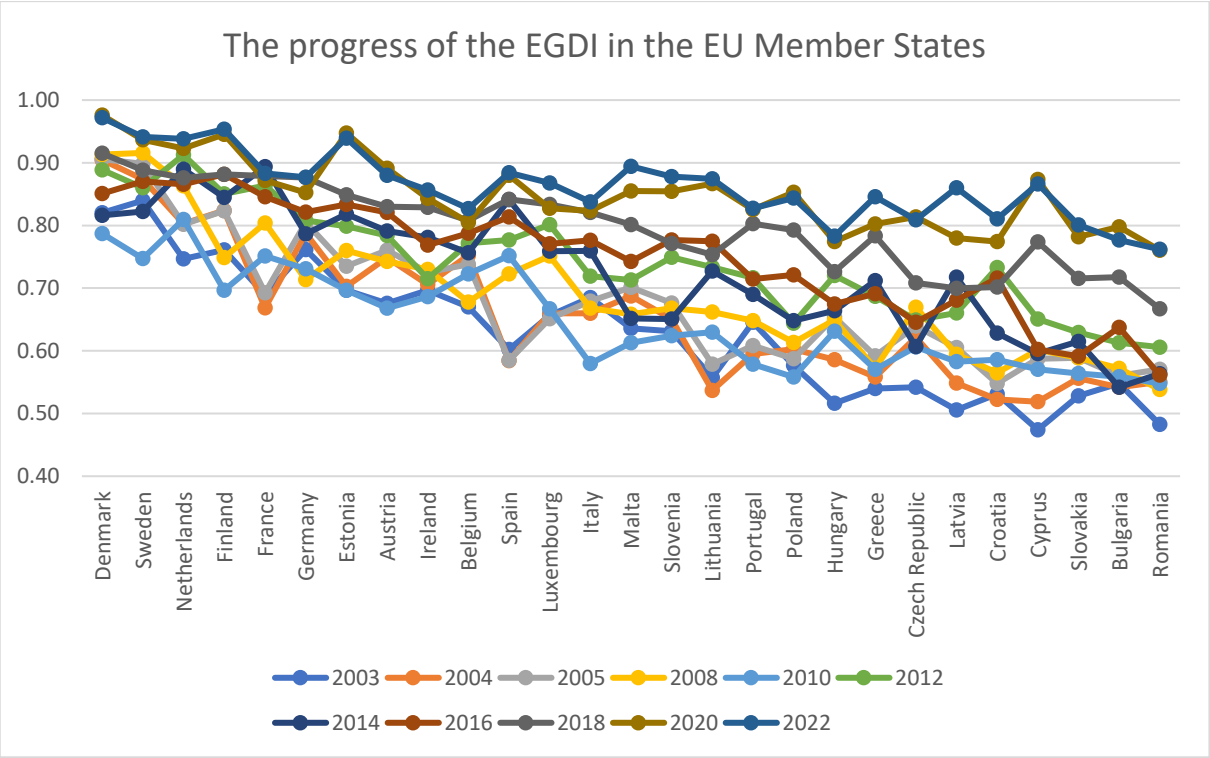

Figure 1. The progress of the EGDI in the EU Member States over the years. Source: own processing.

Figure 2 shows the trends of average values for the sub-indices of the EGDI, i.e., OSI, TII and HCI, between 2003 and 2022. All values are normalized to values between 0 (worst) and 1 (best). The findings demonstrate that in terms of HCU averages there is a slight decline over the years. Although this decline is not significant, and the average values increased in 2020 and 2022, we recommend focusing on improving digital competencies and capabilities of citizens as well as businesses, because human capital is crucial for using digital public services. The results also show that the OSI and TII values improved significantly over the years. Especially the availability and quality of ICT infrastructures in terms of broadband and penetration of devices that can be used to deliver digital public services have seen a steady progress.

On the other hand, these improvements can be also affected in changes of the mix of indicators used for calculating the EGDI. It can be assumed that some countries already used modern ICT and e-government approaches, which were not yet part of the index. But when they were added into the index, the average value of the given sub-index increased. This situation could also occur the other way around, when some countries still used outdated technologies, which were still part of the index. In addition, the weights of individual indicators also affect the overall output.

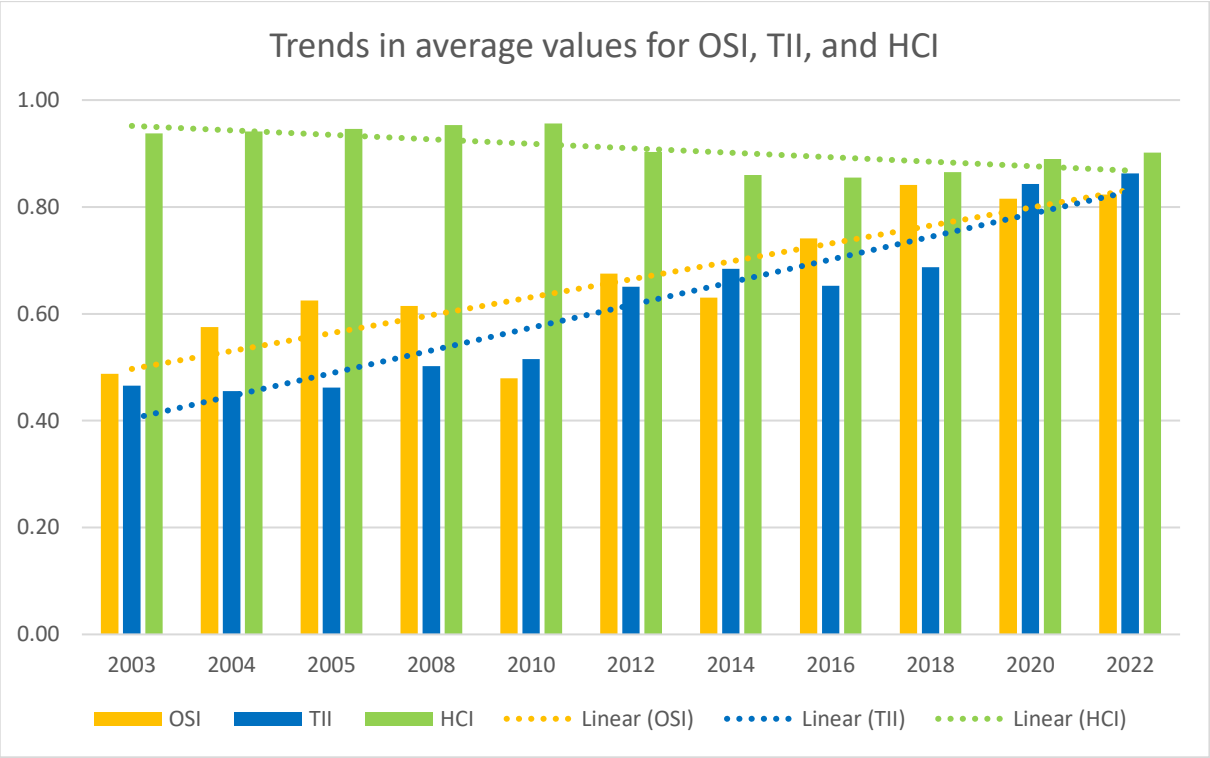

Figure 2. Trends in average values for OSI, TII, and HCI between 2003 and 2022. Source: own processing.

Figures 3 and 4 show the trends of standard deviation and range values. The average differences between sample countries slightly increased in the case of the HCI, decreased in terms of the OSI, and significantly decreased for the TII. For the EU Member States, we can assume that this was enabled by the existence of the European single market and the free movement of goods, capital, services, and people. More precisely, the EU provides funding for increasing network coverage and broadband speeds across the Europe and supports cross-border delivery of digital public services.

All of these enable the unification of procedures and the quality and availability of services in individual countries, which results in citizens and businesses not having to limit their activities to the territory of one country. This contributes to increasing diversity and the exchange of information between different stakeholders from different EU countries. At the same time, it speeds up and makes decision-making processes more efficient and contributes to increasing competitiveness.

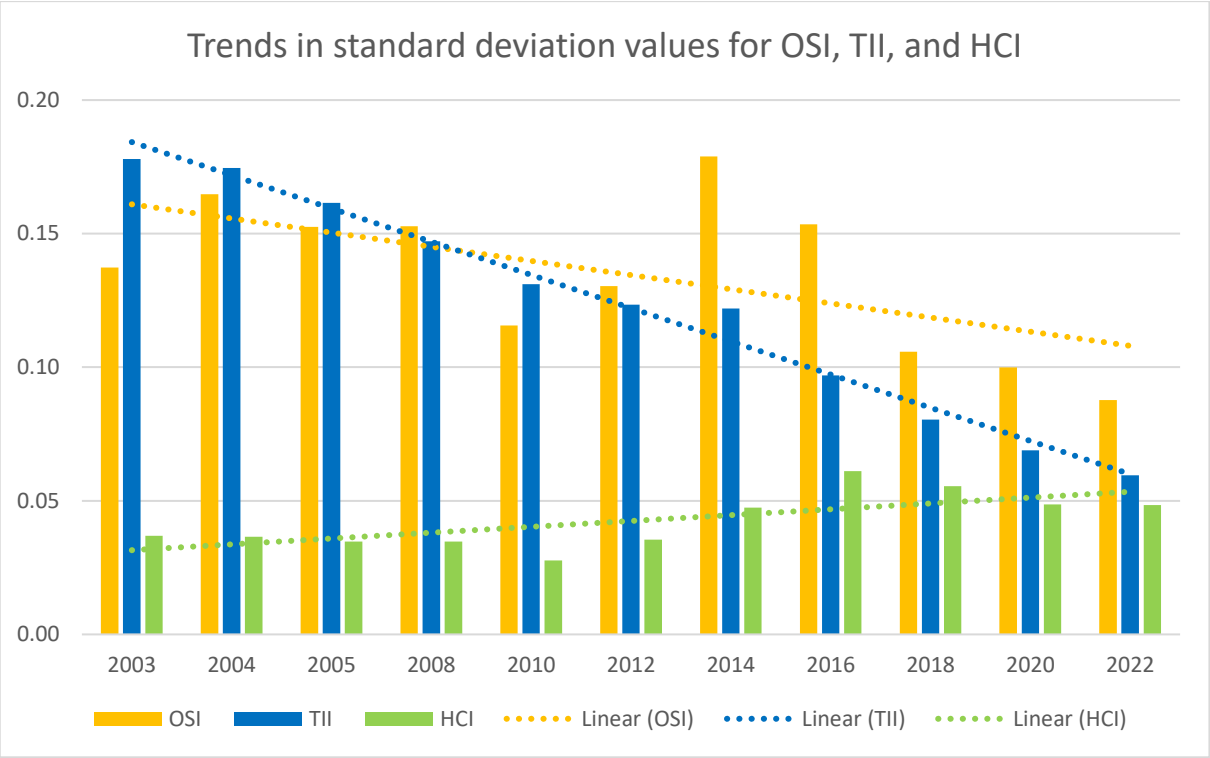

Figure 3. Trends in standard deviation values for OSI, TII, and HCI between 2003 and 2022. Source: own processing.

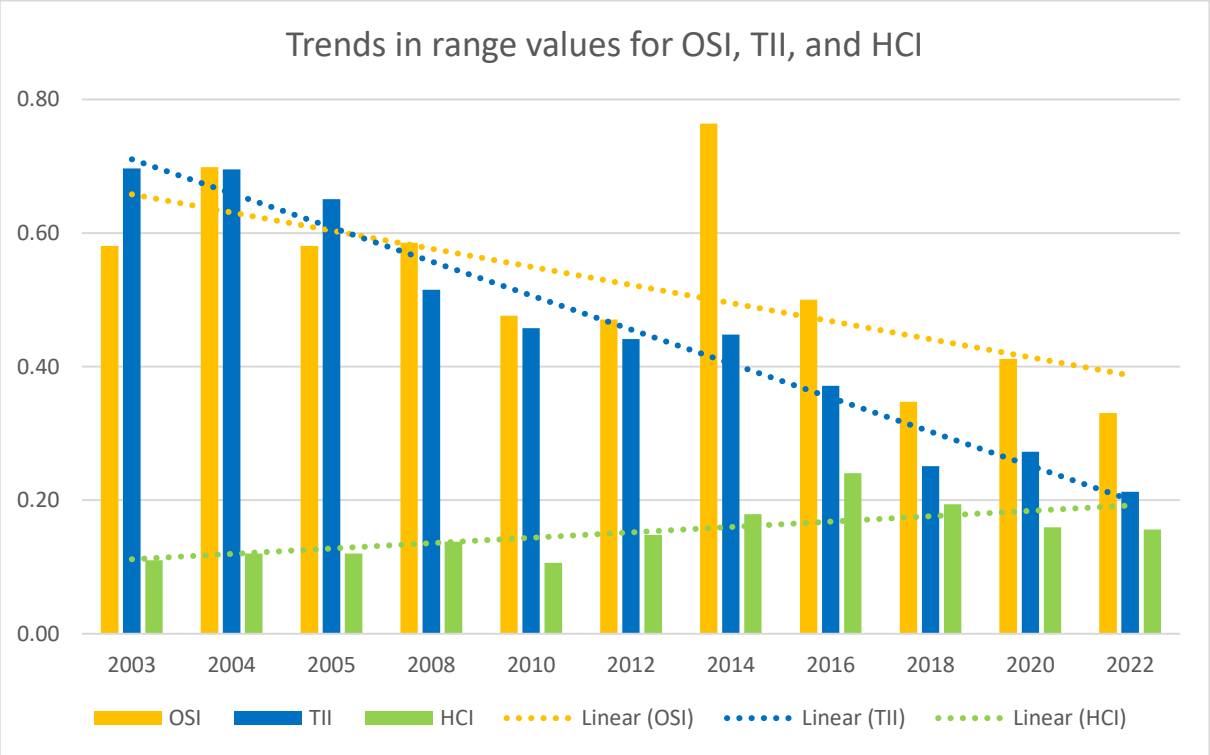

Figure 4. Trends in range values for OSI, TII, and HCI between 2003 and 2022. Source: own processing.

Figure 5 displays the progress of the OSI in the EU Member States. Country-by-country results vary significantly, making it difficult to draw any conclusions. On the other hand, this chart can

be used as an input to a more detailed analysis that would investigate why the values of this index fluctuate so significantly in some countries and the increases are stable in countries like Belgium or Ireland. It can be assumed that these changes are related to political cycles, related investments and other support tools that do not support sustainability, i.e., when the funding of the project is finished, the service is no longer a priority, or it is not promoted.

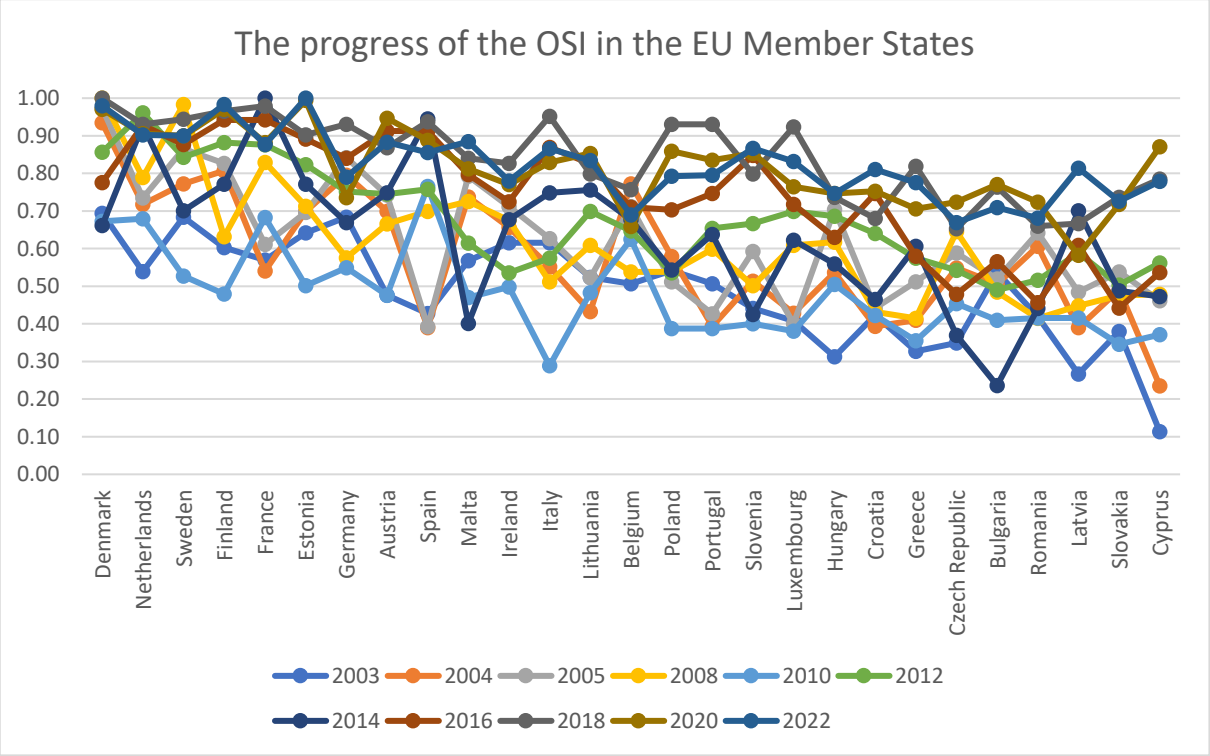

Figure 5. The progress of the OSI in the EU Member States between 2003 and 2022. Source: own processing.

Figure 6 shows how the quality and availability of telecommunications infrastructures have developed over the years. The difference between EU Member States have decreased and in recent years it seems that most countries are on the same level. Romania, Bulgaria, and Poland have made the most progress. The progress of values of the HCI displayed in Figure 7 indicates that the top-performing EU countries have made significant investments in education and training programs, which have resulted in a highly skilled and productive workforce. On the other hand, some of the lower-performing countries may need to focus more on improving access to education as well as providing opportunities for work experience and skills development.

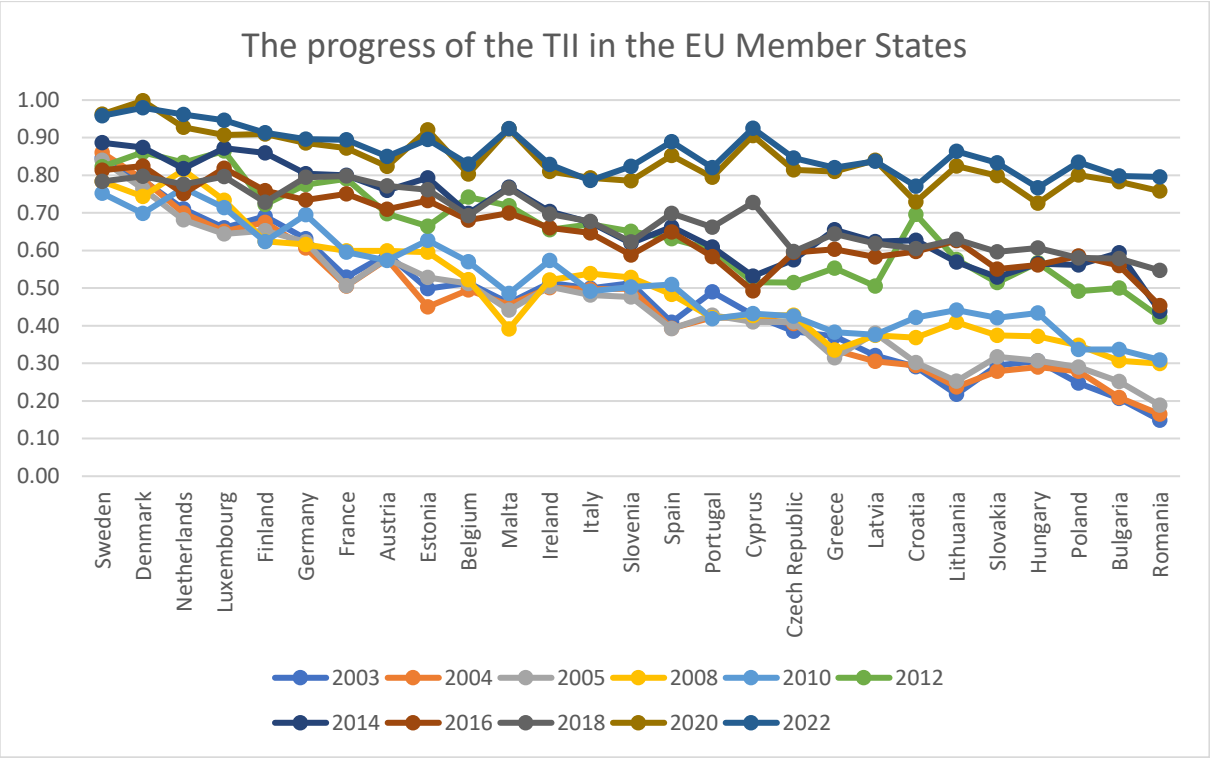

Figure 6. The progress of the TII in the EU Member States between 2003 and 2022. Source: own processing.

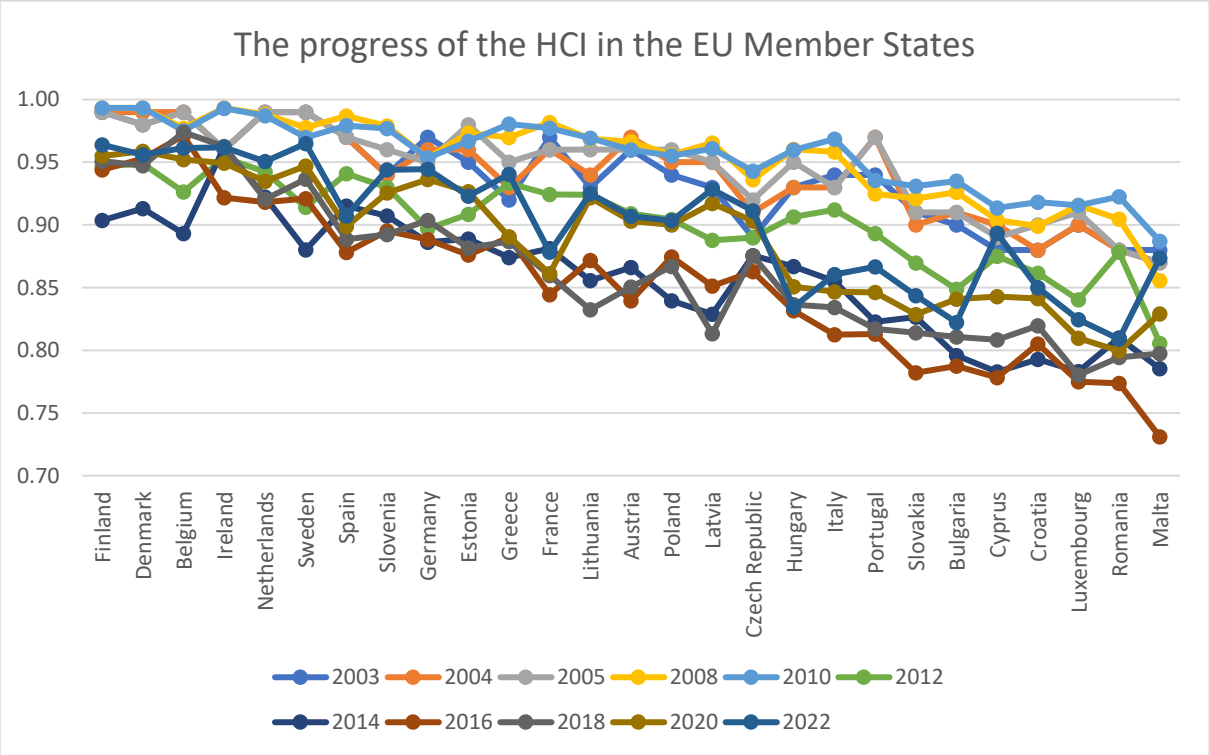

Figure 7. The progress of the HCI in the EU Member States between 2003 and 2022. Source: own processing.

4.2.2 Digital economy and society index

Table 7 shows top 5 best performing countries for the DESI. There are no significant changes over the years, only the fifth place has changed. Figure 8 shows the progress of the DESI in the EU Member States. The countries are ranked according to the average value for the entire period covered. The unit of measure of the DESI is weighted score (0 to 100). In contrast to Figure 1 and the progress of the EGDI, we can conclude that all countries continuously improve their performance in respective dimensions. However, the differences between individual countries tend to increase. The best performing countries improved their values between 2017 and 2022 more than countries such as Romania and Bulgaria. The results from the latest editions of this index, which were affected by the Covid-19 pandemic, show that some countries improved more than in previous years and we can argue that they took this opportunity for improvements.

Table 7. Top 5 best performing countries for the DESI from 2017 to 2022. Source: own processing.

Rank	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
1.	Finland	Finland	Finland	Finland	Denmark	Finland
2.	Denmark	Sweden	Denmark	Denmark	Finland	Denmark
3.	Sweden	Denmark	Sweden	Sweden	Netherlands	Netherlands
4.	Netherlands	Netherlands	Netherlands	Netherlands	Sweden	Sweden
5.	Luxembourg	Luxembourg	Luxembourg	Malta	Ireland	Ireland

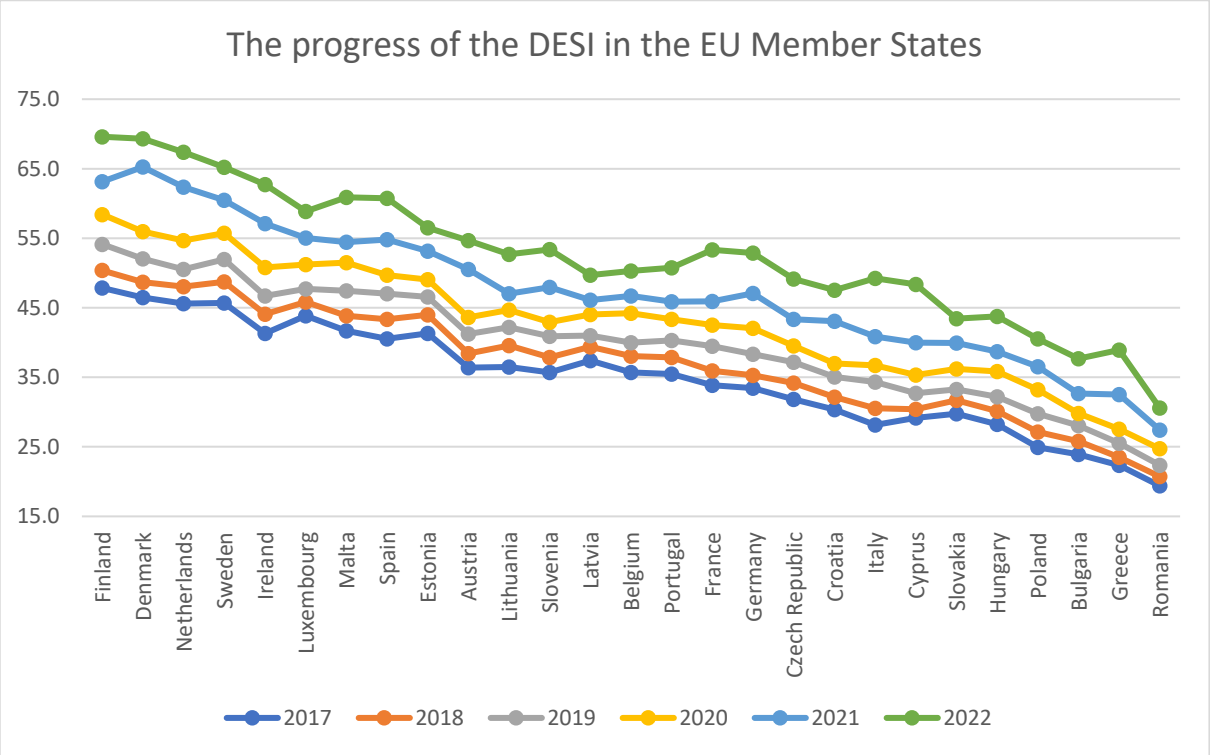

Figure 8. The progress of the DESI in the EU Member States over the years. Source: own processing.

Figure 9 shows the average values for dimensions of the DESI between 2017 and 2022. The findings illustrated that there was a steady growth in the averages from the period 2017 to 2022. Although the weights for dimensions were different through the years, see Table 5, the values in Figure 9 were recalculated so that each dimension has a weight of 25% and the results are comparable among different years. We can conclude that the dimensions that have improved most are connectivity and digital public services. Those are similar to findings for the EGDI.

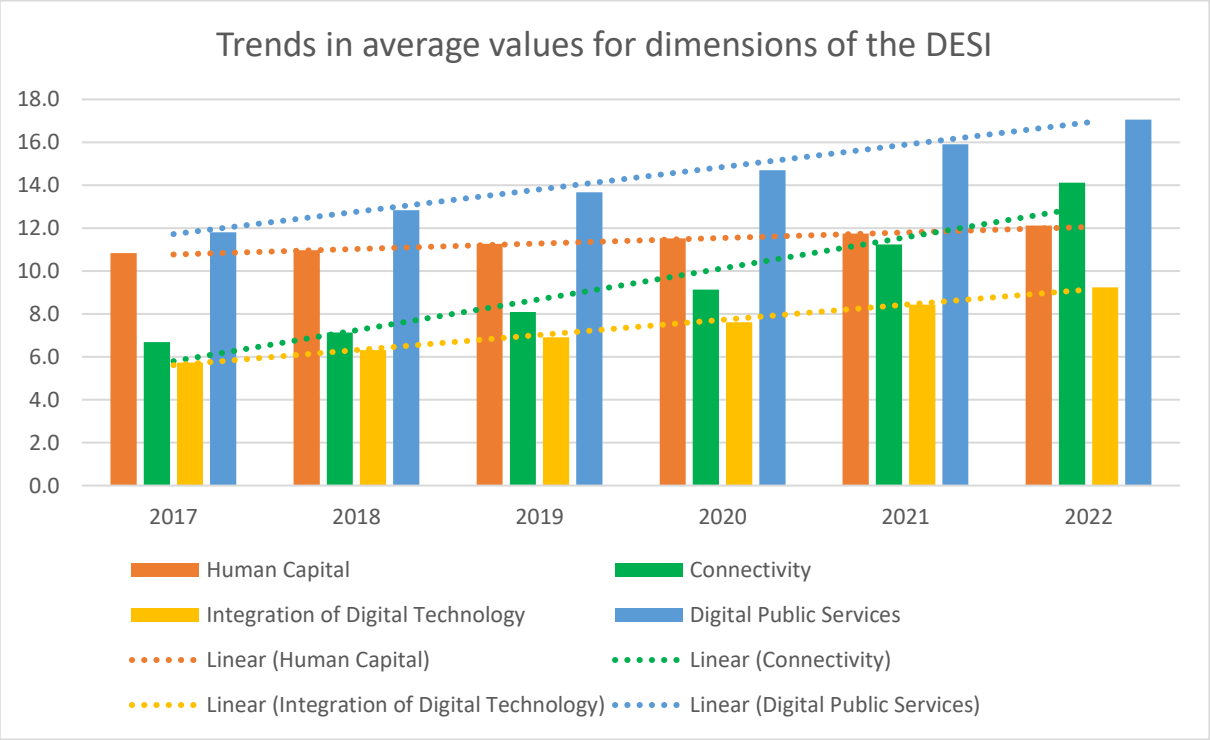

Figure 9. Trends in average values for dimensions of the DESI between 2017 and 2022. Source: own processing.

Figures 10 and 11 present the trends of standard deviation and range values. The findings illustrate that there was a growth in standard deviations and range values from the period 2017 to 2022. This means that the differences between best and worst countries are slightly widening. Although the differences are not significant, the trend is obvious. Especially the integration of digital technology dimension could result in bigger disparities and digital divides among the EU countries. In this regard, countries should focus on developing projects that will improve the use of big data, AI, and ICT for environmental sustainability. These trends are crucial to reuse the existing data sources in the public as well as private sector and uncover hidden values from these data. In addition, AI and machine learning techniques are the key tools that could help in these efforts. It should be highlighted that this should be a priority for both governments and businesses, i.e., to improve digital intensity of their actions, to be able to provide more effective, faster, and quality digital services to citizens.

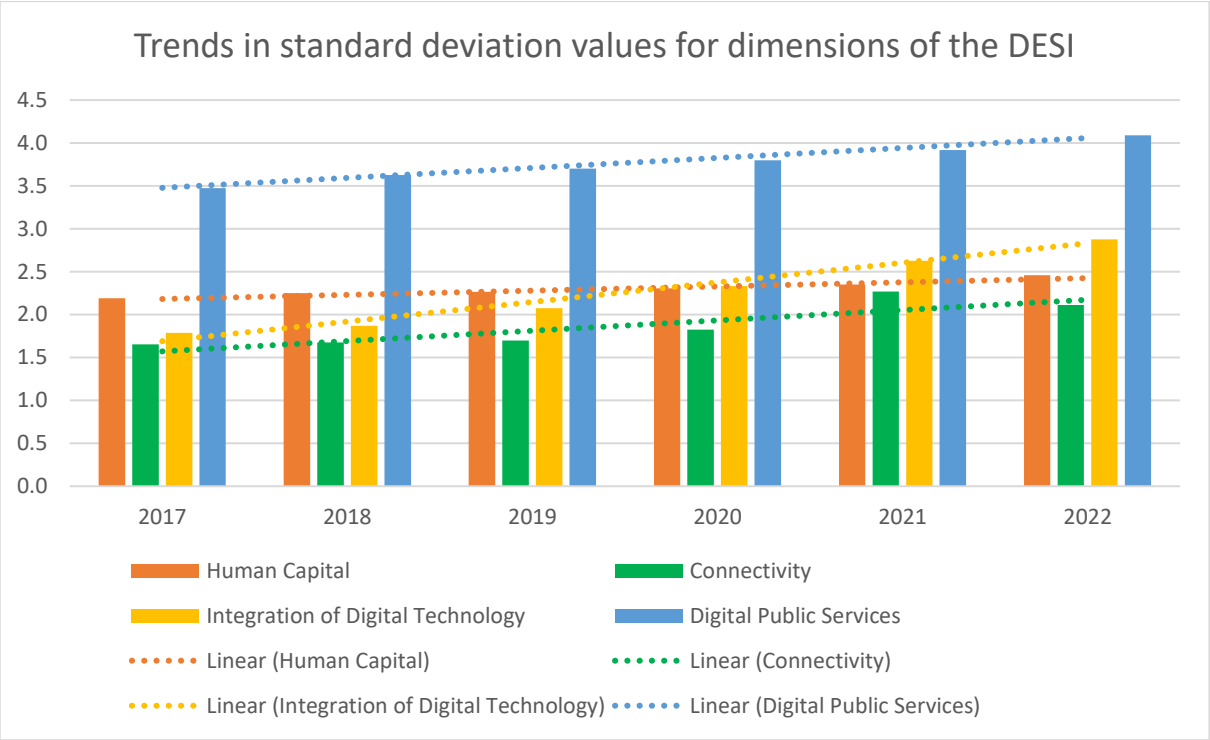

Figure 10. Trends in standard deviation values for dimensions of the DESI between 2017 and 2022. Source: own processing.

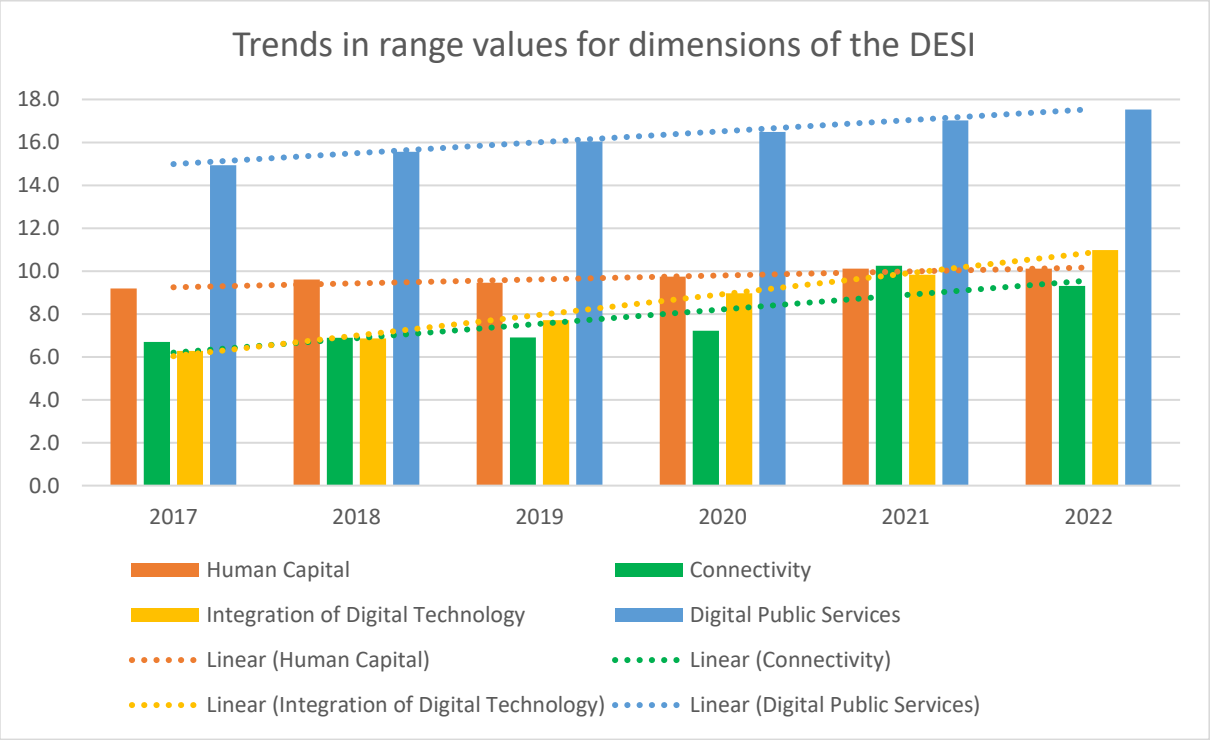

Figure 11. Trends in range values for dimensions of the DESI between 2017 and 2022. Source: own processing.

Figure 12 displays the progress of the human capital dimension in the EU Member States. Overall, the human capital dimension of the DESI indicates that the Nordic countries (Finland,

Sweden, and Denmark) and Ireland and the Netherlands are leading the way in terms of digital skills and ICT expertise. These countries have invested heavily in education and training to develop their human capital and prepare their populations for the digital economy. On the other hand, countries such as Romania, Bulgaria, and Poland have not made almost any progress in 6 years. However, it should be noted that improvements and changes of educational systems are demanding, complex and may take longer than 10 years to manifest.

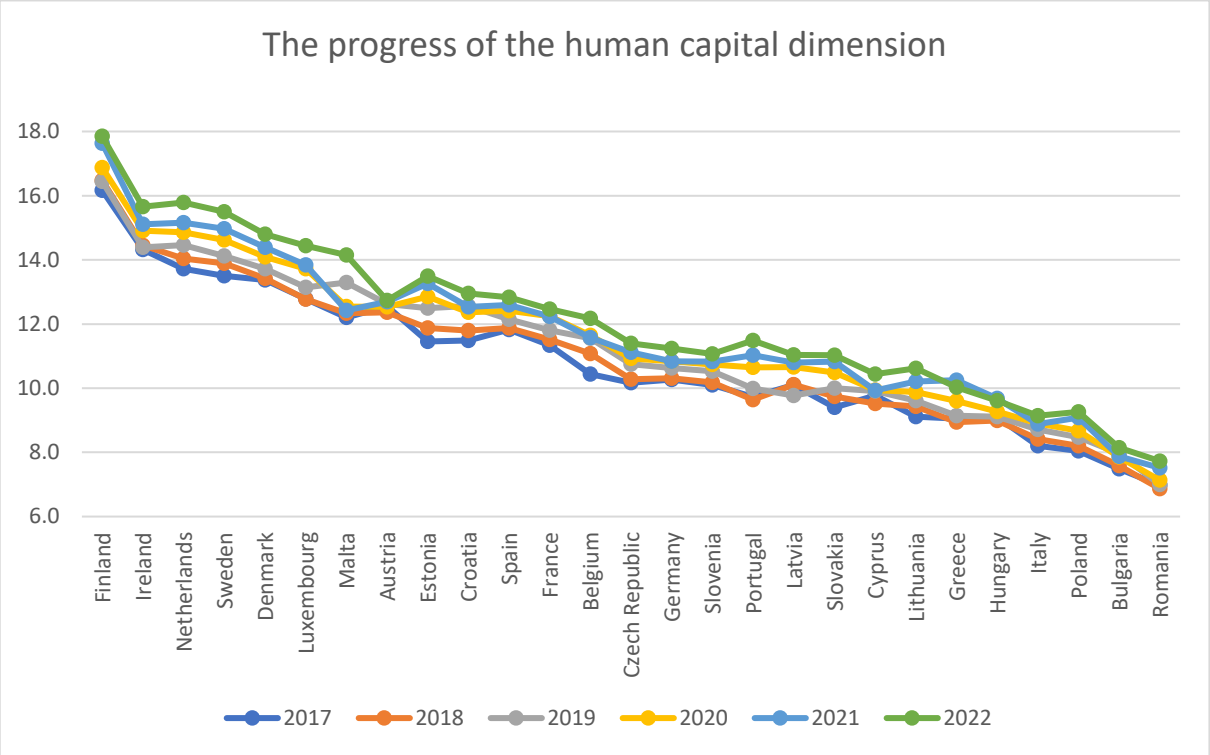

Figure 12. The progress of the human capital dimension of the DESI between 2017 and 2022. Source: own processing.

The progress of the connectivity scores among the EU Member States is presented in Figure 13. Based on the results, we can argue that building top performance, secure, sustainable, and optimised digital connectivity infrastructures are priorities for most of the countries in the last two years. Denmark, Germany, France, Ireland, and Italy improved most. As mentioned above, related strategies and projects aiming to improve connectivity were accelerated by the Covid-19 pandemic. In addition, these infrastructures must be prepared for emerging data processing capabilities, new applications for AI, quantum computing, virtual reality, metaverse etc. Thus, we recommend to support investments in high-performance connectivity infrastructures.

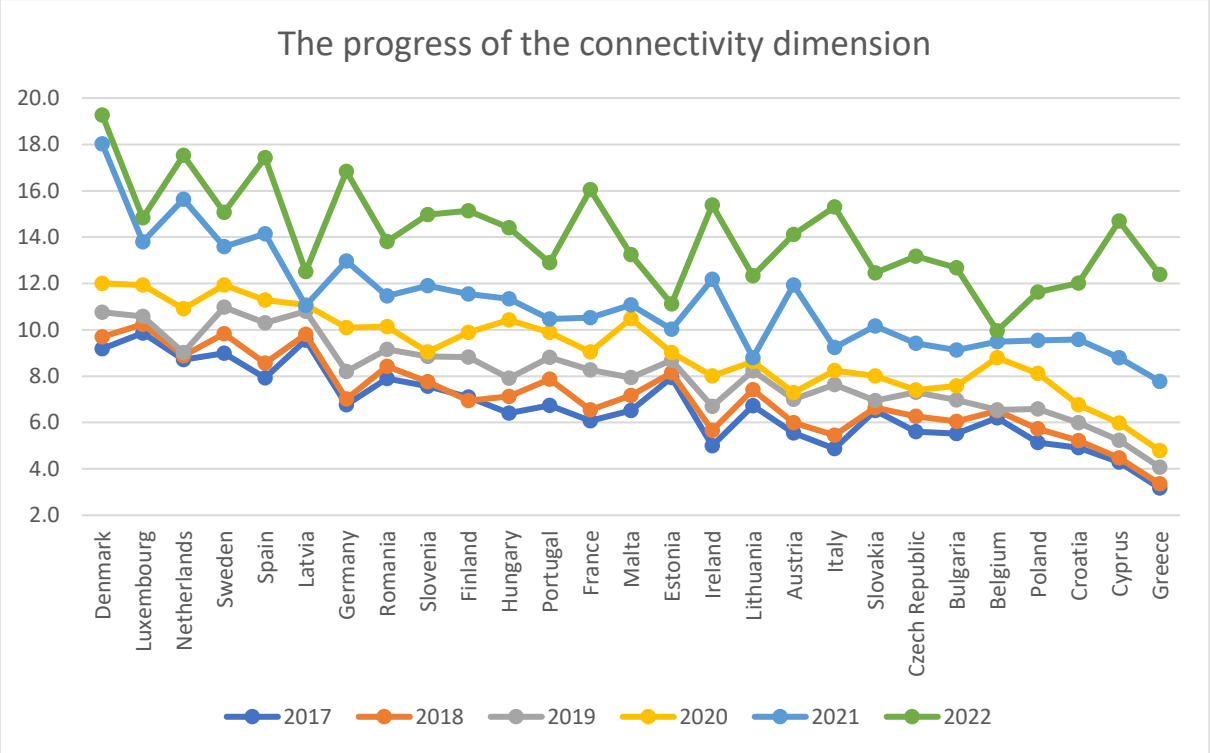

Figure 13. The progress of the connectivity dimension of the DESI between 2017 and 2022. Source: own processing.

Integration of digital technology in the EU countries has been on the rise in recent years, driven by the increasing availability of digital tools and services. This progress can be seen in Figure 14. The EU's Digital Single Market initiative, which points to expel boundaries to cross-border e-commerce and advance computerized advancement, has moreover played a part in advancing the integration of digital technology over the EU. In any case, there are still contrasts in innovation integration over EU countries, with a few slacking behind in certain areas. The Covid-19 pandemic has also highlighted the significance of computerized framework and computerized competencies and skills in empowering farther work and online instruction, advance emphasizing the require for proceeded endeavours to advance innovation integration over the EU.

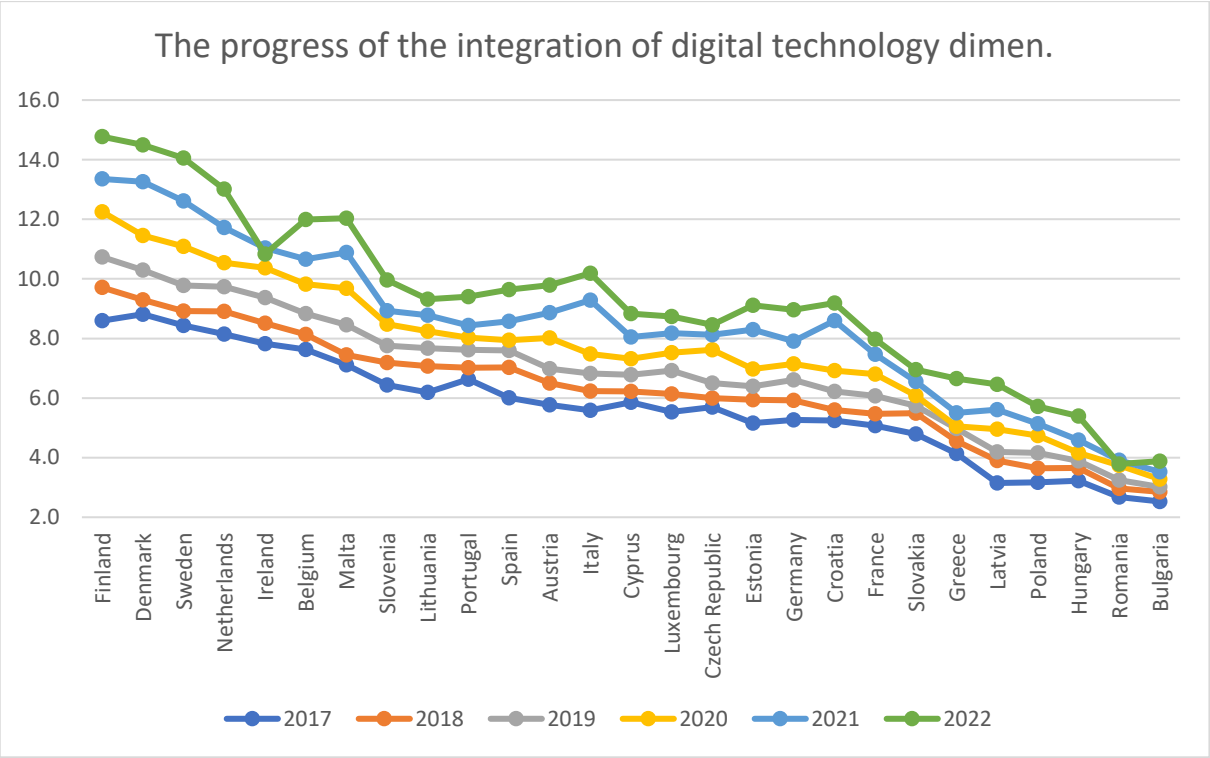

Figure 14. The progress of the integration of digital technology dimension of the DESI between 2017 and 2022. Source: own processing.

Digital public services are a vital component of the computerized change within the EU and are significant for empowering citizens and businesses to get to government administrations and data online. Digital public services incorporate e-government, e-health, e-education, and other online administrations given by public sector agencies and institutions. Whereas advance has been made, some challenges stay within the development and usage of digital public services within the EU. These incorporate issues related to information security, interoperability, and the digital skills gap. Ongoing investments in digital infrastructures, competencies and skills improvements, and indicators to guarantee the complete support of all citizens within the advanced digital society are critical to ensure the persistent improvement of high-quality computerized digital public services within the EU. Figure 15 displays the progress for this dimension. We can conclude that the availability of online public services has been growing steadily over the last several years. However, some countries such as Romania or Greece are lagging behind the rest of the EU's Member States.

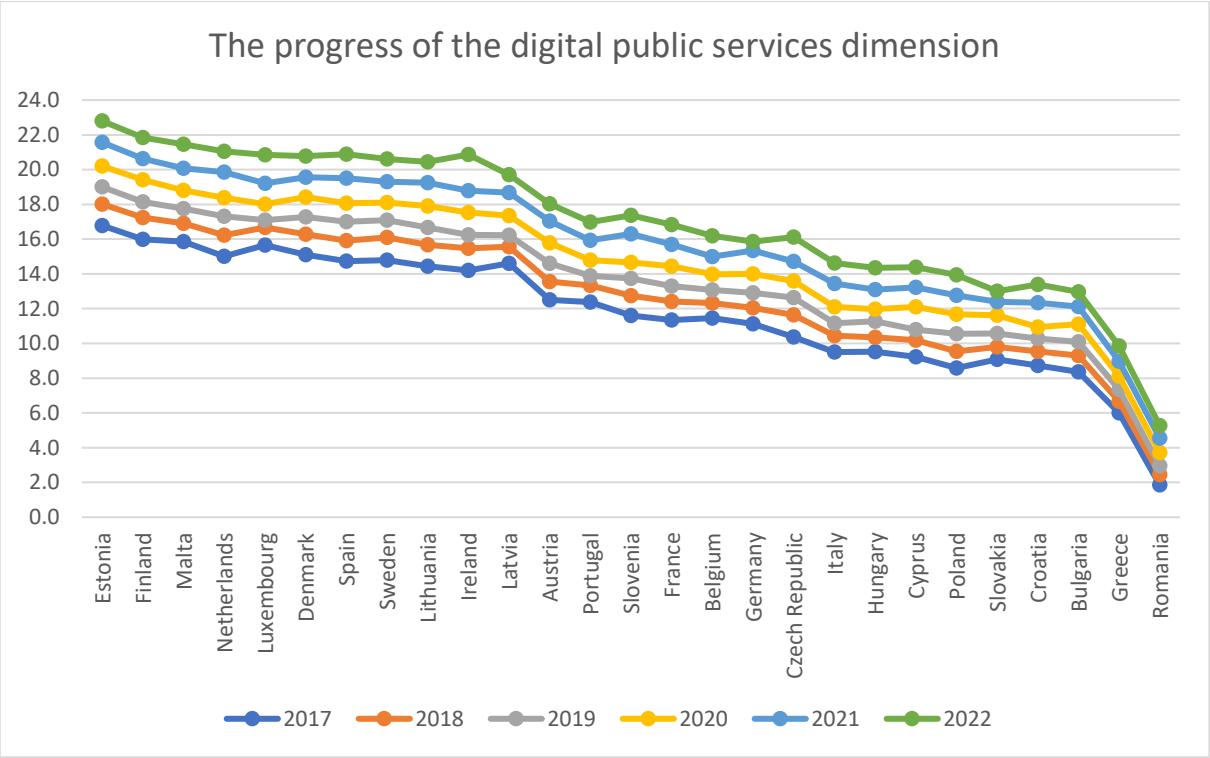

Figure 15. The progress of the digital public services dimension of the DESI between 2017 and 2022. Source: own processing.

4.3 CLUSTER ANALYSIS

To identify similarities between countries in respect to sub-indices and dimensions, we applied the cluster analysis. With this, we aimed to understand whether it is possible to determine clusters based on indicators that would allow us to identify strengths and weaknesses that may be recognized as best practices to improve e-government and digital society development. Also, we are interested in whether the composition of the clusters has changed over the years. For the EGDI, we performed the cluster analysis for 2004, 2008, 2012, 2016, and 2020. For the DESI, we selected the years 2018, 2020, and 2022. The main reasons for this were clarity of results and to observe larger time spans over which some changes can be expected to occur.

We used the STATISTICA 12.0 analytics tool. First, we created data files for each index and respective years, i.e., we had two Excel workbooks with five and three sheets respectively. Then, the files (sheets) were imported into the tool – the options *Get variable names from first row* and *Get case names from the first column* were checked. The three sub-indices of the EGDI are already normalized scores and the Z-score standardization procedure was implemented for each component indicator, see the methodology section in United Nations (2022). However, the four dimensions of the DESI must be standardized before the cluster analysis takes place. This was done using *Transformations* – *Standardize* in the STATISTICA 12.0 analytics tool.

A joining (tree clustering) hierarchical algorithms and non-hierarchical K-means clustering method were applied then for each sheet. Initial tuning/setup of cluster centres was performed using a hierarchical single linkage algorithm and Ward's minimum variance method. By checking the dendrograms for both methods, we can get information about how the clusters are formed. In this regard, the non-hierarchical clustering was carried out using the K-means algorithm for 4, 5, and 6 clusters. Of the given numbers, 5 clusters provide the highest quality clustering (e.g., intra-cluster and inter-cluster distances, no empty cluster, no cluster with a single member etc.) for both the EGDI and DESI. This number has been selected for further processing.

The countries in each cluster for the EGDI in selected years are shown in Table 8, where the country with the largest distance from the centre is highlighted in bold. The findings from the analysis demonstrate that there are significant differences between the countries in terms of the periods 2004 to 2020. By analysing the *plot of means for each cluster* in all selected years, we can conclude that the most important variables (sub-indices) for the clustering are the OSI and TII. In 2004, countries with the highest average values for these sub-indices can be found in cluster 5, while countries with the lowest values are in cluster 4. In the next years, countries were clustered together based on increasing/decreasing values for the OSI and TII (see Figures 5 and 6 in the section 4.2.1). Denmark, Finland, Netherlands, and Sweden are usually clustered together in the cluster with the highest values, while Bulgaria, Hungary, Romania, and Slovakia are usually clustered together in the cluster with the lowest values for all sub-indices. In 2020, countries with the lowest average value for the OSI are in cluster 3 but they have the second highest average value of the HCI and the third highest for the TII. This can be explained by the fact that some countries focus more on digital infrastructures and human capital when they expect these to be the key indicators for innovations.

If the cluster analysis would be performed without the OSI then the members of the clusters would remain more or less the same in all years because of how the TII values evolved over the years, i.e., proportionally for the given groups of countries. Therefore, it can be concluded that the similarities between groups in selected years are primarily based on how countries have implemented and improved the availability of their digital public services over the years. The progress of building digital and telecommunication infrastructures and the quality of their parameters such as broadband also have an influence on this. However, the existence of online services for citizens and businesses is key, because if they do not exist or are of poor quality, their uptake will be low.

Table 8: Clustering in selected years for the EGDI using K-means algorithm. Source: own processing.

2004	
Cluster 1	Czech Republic, France, Italy, **Luxembourg**, Slovenia
Cluster 2	Austria, Belgium, Estonia, **Germany**, Ireland, Malta
Cluster 3	Croatia, **Cyprus**, Greece, Latvia, Portugal, Spain
Cluster 4	Bulgaria, Hungary, Lithuania, Poland, **Romania**, Slovakia
Cluster 5	**Denmark**, Finland, Netherlands, Sweden
2008	
Cluster 1	Austria, Estonia, Finland, France, Ireland, **Luxembourg**
Cluster 2	Belgium, **Germany**, Italy, Slovenia
Cluster 3	Denmark, **Netherlands**, Sweden
Cluster 4	Czech Republic, Hungary, Lithuania, **Malta**, Portugal, Spain
Cluster 5	Bulgaria, Croatia, Cyprus, Greece, Latvia, **Poland**, Romania, Slovakia
2012	
Cluster 1	Austria, **Estonia**, Hungary, Lithuania, Portugal, Slovenia, Spain
Cluster 2	Denmark, **Finland**, France, Netherlands, Sweden
Cluster 3	Belgium, Croatia, **Ireland**, Italy, Malta
Cluster 4	Bulgaria, Cyprus, Czech Republic, Greece, Latvia, Poland, **Romania**, Slovakia
Cluster 5	Germany, Luxembourg
2016	
Cluster 1	Croatia, Italy, Lithuania, **Malta**, Portugal, Slovenia
Cluster 2	Belgium, Ireland, **Poland**
Cluster 3	Bulgaria, Cyprus, Czech Republic, Greece, Hungary, Latvia, **Romania**, Slovakia
Cluster 4	Austria, Estonia, Finland, France, Germany, Netherlands, **Spain**, Sweden
Cluster 5	Denmark, Luxembourg
2020	
Cluster 1	**Denmark**, Estonia, Finland, Netherlands, Sweden
Cluster 2	**Austria**, France, Italy, Lithuania, Poland, Portugal, Slovenia, Spain
Cluster 3	Belgium, Czech Republic, Germany, Greece, Ireland, **Latvia**
Cluster 4	**Cyprus**, **Luxembourg**, Malta
Cluster 5	Bulgaria, Croatia, Hungary, Romania, **Slovakia**

The countries in each cluster for the DESI in selected years are shown in Table 9, where the country with the largest distance from the centre is highlighted in bold. Based on the *plot of means for each cluster* in 2018, countries with the highest average values for all dimensions, expect of the connectivity, can be found in cluster 5, while countries with the lowest average

values for all dimensions, expect of the connectivity, are in cluster 1. It seems that indicators related to connectivity (see Table 5 in the section 3.3) are the ones that have influenced the clustering of countries in this year the most. However, it should be noted that this dimension has changed the most over the years, respectively its indicators, so it is difficult to identify any relevant indicators that can be recognized as best practices.

In 2020, the results are similar to 2018, i.e., cluster 5 includes the countries with the highest average values and cluster 4 covers the countries with the lowest average values. Connectivity and integration of digital technology are the dimensions that affected the clustering in this year. The post-covid year 2022 is characterized by significant progress in the connectivity dimension for most countries. This resulted in a rearrangement of cluster members compared to 2020. Countries with the best values are in cluster 4 and countries with the lowest values can be found in cluster 5. The countries in cluster 5 significantly lag behind the others in the dimensions of integration of digital technology and digital public services.

Table 9: Clustering in selected years for the DESI using K-means algorithm. Source: own processing.

2018	
Cluster 1	Bulgaria, Hungary, Poland, **Romania**
Cluster 2	Austria, Belgium, Czech Republic, France, Germany, **Lithuania**, Portugal, Slovakia, Slovenia
Cluster 3	Estonia, **Latvia**, Luxembourg, Spain
Cluster 4	Croatia, Cyprus, **Greece**, Italy
Cluster 5	Denmark, Finland, **Ireland**, Malta, Netherlands, Sweden
2020	
Cluster 1	Germany, **Hungary**, Latvia, Portugal
Cluster 2	Austria, Belgium, Croatia, Cyprus, Czech Republic, France, Italy, **Lithuania**, Slovakia, Slovenia
Cluster 3	**Estonia**, Luxembourg, Malta, Spain
Cluster 4	Bulgaria, Greece, Poland, **Romania**
Cluster 5	Denmark, Finland, **Ireland**, Netherlands, Sweden
2022	
Cluster 1	**Finland**, Ireland, Luxembourg, Malta, Sweden
Cluster 2	Cyprus, France, Germany, **Italy**, Slovenia
Cluster 3	Austria, **Belgium**, Croatia, Czech Republic, Estonia, Latvia, Lithuania, Portugal
Cluster 4	Denmark, Netherlands, **Spain**
Cluster 5	Bulgaria, Greece, Hungary, Poland, **Romania**, Slovakia

5 RESULTS AND DISCUSSION

The main theoretical contributions can be found in chapter 2.3 *Benchmarking and evaluation reports* and especially chapter 3 *Identification and comparison of relevant indicators*. These chapters provide overview of the most important indices, rankings, and reports that focus on the e-government and digital society development and analyse their structure of sub-indices, dimensions, pillars, and individual indicators that are used to evaluate these developments. We found that the most important ones are the EGDI, which is published since 2001, and the DESI, which is published since 2014. Both of them are still active, i.e., the current editions available are from 2022, so we analysed how the indicators changed over the years. While the EGDI's structure and composition of indicators were slightly changed and some outdated technologies were replaced by more current ones, the DESI's dimensions, indicators, and their weights towards the overall score of the index has changed significantly.

ICT, technological infrastructures, services to access and use digital platforms, knowledge and skills, and other activities performed by citizens, businesses, and governments to interact with each other, and exchange information had dramatically evolved over the years. So, it is obvious that all indices must respond to these with corresponding indicators. Because the EGDI covers all the UN's Member States, its structure cannot be changed so much because there developed as well as developing countries. On the other hand, the DESI covers only the EU's Member States which are developed countries that rely on modern technologies and have financial and human resources to transform their use into innovations and economic growth.

The main contributions for practice are presented in section 4 *Analysis of indicators in selected countries*. We chose the EU Member States and performed the statistical and cluster analyses using the data for the EGDI and DESI. The results showed that the OSI and TII values improved significantly over the years. For the DESI, the dimensions that have improved most are connectivity and digital public services. We also found that the Nordic countries are usually among the best performers, so we can recommend to learn from their experiences. On the other hand, some countries such as Bulgaria, Romania, Hungary, Poland, or Slovakia are still lagging in some areas compared to other Member States.

To sum up, the use of indicators to identify the significant differences existing between and within countries' adoption of the DESI and the EGDI allowed for the easy assessment and establishing of the degree of integration. More so the nature of the information in tabular and format as well as charts allowed us to make cross comparisons per country per use without too

many explanations tied to the observations. With evidence gathered specifically to the identified indicators only used to understand the country performance specific to the sub-indicator. These significant differences played a critical role in differentiations of country adaptation to digitalisation and the extent to which the digital integration was made. Further evidence demonstrates that digital rankings and placing of countries based on the weighted and average digital performance into ranks is difficult to establish. There are major flows in the approach especially given changes in digital trends and digital integration at each level of integration.

The findings from the data indicated that there were significant differences between these composite indicators. However, comparisons could only be done in terms of countries with challenges associated with the use of these indicators were noted, that is updating the changes that were encountered as the indicator was modified or utilised would imply changes to the entire index's structure. Thus, these small and minor differences can make the whole analysis interpretation difficult to cross compare and establish validity and reliability of the findings.

Another indicator which is effort expectancy was also bright forwards where the belief is around individual potential users hang the belief that the govern application is useful and at the same time believing that the system might be useful. In that regard, user apathy is usually triggered, but on the other hand, some provoked the thought that the performance benefits of usage may be outweighed by the effort in using the application. According to Ding et al. (2012), various factors may influence effort expectancy for technologies. They suggested to link available open data to increase transparency of actions. Petychakis et al (2014) argued that due to the large amount of available data, it can then be hard to find the exact open data set that individuals would be intending to use as they do their work and deliver services, these datasets are so diverse and the way they are coded for access may use different syntax as compared to the usual Internet. In this regard, governed codes by the government facilitate the ease observation and monitoring of Internet (Alexopoulos et al., 2018). Furthermore, government can detect where illegal activities are being done, how they are being done and curb such without any challenges.

Most people believe that digitalization makes like ease, however other scholars within the scope of theory of digital change and acceptance believe different and are furthering the motion that digitalization is critical but also a deprivation to progress for the less educated masses who may be the clients got the digital platforms. Thus, it can be highlighted or noted that e-government is broader that physical government as the level of effort required overlaps boarders and transfers over community jurisdictions and boundaries that are usual for the enforcing agents (Chen et al., 2007; Falk et al., 2017).

These are registered as aspects of the digital technologies that enable the experience of use of technology to be friendly and accepting of the diversity. The approach allows for an understanding of adaptation of reasonable accommodation on the part of all involved within the scope of the technological inventions. This is understood as the degree of which the individual believes that an organization and technical infrastructure exists to support the use of the system. On the contrary others such as Dwivedi et al. (2017), facilitating condition maybe the best predictors for behavioural intentions and these can and may be best for e-government services.

Finally, the question dealing with what users, i.e., citizens and businesses, want and expect to get from the supply side, i.e., the governments, still remains unanswered, especially with regard to the effectiveness of the public sector agencies and institutions in delivery of digital public services. Indicators that would reflect these views among stakeholders are however difficult to get agreement on them and then obtain the relevant data.

CONCLUSIONS

The aim of the master's thesis was to perform an analysis of e-government and digital society indicators in selected countries. For this purpose, the relevant literature was first examined, and the basic terms related to the researched area were described. Most of them are to a greater or lesser extent related to ICT and how these technologies are used by citizens, businesses and public sector agencies and institutions. We found that the digitization of the society is key for communication and the exchange of data and information between stakeholders, and at the same time the development of digital societies determines what services will be delivered using ICT. With this in mind, in the next section of this chapter we focused on digital public services for citizens and businesses and how governments deal with this topic. Since the main goal of these efforts is open government, transparency and increasing the participation and engagement of citizens and businesses in the decision-making processes occurring in the public sector, these topics were also described more in detail.

The second chapter was focused on definitions and developments of the terms e-government and digital society. We provided an overview of indices, rankings, and reports that appeared since 2000 and benchmarked countries in ICT use, e-government development, digital society, and other indicators. We found that changes in the mix of indicators used by these indices can be attributed to advances in ICT and channels through which people communicate and receive information. We suggest that each index should include indicators that contribute to increase of efficiency of decision-making processes, support the growth of human capital, development of digital infrastructures, and delivery of new digital services.

The third chapter provided input information and data for the analyses performed in the next chapter. More precisely, we focused on the identification and comparison of the indicators, as well as sub-indices, dimensions, pillars etc., relevant for the e-government development and digital society context. We provided an overview of existing indicators and how publishers of respective indices and reports include modern technologies in their frameworks. Based on the lists of indicators included in each index, the number of countries covered, changes in the methodology, comparability of data over years, and the availability of the input data, we chose the EGDI and DESI and their indicators for the analyses. We decomposed them and discussed changes in the sets of indicators that were used by these indices over the years.

The main part of the thesis explored and analysed e-government and digital society indicators in the EU Member States using the indicators of the EGDI and DESI. The following objectives

were addressed in this chapter: 1) the progress of selected sub-indices and dimensions of the EGDI and DESI in the EU Member States over the years and 2) similarities among groups of the EU Member States for the EGDI and DESI over the years. We used statistical and cluster analyses to achieve these objectives. The findings revealed that digital and telecommunication infrastructures and the quality of their parameters such as broadband have the biggest influence on progress of the e-government and digital societies developments and contribute most to clustering of the EU Member States into groups. However, the existence of online services for citizens and businesses is also crucial, because if they do not exist or are of poor quality, their uptake will be low.

Overall, this thesis emphasized the importance of relevant indicators used for evaluation and benchmarking of countries in terms of their e-government and digital society developments.

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