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Similarities and differences between digitalization indexes

Olena Korzhyk [a], Jorge Vareda Gomes [a]*, Gonçalo João [a]

[a] *Universidade Autónoma de Lisboa, Lisboa, Portugal*

ABSTRACT

Digitalization is nowadays one of the fastest developing processes. The adoption of digital technologies can provide innumerous opportunities for the organizations to evolve and gain competitive advantage by leveraging of technologies to respond to dynamic expectations and demands. Information about the country digitalization level is essential to decision makers in both public and private organizations. It can present insights on which areas need the most investment, and furthermore to gain feedback on the outcomes of these investments. For companies, it can create a certain predictability on which products and services will be required the most. To assess the evolution of this process in different countries, various indexes were proposed and employed by different corporations. The Digital Economy and Society Index (DESI) and ICT Development Index (IDI) are used by public organizations. Digitalization Index (DiGiX) and Cisco Digital Readiness Index (CISCO) are used by private companies. Comparing two sectors highlights the most common factors of digital evaluation. Indexes are analyzed thoroughly by their structure, coverage, weights, methodology and ranking. The result of the practical work is a equivalence table which shows the percentage of their similarity. Additionally, a new digitalization index is proposed, based on the result of the previous comparison, which can be applied to analyze both public and private sector of the country's digitalization level.

KEYWORDS

Digitalization index; Business digital transformation; Online economy; DESI; DiGiX; ICT Development index; Cisco Digital Readiness index

* Corresponding author: Jorge Vareda Gomes
E-mail address: jorge.gomes@ulusofona.pt

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1. Introduction

Digitalization is becoming an inevitable part of the growth of entrepreneurship in the modern world (Satalkina & Steiner, 2020; Ungureanu, 2021). Digitalization assessment is not yet used in all countries and prevents them from leading in innovation, multi-channel service delivery and advancement in e-commerce and the digital economy (Shin, Ho & Pak, 2020). Although digital technologies still do not have a recognized model for evaluating economic effects, growth and development (Stremousova & Buchinskaia, 2019), many studies have been carried out on the subject of the impact of the digital transition on specific sectors and processes of the economy (Tarasova, Averina & Pecherskaya, 2020). This work focuses on the nature of digitalization and the type of assessments that are carried out on digitalization processes. For this, it is important to define the digitalization, compare digitalization rates and find the most ideal among the suggested variants (Kotarba, 2017). Four digital indexes were chosen, considering their importance and nature. DESI (European Union) and the ICT Development Index (International Telecommunications Union) which belong to the public sector and the DiGiX (BBVA) and CISCO Digital Readiness (CISCO) to the private sector. Digital indices vary geographically and are compared by territory (Konovalova, Kuzmina & Zhironkin, 2020). The assessment of digitalization in different regions can vary dramatically due to political situations, ideologies, cultures and levels of development (Petrenko et al., 2017). As digitalization is a recent process (Lederer, Knapp & Schott, 2017), the research is based on the latest data and definitions. This work can be applied to all demographic groups and communities. The most specific aspect is to develop an ideal digital assessment of the country, company and location. This is done through the verification of equivalence between the most used digital indexes and the conclusion of the most important aspects for this process (Kotarba, 2017).

2. Background

2.1. Digitization, digitalization, digital transformation and the digital economy

Digitization, digitalization, and, later, digital transformation are drivers of change in the corporate world, as they establish new internet-based technologies with implications for society (Unruh & Kiron, 2017).

Digitization (i.e., the process of converting analog data into digital datasets) is the framework for digitalization, which is defined as the exploitation of digital opportunities. Digital transformation is then defined as the process that is used to restructure economies, organizations and society (Annarelli et al., 2021); Brennen & Kreiss, 2016; Unruh & Kiron, 2017). Digitization and digitalization are often used interchangeably, but there are important conceptual differences. Digitization is the technical process of converting analogue signals to digital signals (Tilson, Lyytinen, & Sørensen, 2010). Digitalization is the sociotechnical process of leveraging digitized products or systems to develop new organizational procedures, business models, or commercial offerings (Brynjolfsson & McAfee, 2014). While digitization describes a technology or system of technologies in terms of what it is and its capabilities, digitalization accounts for why that technology is relevant to a specific process or organization (Saarikko et al., 2020).

For Petrenko (2017), digitalization is the transition from the analog form of transferring information to the digital form, with the assumption of not only digitizing, but also creating a new innovative product with new consumer properties and functionality. The process of digitalization leads to digital transformation that is defined as a process of restructuring economies, institutions, and society (Annarelli et al., 2021). Unruh and Kiron (2017) define digital transformation as the restructuring at the level of economic systems, institutions and society that takes place through digital diffusion. In recent decades, global companies have not only faced technological changes that have major impacts on business, greater flexibility, responsiveness and individualization of products, but they have also presented enormous challenges, namely, in rapid technological change, increasing complexity and

changing customer preferences and legal requirements (Sidorenko & Khisamova, 2020). This new situation has transformed an increasingly challenging corporate context (Lerch & Gotsch, 2015). Informational progress in everyday life, with the rapid development of information technologies and the internet of things, has already reached all sectors of the economy and we are rapidly moving towards the digital economy (UNCTAD, 2019). Digital transformation belongs to "Industry 4.0" in the sphere of manufacturing and service development, designed to create "intelligent manufacturing" and integrate it into all aspects of human life, customizing it to the tasks of everyone (Bataev & Aleksandrova, 2020). To achieve the benefits associated with a successful adoption of digital transformation, companies need to take the initiative and develop specific capabilities at various organizational and operational levels of their business model (Eller et al., 2020). The digital transformation increases the profitability of the company by simplifying processes and interactions within the company. The technologies linked to the digital transformation such as big data, artificial intelligence, cloud computing, social networks and the internet of things, offer new uses based on innovation and focused on the needs of the consumer (Mahraz et al., 2019). The term "digital economy" is increasingly heard by politicians, businessmen and the media. It is the physical transformation of information, with the help of digital devices, to create a new form of communication, in addition to processing the enormous amount of information that can be provided from anywhere in the world (Nemoto & López González, 2021). The digital economy describes an economic system where the use of information and communication technology is widespread, and which includes: (Nemoto & López González, 2021):

- Basic infrastructure (high-speed Internet access, computing power, security services)。
- E-business (business models with high use of ICT for front and back-office functions).
- E-Commerce (use of ICT in business-to-business (B2B), business-to-consumer (B2C) and consumer-to-consumer (C2C) transactions).

The digital economy is growing rapidly (Lederer, Knapp & Schott, 2017). Daily, issues related to the digitalization of the economy are discussed by national governments, international organizations, large corporations, small and medium-sized enterprises (UNCTAD, 2019). The size of the digital economy is estimated to range from 4.5% to 15.5% of the world's GDP (UNCTAD, 2019). Investors are actively funding technology companies such as Apple, Amazon, Google, Facebook and Microsoft that represent 21% of all publicly traded US companies (Galloway, 2020). The main role in this process is played by the application of production digitization, implementation of technologies related to Industry 4.0 with big data analysis, using artificial intelligence and industrial internet of things (UNCTAD, 2019). Expectations regarding the economic effectiveness of implementing these technologies are optimistic (Gronum, Steen & Verreynne, 2016). According to researchers, investment in the internet of things in 20 countries (US, Switzerland, Finland, Sweden, Norway, Netherlands, Denmark, UK, Japan, Germany, Australia, Republic of Korea, Canada, China, France, Spain, Brazil, Italy, India and Russia) will provide additional GDP growth of $10.6 trillion (Purdy & Davarzani, 2015). According to World Economic Forum (2016), every US dollar devoted to investment in digital technology over the past 30 years has increased GDP by US$20. And every dollar devoted to non-digital investment has increased GDP by just US$3 (Xu & Cooper, 2017). It is expected that by 2025, 24.3% of the world GDP will receive digital technologies such as artificial intelligence and cloud computing (Kumar, 2019). The characteristic feature of the digital economy is its connection with the on-demand economy, which foresees not the sale of goods and services, but their access now or when necessary. On the supply side, new technologies are emerging in all industries. For example, big data usage technology identifies the needs and products desired by users. Also, 3D printing technology helps to achieve custom production and design. The boundary between supply and demand has become increasingly blurred. For industry leaders, it is necessary to provide information that they have a supervisory board and executive with digital expertise. Must be multigenerational, diverse, and experienced enough to advise on rapidly changing business and technology topics such as cybersecurity. Digital transformation must be conducted at the CEO and board level of the organization.

From a business perspective, the organization must ensure that it is working with industry clusters, has a business strategy consistent with its role in the industry and the implementation of digitization will be rewarded by superior performance. From a talent and leadership perspective, industry leaders must address both technical and creative digital skills in talent strategy, recruit the best talent, and have an action plan to assess employee effectiveness (Laurens, 2019). For governments and policy makers the tasks may wary. They must accomplish the government operations and mission. Government operations mean that the customer service model is user friendly, using open standards and easily accessible in line with industry digital best practices, Also, there should exist the platform for rapid multi-stakeholder interaction and corporate consultation; clarity on the implication of the global security, privacy and cross border data flows in the industry, timeline to coordinate and resolve challenges with industry stakeholders (World Economic Forum, 2016). Government mission is in understanding the implications for the industry when addressing the societal opportunities, implementing flexible policy frameworks to realize benefits in the short and medium term. Policy makers should consider for policies that are currently subject to legal challenge and increase the relevance of regulations and policy frameworks to foster innovation while protecting customer interests (World Economic Forum, 2016). For consumer industry there is a huge open market for digital transformation. There are four digital transformation themes – consumer data flow and value capture, experience economy, omni-channel retail and digital operating model (Rachinger et al., 2019).

2.2. Similarities and differences between indexes and ID rating

The main indicators measuring the level of the digital economy are analyzed here. It is shown that each of the indices has different methodological approaches to determining the level of digitization and contains several factors (Table 1).

Table 1. Indexes of digital development (Kononova,2015).

Initials	Name of index	Source	1st publication	Countries covered	Partial indicators
DESI	Digital economy and society index	European union	2014	28	33
CISCO	Digital readiness index	CISCO company	2016	141	30
DIGIX	The digitization index	BBVA	2015	100	22
IDI	Information and computer Technology development index	International Trade union	2006	180	13

The most developed countries also have the highest levels of digitization of their own economies, with ample access to high-quality internet, a high level of scientific and technological capacity development and a wide access to information (Kononova, 2015).

3. Methodology

3.1. Case study

The methodology used in this research, which consists of the use of one or more qualitative methods of collecting information. The sources of information are predominantly organizational sources, such as conference materials, reports and strategy documents, government sources, like publications, national statistics and reports, as well as printed or online articles. The main methodological comparison tools are clear explanations about the structure of digitization indexes and their respective sub-indicators. Sub-indicators may vary in names, but data used for assessment may be the same or very similar.

3.2. Digital Economy and Society Index (DESI)

The Digital Economy and Society Index (DESI) is a composite index prepared annually by the European Commission since 2015 that seeks to assess the digital competitiveness of Member States, following its evolution over time (European Commission, 2020). The index measures the digital maturity of the 28 EU economies through a set of quantitative indicators that make up the final score.

DESI 2020 considers 37 indicators and is divided into the following dimensions: (1) Connectivity; (2) Human Capital; (3) Use of Internet Services; (4) Integration of Digital Technology; and (5) Digital Public Services. The progress of the country is defined by the sum of all these parameters (Table 2).

Table 2. Digital Economy and Society Index (DESI) (European Commission, 2020a).

Dimension	Explanation
Connectivity	Connectivity is the dimension, which revels the level of fixed broadband coverage, what is the percentage of households which use broadbands, DSL, cable, MiMAx and FTTP. Next is the mobile broadband, described in number of people who use mobile data per 100 people. Also, the internet connection is about speed, which is enough when it is more than 30 Mbps. The last sub-factor of connectivity is affordability, comparison of fixed price of broadband between 12 and 30 Mbps
Human capital	Human capital is the degree to which citizens of the European union can use the Internet and other tools and services. Use of internet parameter indicates the productivity of people in the time of using the digital providers.
Digital public service	Digital public service is a branch of so-called eGovernment. It is about the modernization of the public administration for better serving of citizens. Connectivity factor is about the broad infrastructure and the quality of it.
Use of Internet	Use of Internet value is the content, communication and transactions. People search different content in digital tools, like news, music, video, games. Lately the communication is getting the higher rank, and e-communication consists of social networking, mailing and video calls. The transactions online are shopping or banking. Digital skills can be basic, advanced or developing. Basic skills element in the table shows the amount of Internet users who access at least once a week and people who are using editing, mailing or installing. Advanced and developing skills already have higher level, and people who use Internet or tools already not only for personal use on everyday basis, but they make certain contribution into development of digitalization or use the means of it for educative purposes in other spheres of science. Such people are Information and Communication Technology specialists (ICT specialist hereinafter) like ICT professionals, technicians, service managers. Also, to the advance users are connected people with degree of science, technology, mathematics, engineering.
Integration of Digital Technology	Integration of Digital Technology value includes business digitalization and ecommerce. Electronic formation sharing is the first characteristic of the business digitalization. It is number of businesses who used software's for resource planning or sharing the information between the functional departments like accounting, production, marketing and planning. Second characteristic is the Radio Frequency Identification (RFID) ratio which is the extend of technologies for delivery or identification of goods. Next goes the social media, when businesses use more than social media, for example networks, websites, blogs, and many others. The business should create own profile or account and fulfil the legislative requirements for advertisement. Invoices which are not made manually by the company, but digitally in standard forms and they are being automatically processed.

Methodology of evaluation (European Commission, 2020) uses 3 level structure of evaluation, dimension, sub-dimension, and indicator (Appendix 1). The indicators descriptions, breakdown, units of measurement, sources of information and also the weighting of indicators (Appendix 1). In the Figure 1 is presented the ranking of EU countries with the DESI index, with reference to the average value of the index (European Commission, 2020).

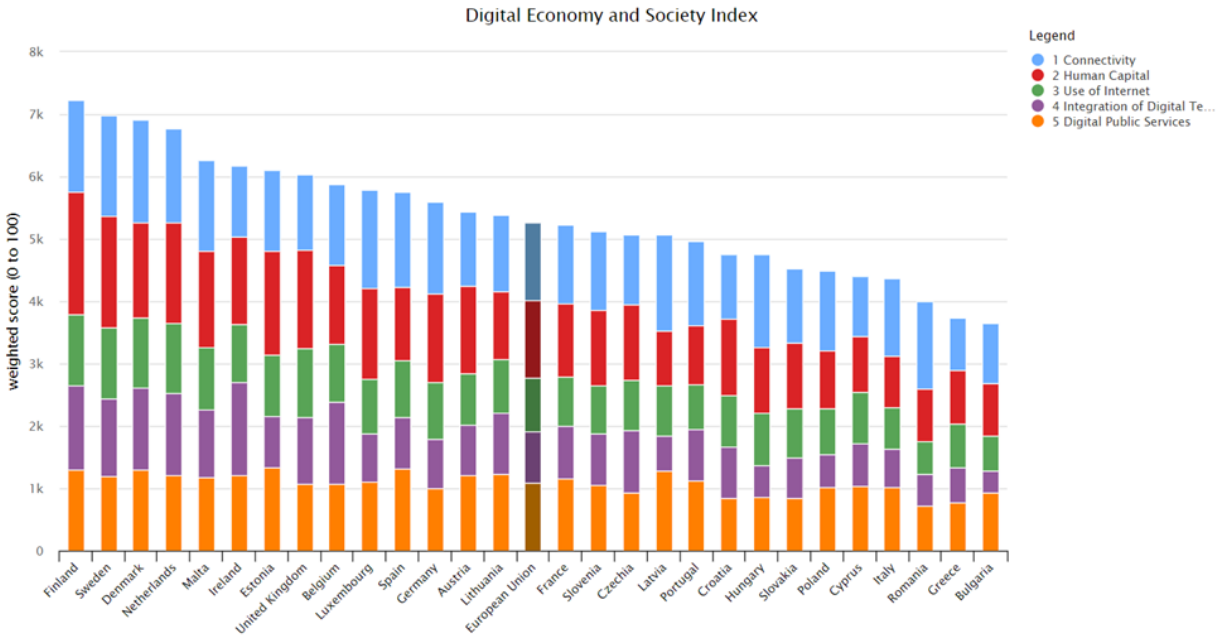


Figure 1. Ranking of countries DESI index (European Commission, 2020).

3.3. Digitalization index (DiGiX)

The DiGiX Digitalization index was created by BBVA company (Banco Bilbao Vizcaya Argentina) and it is considered as one of the largest financial institutions of the world (Cámara, 2020). DiGiX index evaluates the behaviour of institutions and agents and factors that help the community to use the information and communication technology to increase the competitiveness (Cámara & Tuesta, 2017).

DiGiX aims to capture the digitization status over the world in order to compare digitization degrees across countries and identify areas requiring action. Collaboration of governments, financial institutions, and regulatory bodies will be necessary to enhance digitization to serve society (Cámara, 2020).

DIGIX analyses 100 countries through six main components (Table 3): affordability, adoption of users and enterprises, costs, regulations, infrastructure and contents (Kravchenko et al., 2019). Each dimension is in turn divided into several individual indicators. Each dimension summarizes information of several individual indicators (from 1 up to 6). The indicators included in the index are grouped in six dimensions that represent three broad pillars: supply conditions (infrastructure and costs), demand conditions (user, government and enterprise adoption), and institutional environment (regulation). DIGIX differs from other indexes in the literature due to the lack of human capital indicators. A more restricted definition was chosen and only variables directly related to digitization are considered. DIGIX assumes that behind a set of correlated variables, there is an underlying latent structure that can be identified through a latent variable, as in the case of digitization. Weighting indicators or sub-indexes is critical to maximizing the information from a data set included in an index. A good composite index should contain important information from all indicators but should not be heavily biased towards one or more of these indicators. The two-stage principal components methodology was applied to estimate the degree of digitization as an indexing strategy. The dataset contains causal variables that summarize the information for digitization and each causal variable relates to different dimensions that define digitization.

The purpose of dividing the overall set of indicators into three sub-indexes is twofold. On the one hand, the three sub-indexes provide additional disaggregated information that is useful for policy formulation. On the other hand, since the sub-indexes contain highly inter correlated indicators, we estimate the sub-indexes first, instead of

estimating the overall index directly by choosing all the indicators at the same time (Table 4).

Table 3. DIGIX index components (adapted from Cámara & Tuesta, 2017).

Components	Indicators
Affordability	Fixed broadband internet tariffs
	Internet & telephony competition
Infrastructure	3G or more mobile network coverage
	International internet bandwidth (in bits/s per internet user and in Mbit/s
	Secure internet services
Contents	Government Online Service Index
User´s adoption	Active mobile-broadband subscriptions
	Fixed (wired)-broadband subscriptions
	Use of virtual social networks
	Households with internet
	Individual using internet
Enterprise's adoption	Business-to-business internet use
	Business-to-consumer internet use
	Firm-level technology absorption
Regulation	Effectiveness of law-making bodies
	Judicial independence
	Efficiency of legal system in setting disputes
	Efficiency of legal system in challenging regulations
	Laws relating to ICTs
	Software piracy rate, % software installed

Table 4. DiGiX variance by indicator (Cámara & Tuesta, 2017).

% Explained variance	First Component
Infrastructure (I)	47%
Costs (C)	58%
Regulation (R)	80%
User´s adoption (UA)	80%
Enterprise's adoption (EA)	90%
Digital Content (DC)	100%
BBVA-DIGIX	64%

The latent variable DiGiX is linearly determined as follows:

$$\boldsymbol{DiGiXi = \beta_1 \times I_i + \beta_2 \times UA_i + \beta_3 \times EA_i + \beta_4 \times C_i + \beta_5 \times R_i + \beta_6 \times DC_i + \varepsilon_i} \quad (\mathbf{1})$$

Where "i" denotes the country, and (I, UA, EA, C, R and DC) capture the dimensions. The total variation in DiGiX is represented by two orthogonal parts: variation due to causal variables and variation due to error (ε_i). If the model is well specified, including an adequate number of explanatory variables, we can reasonably assume that the total variation in DiGiX can be largely explained by the variation in the causal variables. The relative weights (importance) of each dimension, β_j, in the DiGiX are computed as:

$$\boldsymbol{B_j = \frac{\sum_{j=1} \lambda j \Phi j k}{\sum_{j=1} \lambda j}} \quad (\mathbf{2})$$

Where λ_j represents the variance of the j^{th} principal component (weights), for our index, the first component and k the number of variables in the overall index or in each dimension. The Appendix 2 presents the weights by indicator and by dimension. The application of a min-max transformation preserves the order of, and the relative

distance between, the scores. Each score in the DiGiX is between 0 and 1, with higher values representing better performance.

$$Z_{ij} = \frac{xij - min(xj)}{max(xj) - min(xj)} \quad (3)$$

The Figure 2 presented the countries according with the DiGiX index.

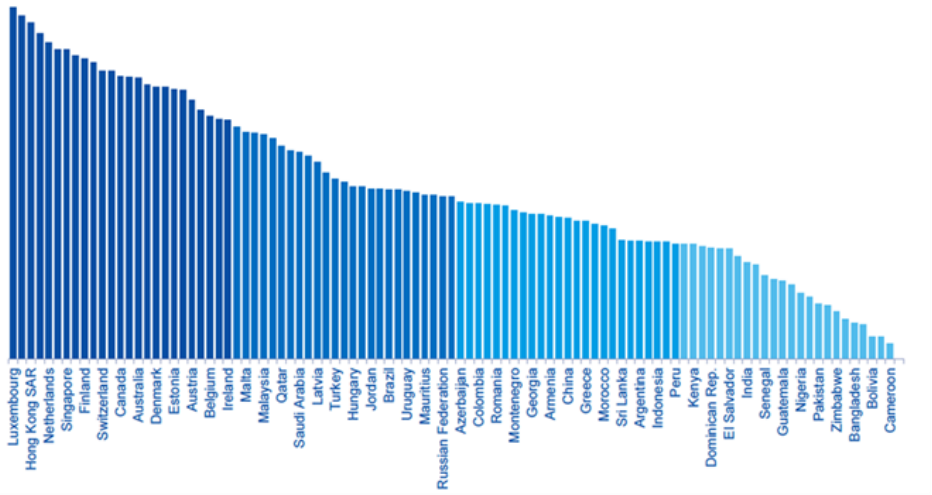


Figure 2. DIGIX Comparison among countries (Cámara & Tuesta, 2017).

3.4. ICT development index (IDI)

The ICT Development Index (IDI) is a composite index that has been reported, since 2009, by the International Telecommunication Union (ITU, 2018). The index is intended to measure the progress of each country towards the information society, respectively it is as a tool able to describe the current state of development of the ICT sector (Preda et al., 2019). IDI framework includes 3 dimensions which represent the combination of factors needed for each country in the transformation process: the availability of ICT structure and access, the level of ICT usage, and the capability to use ICTs effectively.

The IDI has 3 sub-indexes and 11 indicators. The "ICT access" sub-index includes 5 infrastructure and access indicators, the "ICT use" sub-index comprises 3 intensity and usage indicators, and the "ICT skills" sub-index includes 3 proxy indicators showing relevant skills for ICTs. Each IDI sub-index is calculated as a simple average of its indicators (ITU, 2017). The list and description of the ICT indicators is as follows:

3.4.1. ICT access

International Internet bandwidth (bit/s) per internet user. It is the total used Internet bandwidth capacity, calculated in megabits, taking to consideration average of incoming and outgoing internet traffic (Preda et al., 2019). Percentage of household with computer. Computers are desktop, tablet, laptops and other similar. Telephone devices as smartphones and mobile phones, smart TVs are not included. Computer of the household is not necessary belongs to the owner but is considered as an asset of the household.Percentage of households with Internet access. This index includes the availability of Internet for all members of the households at any time.

- Population covered by at least 3G mobile networks.
- Fixed-broadband subscriptions by speed tiers, equal to or above 10 Mbit/s (Preda et al., 2019).

3.4.2. ICT use

Percentage of individuals using the Internet. Individuals who used Internet in the last three months by any device. This is still not very developed indicator, as data is taken from the national statistic offices and some developing countries do not conduct this statistic. Active mobile-broadband subscriptions per 100 inhabitants. It is a sum of dedicated (USB modems or dongles) and standard (with access to Internet via HTTP) mobile subscriptions, used on computer or handset devices.

- Mobile-broadband Internet traffic (per mobile-broadband subscription).
- Fixed-broadband Internet traffic (per fixed-broadband subscription).
- Mobile phone ownership (Preda et al., 2019).

3.4.3. ICT skills

Mean years of schooling. Secondary gross enrolment ratio. This ratio is explaining the enrolment to certain education level, regardless of the age. It is calculated as a percentage of school-age population to the actual level of education. Tertiary gross enrolment (Preda et al., 2019).

There are five steps in methodology of ICT index calculation: imputation of missing data, normalization of data, weighting and aggregation, calculating the IDI and sensitivity analysis. There are various techniques to calculate the missing data. Mostly it is used the hot-deck imputation to impute the missing data. The similar characteristics for the hot-deck imputation are Gross National Income per capita and the geographic location (ITU, 2018). Normalization of data is needed because the unit of measurement should be the same for all sub-indexes, otherwise it will not be possible to align the data. Normalization procedure can allow to check the countered progress over the time. The distance to the reference measure is a chosen method of normalization (ITU, 2019). Reference measure is a goalpost, or the perfect measure. To set up the correct evaluation, it is necessary to have the table of weights of indicators (Appendix 2). Sensitivity analysis was carried out to investigate the robustness of the Index results in terms of the relative position in the overall ranking, using different combinations of methods and techniques to compute the Index (Figure 3).

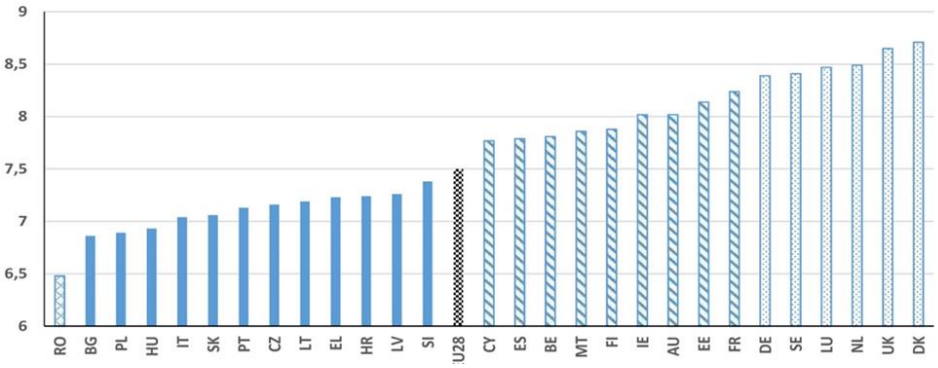


Figure 3. The EU 28 countries ranked by their ICT Development Index 2017 (ITU, 2017).

3.5. CISCO global digital readiness index

CISCO provides recent reports and profound studies of digitalization as the main profit for this company is consulting and cybersecurity, as well as selling the hardware. The information is taken from the CISCO Global Digital Readiness Index 2019 Report (CISCO, 2020). The document consists of:

3.5.1 Basic needs

The true value of technology and infrastructure is delivered through a population's ability to take advantage of

it. Without a population's basic needs met, communities are not able to reap the benefits of technology. To measure a population's basic needs, the assessed data are relating to life expectancy, the mortality rate of children under five years of age, and access to basic services such as electricity and safe drinking water (Yoo, De Wysocki & Cumberland, 2018).

3.5.2. Human capital

The ability to utilize and create advanced digital services is determined in part by the digital skills level within the workforce. There are examined four factors to determine the presence of an appropriately skilled labour force that is available to support digital innovation: the total labour force participation rate, adult literacy rate, and the country's education quality and average years of schooling.

3.5.3. Ease of doing business

Human capital skills can only contribute to the economy if people are gainfully employed, so having a thriving business ecosystem is another key determinant of a country's digital readiness. This was measured by examining the ease of doing business within each country, including factors such as: local rule of law, the Ease of Doing Business Index, the Logistics Performance Index (LPI) infrastructure rating, and the time it takes businesses to obtain access to electricity.

3.5.4. Business and government investment

Building digital infrastructure and capabilities requires significant investment on behalf of both government and business. To measure these investments, should be different sources of private and public investment, including foreign direct investment, research and development spending, and investment freedom.

3.5.5. Start-up environment

Start-ups create new innovations that can benefit entire markets and communities. They also demonstrate high levels of agility in terms of their ability to adapt to new market conditions and are often the leading creators of new wealth from digital technologies, and a crucial source of job creation. To assess a country's start-up environment, should be examined factors such as its venture capital availability and investment, new business density, and patent and trademark registrations (Yoo, De Wysocki & Cumberland, 2018)

3.5.6. Technology adoption

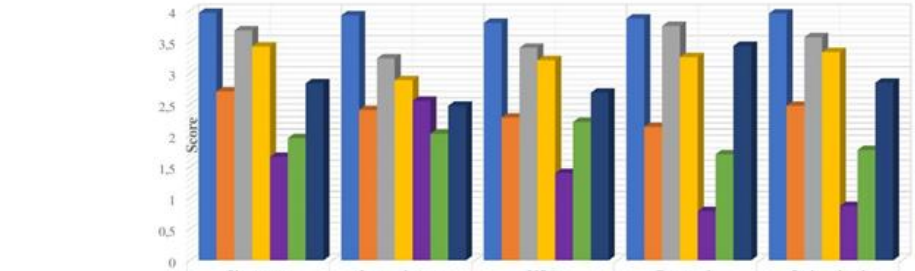
In the technology adoption indicator, it is evaluated the demand for digital products and services. The sub-indicators are mobile device penetration, internet usage and cloud services, such as cloud service spent and IT forecast data.

3.5.7. Technology infrastructure

Technology infrastructure means the infrastructure available to enable the digital activities and conceited consumers. It is measured by the level of mobile and fixed broadband subscriptions, secure internet servers and networking services (Yoo, De Wysocki & Cumberland, 2018).

In the methodology of the CISCO company report it is mentioned that they use the company use the holistic method using the sub-indicators, apply to the 141 countries, and have a rating scale of 0 to 25. The datapoints for the Cisco Digital Readiness Index are reputable sources, such as United Nations, World Economic Forum, World Bank, Heritage Foundation, International Monetary Fund, Centre for American Entrepreneurship, International Labour Organization, World Health Organization and World Justice Project (CISCO, 2020). In the Appendix 3 is

shown the metrics and sources for evaluating each component of the CISCO index and the sub-indicators and indicators percentages of Cisco Digital Readiness Index. This information is going to be used to find out the equivalences of indexes in the following chapter. Below is introduced the top five and bottom five results of Cisco Digital Readiness index (Figure 4).



	Singapore	Luxembourg	USA	Denmark	Switzerland
Basic Needs	3,97	3,93	3,81	3,88	3,96
Busin. & Gov. Investment	2,71	2,41	2,29	2,14	2,48
Ease of Doing Business	3,69	3,24	3,41	3,76	3,58
Human Capital	3,43	2,89	3,21	3,26	3,34
Start-Up Environment	1,66	2,56	1,4	0,79	0,87
Technology Adoption	1,96	2,03	2,22	1,7	1,77
Technology Infrastructure	2,84	2,48	2,69	3,44	2,85
Overall DRI Score	**20,26**	**19,54**	**19,03**	**18,98**	**18,86**
Ranking Position	#1	#2	#3	#4	#5

Figure 4. Top 5 of Cisco Digital Readiness Index (adapted from CISCO, 2020).

Singapore is known as the country with the highest quality of life and in the CISCO analysis it is taking the first place by the level of basic needs, ease of doing business and human capital. Slightly below Singapore, Luxembourg. USA, Denmark and Switzerland show with the win formula of high results in ease of doing business, basic needs, human capital and technology infrastructure.

4. Discussion

Each index consists of indicators and contains on each indicator there is one or more sub indicators. To make the comparison as accurate as possible, the sub-indicators of the proposed four indexes were compared and considered each ones' percentage weights. This information was taken from the tables of weights from de previous chapter. These values are needed not only to understand more precisely the equivalence between indexes, but also for defining key sub-indicators, which have higher value to consider.

4.1. Sub-indicators equivalence

Some of indexes have a lot of matching sub-indicators by their content. By the comparison (Table 5) we can define that the most common evaluators, such as: mobile broadband coverage with at least 3G connection, fixed and mobile broadband subscriptions, internet user skills, level of business digitalization in the technology adoption, cloud database, and logistics, e-commerce availability, e-government and research and development spending.
The sub-indicators differ, in the first place, because of the difference in definition of the organizations that created them. Indexes of public organizations such as DESI and ICT development differ in the assessment of society's advanced skills, online banking, mobile and fixed internet traffic. Private indexes such as DiGiX and CISCO differ in the assessment of indicators such as use of social media, judicial independence, efficiency of the legal system in resolving challenging disputes and regulations, patents and trademark registrations, and secure Internet servers. After comparing the sub-indicators by content, the next step will be to define the weights. Although the sub-indicators are matched by their content, they have different weights for the index itself.

Table 5. Equivalence of indicators.

Sub-indicator	DESI	%	DIGIX	%	ICT	%	CISCO	%
A	Broadband price	6,25	Fixed broadband tariffs	4,5				
B	Mobile broadband	6,25	3G or more mobile network coverage	6	Population covered by at least 3G mobile networks	8		
C	Internet use	5	Individuals using the Internet	3,8	Percentage of individuals using the Internet	8	Internet usage	4
D	Internet user skills	12,5			Percentage of individuals using the Internet	6,67	Average years of schooling	5,34
					Secondary gross enrolment ratio	6,67	The education quality	5,34
					Tertiary gross enrolment	6,67		
E	Advanced skills and development (ICT graduate specialists)	12,5						
F	Activities online	5	Use of virtual social networks	3,8				
G	Transaction (banking shopping)	5	Business to Consumer use	6,33				
H	Business digitalization	10	Firm level technology adaptation	6,33				
I	eCommerce	10	Business to business consumer use	6,33			Investment freedom	4
							Venture capital availability	4
J	eGovernment	15	Government online service Index effectiveness of law-making bodies	20			Research and development spending	4
							Private and Public investment	4
K	Fixe broadband take-up	6,25	Fixed (wired) broadband subscription	3,8	Fixed broadband subscriptions by speed	8	Level of fixed broadband subscriptions	4
L			Internet and telephony competition	4,5	Fixed broadband subscriptions by speed	8	Mobile device penetration	4
M			Households with Internet	3,8	Percentage of households with Internet	8	Household internet access	4
N			Judicial independence	3				
O			Efficiency of legal system in settling the disputes and regulations	6				
P			Laws regarding ICT	3			Local rule of law	4
Q			International internet bandwidth	6	International internet bandwidth	8		
R			Software privacy rate and percentage of software installed	3			Patent and trademark registrations	4
S			Secure internet servers	6			Secure Internet servers	4
T	Mobile broadband	6,25	Active mobile broadband subscriptions	3,8	Active mobile broadband subscriptions per 100 inhabitants	8	Level of mobile subscriptions	4
U					Mobile and fixed internet traffic	16		
V					Percentage of household with computer	8		
W							Life expectancy	5,33
X							Mortality rate	5,33
Y							Access to basic services	5,33
Z							The total labour participation rate	5,33

After making the comparison of the sub-indicators by their content, next important step is to find out the equivalence should be taken to define the weights (Table 6). To normalize the sub-indicators were considered the

Table 6. Index equivalence.

DESI (W1) to DiGiX (W2) equivalence			
Matching sub- indicator	Weight W1 (%)	Weight W2 (%)	Average = (W1+W2)/2 (%)
A	6,25	4,5	5,38
B	6,25	6	6,13
C	5	3,8	4,40
F	5	3,8	4,40
G	5	3,8	4,40
H	10	6,33	8,17
I	10	6,33	8,17
J	15	20	17,5
K	6,25	3,8	5,03
T	6,25	3,8	5,03
The DESI index is equivalent to the DiGiX in			69,85 %
DESI (W1) to ICT (W3) equivalence			
Matching sub- indicator	Weight W1 (%)	Weight W3 (%)	Average = (W1+W3)/2 (%)
A	6,25	8	7,13
A	6,25	8	7,13
B	6,25	8	7,13
C	5	8	6,50
D	12,5	20	16,25
K	6,25	8	7,13
T	6,25	8	7,13
The DESI index is equivalent to the ICT in			44,13%
DESI (W1) to CISCO (W4) equivalence			
Matching sub- indicator	Weight W1 (%)	Weight W4 (%)	Average = (W1+W4)/2 (%)
C	5	4	4,5
D	12,5	10,67	11,59
H	10	20	15
I	10	8	9
J	15	8	11,5
K	6,25	4	5,13
T	6,25	4	5,13
The DESI index is equivalent to the CISCO in			61,85%
DiGiX (W2) to ICT (W3) equivalence			
Matching sub- indicator	Weight W1 (%)	Weight W4 (%)	Average = (W1+W4)/2 (%)
B	6	8	7
C	3,8	8	5,9
K	3,8	8	5,9
L	4,5	8	6,25
M	3,8	8	11,5
Q	6	8	5,9
T	3,8	8	5,9
The DIGIX index is equivalent to the ICT in			43,85%
DiGiX (W2) to CISCO (W4) equivalence			
Matching sub- indicator	Weight W2 (%)	Weight W4 (%)	Average = (W2+W4)/2 (%)
C	3,8	4	3,9
H	6,33	20	13,17
I	6,33	8	7,16
J	20	8	14
K	3,8	4	3,9
L	4,5	4	4,25
M	3,8	4	3,9
P	3	4	3,5
R	3	4	2,5
S	6	4	5
T	3,8	4	3,9
The DIGIX index is equivalent to the CISCO in			66,19 %
ICT (W3) to CISCO (W4) equivalence			
Matching sub- indicator	Weight W3 (%)	Weight W4 (%)	Average = (W3+W4)/2 (%)
C	8	4	6
D	13,3	10,67	11,99
K	8	4	6
L	8	4	6
M	8	4	6
T	8	4	6
The ICT index is equivalent to the CISCO in			41,99 %

average. A dual comparison between two indexes and their all-matching sub-indicators was developed. The total sum of the average weights is the equivalence between two indexes.

Following matrix of all the equivalences between indexes (Table 7).

Table 7. Results of overall index equivalence.

	DIGIX	ICT	CISCO	DESI
DIGIX		43,85%	66,19%	69,85%
ICT	43,85%		41,99%	44,13%
CISCO	66,19%	41,99%		61,85%
DESI	69,85%	44,13%	61,85%	

The highest equivalence is between the DESI and DIGIX index, 69.85%, which means that the indicators of these indexes not only are very similar by the context and data.

High equivalence is also between DIGIX and CISCO indexes, 66.19%. It might be the reason that indexes are more equivalent because they are created by the private companies, BBVA and CISCO. With a little difference, DESI is equivalent to CISCO, by 61.85%. ICT index shows the least equivalence by the matching indicators to all other indexes. It is equivalent to DESI by 44.13%, to DIGIX by 43.85% and to CISCO by 41.99%.

4.2. New index

After analysing the equivalences between the most used digitalization evaluation indexes, it can be concluded which factors have been the most valuable in the index calculation.

The indicators and sub-indicators weights are based on the average weight of similar matching indicators from the compared indexes. The proposed index has the following indicators:

- Connection - this indicator is displaying network coverage, broadband, and speeds.
- Government regulation – includes the government online and privacy and ICT goals.
- Business integration – e-commerce and possibility to conduct the business easily.
- Users' analysis – price per broadband, content of use, fixed price per broadband and content of use.

The weight of sub-indicators is calculated as the average from the equivalent indexes and by settling priorities.

5. Conclusions, limitations and future research

The last few decades have seen rapid changes in technology and the growing proliferation of digitized devices and services. The pace of change is likely to accelerate with the development of artificial intelligence, robotics, biotechnology and nanotechnology. Digitalization is directly connected to the digital economy. Digital economy is supported by the dissemination of information and communication technologies to all industry sectors with a focus on increasing productivity. The digital transformation of the economy is changing the conventional patterns of business structure, the way consumers obtain services, information and goods, and also how countries need to adapt to these new regulatory challenges. Digitization is closely associated with the adoption of digital technologies and the increase in their use. According to DESI the level of digital performance of EU countries increased to 52.45% in 2019 compared to 44.35% and 39.05% in 2016 and 2014, respectively (see https://digital-agenda-data. me/).

To measure the country digitalization level, it is useful to have an index of evaluation. Nowadays, there is no standardized methods to make this analysis, so the most acknowledged indexes of digital evaluation have been here investigated: DESI, DIGIX, ICT Development Index and CISCO Networking Index.

Table 8. Proposed Index sub-indicators and weights.

Indicator	Sub-indicator	Weight (%)
Connection	3G or more mobile network coverage	7
	Fixed broadband	6
	Active mobile broadband subscriptions	6
	Maximum speed coverage	7
Government regulation	Government online	15
	Laws regarding ICT	3
	Privacy rate	3
Business integration	E-commerce	10
	Ease of doing business	15
Users' analysis	Internet usage	5
	Content of use	10
	Fixed price per broadband	5
	Cloud service availability	8

From the results of the comparison of indexes, it is concluded that there are equivalences. The equivalences are not very strong and these discrepancies in evaluation might be caused by different approaches from public and private companies. The index created included four indicators: Connection, government regulation, business integration and user analysis. The connection indicator includes 3G or more mobile network coverage, fixed broadband, mobile broadband and maximum speed sub-indicators. Government regulation contains such sub-indicators: online government, ICT related laws and privacy tax. Business integration is e-commerce and ease of doing business. The user analysis indicator includes internet usage, usage content, fixed price for broadband and cloud service availability.

As a contribution, the study proposed an approach for measuring digitization, which is based on measurable data and can be applied to carry out the digital assessment of any country. Using the proposed index, we can analyse, explain and predict the level of digitization and gaps to be improved. The main limitation is that the index has not been tested for reliability, which is also a challenge for future research.

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Conflict of interest

The authors declare that they have no conflict of interest.

Appendix

Table A1. The structure of DESI index (adapted from European Commission, 2015).

Dimension	Sub Dimension	Indicator
Connectivity	Fixed broadband take-up	Overall fixed broadband take-up
		At least 1000 Mbps fixed broadband take-up
	Fixed broadband coverage	Fast broadband (NGA) coverage
		Fixed Very High-Capacity Network (VHCN) coverage

	Mobile broadband	4G coverage Mobile broadband take-up 5G readiness
	Broadband price index	Broadband price index
Human capital	Internet user skills	Basic digital skills At least basic software skills
	Advanced skills and development	ICT specialists and graduates Female ICT specialists
Digital public service	E-Government	E-government users Pre-filled forms Online service completion Digital public services for businesses Open data
Use of internet services	Internet use	People who never used Internet Internet users
	Activities online	News, music, videos and games Video calls Social networks Doing an online course
	Transactions	Banking Shopping Selling online
Integration of digital technology	Business digitalization	Electronic information sharing Social media Big data Cloud
	E-Commerce	SME's selling online e-Commerce turnover Selling online cross-border

Table A2. DESI Connectivity dimension (adapted from European Commission, 2020b).

Indicator	Description	Breakdown	Unit	Source
1a1–Overall fixed broadband take-up	% of households subscribing to fixed broadband	All households	% of households	Eurostat – Community survey on ICT usage in Households and by Individuals
1a2 – At least 100 Mbps fixed broadband take-up	% of households subscribing to fixed broadband of at least 100 Mbps, calculated as overall fixed broadband take-up (source: Eurostat) multiplied with the percentage of fixed broadband lines of at least 100 Mbps	All fixed broadband subscriptions	% of households	European Commission, through the COCOM and Eurostat - Community survey on ICT usage in Households and by Individuals
1b1–Fast broadband (NGA) coverage	% of households covered by fixed broadband of at least 30 Mbps download. The technologies considered are FTTH, FTTB, Cable Docsis 3.0 and VDSL	All fixed broadband subscriptions	% of households	Broadband coverage in Europe studies for the European Commission
1b2 – Fixed Very High-Capacity Network (VHCN) coverage	% of households covered by any fixed VHCN. The technologies considered are FTTH and FTTB for 2015-2018 and FTTH, FTTB and Cable Docsis 3.1 for 2019	All fixed broadband subscriptions	% of households	Broadband coverage in Europe studies for the European Commission by IHS Markit, Omdia and Point Topic
1c1–4G coverage	% of populated areas with coverage by 4G - measured as the average coverage of telecom operators in each country	All fixed broadband subscriptions	% of households	% of populated areas with coverage by 4G - measured as the average coverage of telecom operators in each country
1c2–Mobile broadband take-up	Number of mobile data subscriptions per 100 people	All subscriptions	Subscribers per 100 people	European Commission services, through the Communications

				Committee (COCOM)
1c3–5G readiness	The amount of spectrum assigned and ready for 5G use by the end of 2020 within the so-called 5G pioneer bands. These bands are 700 MHz (703-733 MHz and 758- 788 MHz), 3.6 GHz (3400- 3800 MHz) and 26 GHz (1000 MHz within 24250-27500 MHz). All three spectrum bands have an equal weight	5G pioneer bands	% of harmonised spectrum	European Commission services, through the Communications Committee (COCOM)
1d1 – Broadband price index	The broadband price index measures the prices of representative baskets of fixed, mobile and converged broadband offers	All fixed, mobile and converged Broadband offers	Score (0-100)	Broadband retail prices study, annual studies for the European Commission

Source: Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm).

Table A3. DESI Human capital dimension (adapted from European Commission, 2020c).

Indicator	Description	Breakdown	Unit	Source
2a1 – At least basic digital skills	Individuals with 'basic' or 'above basic' digital skills in each of the following four dimensions: information, communication, problem solving and software for content creation (as measured by the number of activities carried out during the previous 3 months).	All individuals (aged 16-74)	% of individuals	Eurostat–Community survey on ICT usage in Households and by Individuals
2a2–Above basic digital skills	Individuals with 'above basic' digital skills in each of the following four dimensions: information, communication, problem solving and software for content creation (as measured by the number of activities carried out during the previous 3 months).	All individuals (aged 16-74)	% of individuals	Eurostat–Community survey on ICT usage in Households and by Individuals
2a3 – At least basic software skills	Individuals who, in addition to having used basic software features such as word processing, have used advanced spreadsheet functions, created a presentation or document integrating text, pictures and tables or charts, or written code in a programming language.	All individuals (aged 16-74)	% of individuals	Eurostat–Community survey on ICT usage in Households and by Individuals
2b1–ICT specialists	Employed ICT specialists. Broad definition based on the ISCO-08 classification and including jobs like ICT service managers, ICT professionals, ICT technicians, ICT installers and servicers.	Individuals in employment aged 15-74	% of individuals in employment aged 15-74	Eurostat–Labour force survey
2b2–Female ICT specialists	Employed ICT specialists. Broad definition based on the ISCO-08 classification and including jobs like ICT service managers, ICT professionals, ICT technicians, ICT installers and servicers.	Females in employment aged 15-74	% of females in employment aged 15-74	Eurostat–Labour force survey
2b3–ICT graduates	Individuals with a degree in ICT	Graduates	% of graduates	Eurostat (table educ_uoegrad03, using selection ISCED11=ED5)

Source: Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm).

Table A4. DESI Use of Internet dimension (adapted from European Commission, 2020c).

Indicator	Description	Breakdown	Unit	Source
3a1–People who never used the internet	Individuals who never used the internet	All individuals (aged 16-74)	% of individuals	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUX)
3a2–Internet users	Individuals who used the internet at least once a week	All individuals (aged 16-74)	% of individuals	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUSE)
3b1 –News	Individuals who used the internet to read online news sites, newspapers or news magazines	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUNW1

3b2–Music, videos and games	Individuals who used the internet to play or download games, images, films or music	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals
3b3 – Video on demand	Individuals who used the internet to use video on demand services and servicers.	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals
3b4–Video calls	Individuals who used the internet to make telephone or video calls (e.g. Skype)	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUPH1)
3b5–Social networks	Individuals who used the internet to participate in social networks (create user profile, post messages or other contributions)	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUSNET)
3b6–Doing an online course	Individuals who used the internet to do an online course (on any subject)	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUOLC)
3c1–Banking	Individuals who used the internet to use online banking	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUBK)
3c2–Shopping	Individuals who ordered goods or services online	All individuals (aged 16-74)	% of internet users (last year)	Eurostat - Community survey on ICT usage in Households and by Individuals (I_BLT12)
3c3–Selling online	Individuals who sold goods or services online	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat - Community survey on ICT usage in Households and by Individuals (I_IUSELL)

Source: Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm).

Table A5. DESI Integration of digital technology (adapted from European Commission, 2020c).

Indicator	Description	Breakdown	Unit	Source
4a1–Electronic information sharing	Businesses who have in use an ERP (enterprise resource planning) software package to share information between different functional areas (e.g., accounting, planning, production, marketing)	All enterprises (no financial sector, 10+ employees)	% of enterprises	Eurostat-Community survey on ICT usage and eCommerce in Enterprises (E_ERP1)
4a2–Social media	Integration of digital technology dimension is as well based on Eurostat statistics. Businesses using two or more of the following social media: social networks, enterprise's blog or microblog, multimedia content sharing websites, wiki-based knowledge sharing tools. Using social media means that the enterprise has a user profile, an account or a user license depending on the requirements and the type of the social media	All individuals (aged 16-74)	% of enterprises	Eurostat-Community survey on ICT usage and eCommerce in Enterprises (E_SM1_GE2))
4a3–Big data	Enterprises analysing big data from any data source	All individuals (aged 16-74)	% of enterprises	Eurostat-Community survey on ICT usage and eCommerce in Enterprises (E_BD)
4a4–Cloud	Businesses purchasing at least one of the following cloud computing services: hosting of the enterprise's database, accounting software applications, CRM software, computing power	All individuals (aged 16-74)	% of individuals who used internet in the last 3 months	Eurostat-Community survey on ICT usage and eCommerce in Enterprises
4b1–SMEs Selling online	SMEs selling online (at least 1% of turnover)	SMEs (no financial sector, 10-249 employees)	% of SMEs	Eurostat-Community survey on ICT usage and eCommerce in Enterprises (E_ESELL)

4b2–e-Commerce turnover	SMEs total turnover from e-commerce	SMEs (nofinancial sector, 10-249 employees)	% of turnover	Eurostat-Community survey on ICT usage and eCommerce in Enterprises (E_ETURN)
4b3–Selling online crossborder	SMEs that carried out electronic sales to other EU countries	SMEs (n financial sector, 10-249 employees)	% of SMEs	Eurostat-Community survey on ICT usage and eCommerce in Enterprises (E_AESEU)

Source: Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm).

Table A5. DESI - Digital public services dimension (adapted from European Commission, 2020c).

Indicator	Description	Breakdown	Unit	Source
5a1–eGovernment users	Individuals who sent filled forms to public authorities over the internet in the previous 12 months	All individuals (aged 16-74)	% of internet users who, during the previous year, needed to send filled forms to the public administration.	Eurostat–Community survey on ICT usage in Households and by Individuals (IGOV12RT)
5a2–Prefilled forms	Amount of data that is pre-filled in public service online forms	Services assessed in the e-government benchmark	Score (0 to 100)	E-government benchmark
5a3–Online service completion	The share of administrative steps that can be done online for major life events (birth of a child, new residence, etc.)	Services assessed in the e-government benchmark	Score (0 to100)	E-government benchmark
5a4–Digital public services for businesses	The indicator broadly reflects the share of public services needed for starting a business and conducting regular business operations that are available online for domestic as well as foreign users. Services provided through a portal receive a higher score, services which provide only information (but must be completed offline) receive a more limited score.	Services assessed in the e-government benchmark	Score (0 to 100)	E-government benchmark
5a5–Open data	This composite indicator measures to what extent countries have an open data policy in place (including the transposition of the revised PSI Directive), the estimated political, social, and economic impact of open data and the characteristics (functionalities, data availability and usage) of the national data portal.	Aggregate score	% of maximum score	European data portal

Source: Eurostat (https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm).

Table A5. Weighting of indicators DESI index (adapted from Stavytskyy, 2019).

Indicator	Sub-indicators	Weighting %	Total weighting %
Connectivity	Fixed broadband take-up	6,25	25
	Fixed broadband coverage	6,25	
	Mobile broadband	6,25	
	Broadband price index	6,25	
Human Capital	Internet user skills	12,5	25
	Advanced skills and development	12,5	
Use of Internet Services	Internet use 5	5	15
	Activities online 5 15	5	
	Transaction 5	5	
Integration of digital Technology	Business digitalization	10	20
	E-Commerce	10	
Digital Public Services	E-Government	15	15

Table A5. ICT Development Index. Table of Weights (adapted from ITU, 2011).

Indicator	Sub-indicators	Weighting %	Total weighting %
ICT Acess	International Internet bandwidth per internet user	8	40

	Percentage of household with computer	8	
	Percentage of households with Internet access	8	
	Population covered by at least 3G mobile networks	8	
	Fixed-broadband subscriptions by speed tiers	8	
ICT use	Percentage of individuals using the Internet	8	
	Active mobile-broadband subscriptions per 100 inhabitants	8	
	Mobile-broadband Internet traffic	8	40
	Fixed-broadband Internet traffic	8	
	Mobile phone ownership	8	
ICT Skills	Mean years of schooling	6,7	
	Secondary gross enrolment ratio	6,7	20
	Tertiary gross enrolment	6,7	

Table A5. Metrics and sources of CISCO index (adapted from Cisco Systems, 2018) and table of weights of CISCO index (adapted from Yoo et al., 2018).

Digital readiness components (indicator)	Definition	Metric (Sub-indicators)	Sub-indicators value %	Total value %
Basic Needs	Basic human needs for a population to thrive	Life Expectancy https://population.un.org/wpp/Download/Standard/Mortality/	5.33	16
		Mortality Rate (Under Age 5) https://www.unicef.org/media/79371/file/UN-IGME-child-mortality-report-2020.pdf.pdf	5.33	
		Access to basic services https://www.unwater.org/who-and-unicef-launch-updated-estimates-for-water-sanitation-and-hygiene/ https://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who	5.33	
Business and Government Investment	Private and public investment in innovation and technology	Foreign Direct Investment https://www.imf.org/external/pubs/ft/fandd/basics/20_direct-invest.htm	4	12
		Research and Development Expenditure http://uis.unesco.org/apps/visualisations/research-and-development-spending/	4	
		Investment Freedom (Heritage Foundation) https://www.heritage.org/index/investment-freedom	4	
Ease of Doing Business	Basic infrastructure/ policies needed to support business continuity	Ease of Doing Business Index https://www.doingbusiness.org/en/rankings	4	16
		Rule of Law World https://worldjusticeproject.org/our-work/research-and-data/wjp-rule-law-index-2020	4	
		Logistics Performance Index https://lpi.worldbank.org/	4	
		(LPI)–Infrastructure Rating https://lpi.worldbank.org/international/global?order=Infrastructure	4	
Human Capital	Skilled labour force available to support digital innovation (build and maintain)	Labour Force Participation Rate https://data.worldbank.org/indicator/SL.TLF.CACT.ZS	4	16
		Adult Literacy Rate http://uis.unesco.org/en/topic/literacy	4	
		Education Index (Years of School) http://hdr.undp.org/en/content/human-development-index-hdi	4	
		Harmonized Test Score (World Bank) https://govdata360.worldbank.org/indicators/hc58163b0	4	
Start-up Environment	Environment which fosters innovation within a community	New Business Density https://data.worldbank.org/indicator/IC.BUS.NDNS.ZS	4	12
		Patents Granted and Trademarks Registered https://www.wipo.int/ipstats/en/statistics/glossary.html	4	
		Venture Capital Investment and Availability https://tcdata360.worldbank.org/indicators/h8a7ea3d1	4	
Technology Adoption	Demand for digital products/services	Mobile Cellular Penetration https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	4	12
		Internet Usage https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	4	

Technology Infrastructure	The infrastructure available to enable digital activities and connected consumers (IoT, Cloud)	Cloud Services (Spend, IT Forecast Data) (Gartner) https://www.gartner.com/en/newsroom/press-releases/2020-11-17-gartner-forecasts-worldwide-public-cloud-end-user-spending-to-grow-18-percent-in-2021	4	16
		Mobile Broadband Subscriptions https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	4	
		Fixed Broadband Subscriptions https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	4	
		Secure Internet Servers https://www.netcraft.com/	4	
		Household Internet Access https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx	4	

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