DESI 2018

Digital Economy and Society Index

Methodological note

Commission européenne/Europese Commissie, 1049 Bruxelles/Brussel, BELGIQUE/BELGIË - Tel. +32 22991111
Office: BU25 01/182 - Tel. direct line +32 229-99599
balazs.zorenyi@ec.europa.eu

Table of Contents

1 Introduction

The Digital Economy and Society Index (DESI) measures progress of EU countries towards a digital economy and society. As such, it brings together a set of relevant indicators on Europe's current digital policy mix.

The index allows four main types of analysis:

- General performance assessment: to obtain a general characterisation of the performance of individual Member States by observing their overall index score and the scores of the main index dimensions.
- Zooming-in: to pinpoint the areas where Member State performance could be improved by analysing the scores of the index's sub-dimensions and individual indicators.
- Follow-up: to assess whether there is progress over time.
- Comparative analysis: to cluster Member States according to their index scores, comparing countries in similar stages of digital development so as to flag the need for improvement in relevant policy areas.

The DESI was developed following the guidelines and recommendations in the OECD's "Handbook on constructing composite indicators: methodology and user guide"[1]. The data included in the index were mostly collected by the European Commission services (DG CNECT, Eurostat) and by ad-hoc studies launched by the Commission services.

---

[1] http://www.oecd.org/els/soc/handbookonconstructingcompositeindicatorsmethodologyanduserguide.htm

2   Structure of the DESI

The DESI has a three-layer structure as depicted in table 1. It is composed of 5 principal dimensions, each divided in a set of sub-dimensions, which are in turn composed by individual indicators.

Dimension	Sub-dimension	Indicator
1 Connectivity	**1a Fixed Broadband**	**1a1 Fixed Broadband Coverage**
		1a2 Fixed Broadband Take-up
	1b Mobile Broadband	**1b1 4G coverage**
		1b2 Mobile Broadband Take-up
	1c Fast Broadband	**1c1 Fast Broadband Coverage**
		1c2 Fast Broadband take-up
	1d Ultrafast Broadband	**1d1 Ultrafast Broadband Coverage**
		1d2 Ultrafast Broadband take-up
	1e Broadband Price Index	**1e1 Broadband Price Index**
2 Digital Skills	**2a Basic Skills and Usage**	**2a1 Internet Users**
		2a2 At Least Basic Digital Skills
	2b Advanced skills and Development	**2b1 ICT Specialists**
		2b2 STEM Graduates
3 Use of Internet	**3a Content**	**3a1 News**
		3a2 Music, Videos and Games
		3a3 Video on Demand
	3b Communication	**3b1 Video Calls**
		3b2 Social Networks
	3c Transactions	**3c1 Banking**
		3c2 Shopping
4 Integration of Digital Technology	**4a Business digitisation**	**4a1 Electronic Information Sharing**
		4a2 RFID
		4a3 Social Media
		4a4 eInvoices
		4a5 Cloud
	4b E-commerce	**4b1 SMEs Selling Online**
		4b2 E-commerce Turnover
		4b3 Selling Online Cross-border
5 Digital Public Services	**5a eGovernment**	**5a1 eGovernment Users**
		5a2 Pre-filled Forms
		5a3 Online Service Completion
		5a4 eGovernment Services for Businesses
		5a5 Open Data
	5b eHealth	**5b1 eHealth Services**

Table 1. DESI Structure

At high level the DESI addresses the five principal policy areas of concern for a digital economy and society. These are not isolated areas that contribute separately to digital development but are in fact interconnected. As such, developments in the digital economy cannot be achieved through isolated improvements in particular areas but through concerted improvement in all areas. For methodological and data availability reasons, DESI 2018 presents structural changes when compared to DESI 2017. Such changes are described in section 2.6.

2.1   Connectivity dimension

A necessary condition for the development of a digital society is the ability of its members to connect to the Internet. Nowadays however, a simple Internet connection is no longer sufficient. In order to benefit from the full spectrum of developments brought about by the Internet, a high-speed Internet connections starts to be desirable, if not mandatory. Hence connectivity is a necessary infrastructure of the digital economy and society.

The Connectivity dimension is divided into five sub-dimensions, each focusing on a relevant aspect of connectivity to the Internet.

2.1.1   Fixed Broadband

This sub-dimension focuses on whether citizens have the possibility to connect to the Internet via a fixed broadband connection, and on the extent to which they do in fact connect to the Internet that way. These phenomena are captured respectively by the Fixed BB Coverage and by the Fixed BB Take-up indicators.

2.1.2 Mobile Broadband

This sub-dimension focuses on how widely 4G services are available (4G coverage) and whether citizens use the broadband capabilities of their mobile devices (Mobile BB Take-up indicator).

2.1.3 Fast broadband

This sub-dimension focuses on the availability and use of fast Internet connections (defined as those offering at least 30 Mbps download speed). The availability of such connections is captured in the NGA Coverage indicator, whereas the actual use of such connections by the population is captured in the Fast broadband (BB) Take-up indicator.

2.1.4 Ultrafast broadband

This sub-dimension focuses on the availability and use of ultrafast Internet connections (defined as those offering at least 100 Mbps download speed). The availability of such connections is captured in the Ultrafast BB Coverage indicator, whereas the actual use of such connections by the population is captured in the Ultrafast broadband (BB) Take-up indicator.

2.1.5 Broadband price index

Finally, this sub-dimension measures how affordable it is to have a broadband Internet connection. The Broadband Price Index measures the prices of twelve representative fixed broadband baskets as the percentage of household income. The baskets include three speed categories (12-30 Mbps, 30-100 Mbps and at least 100 Mbps) and four types of products (standalone internet, internet + TV, internet + fixed telephony and internet + TV + fixed telephony).

2.2 Human Capital Dimension

Having a connection to the Internet is not sufficient; it must be paired with the appropriate skills to take advantage of the Internet and of the myriad of possibilities unravelled by a digital society. Those skills go from basic usage skills that enable individuals to take part in the digital society and consume digital goods and services, to advanced skills that empower the workforce to develop new digital goods and services and to take advantage of technology for enhanced productivity and economic growth. Digital skills are also a necessary infrastructure for the digital economy and society.

The Human Capital dimension is divided into two sub-dimensions.

2.2.1 Basic Skills and Usage

The Basic Skills and Usage sub-dimension captures the digital skills level of the general population. In particular, it assesses whether citizens are able to use the Internet and use it on a regular basis (Internet Users indicator) and whether they possess at least a basic level of digital skills (captured by the Basic Digital Skills, which measures whether citizens have at least basic skills in at least one of four Digital Competence domains: information, communication, content-creation or problem-solving).

2.2.2 Advanced skills and Development

The Advanced skills and Development sub-dimension concerns the workforce and its potential to maintain and grow the digital economy. It takes into account the percentage of people in the workforce with ICT specialist skills (ICT Specialists indicators) and the share of the population with STEM (science, technology, engineering and mathematics) education (STEM graduates indicator).

2.3 Use of Internet Services Dimension

Citizens that are empowered with an Internet connection and the necessary skills to take advantage of it can engage in a wide range of online activities. These can be through consumption of online content (e.g., entertainment such as music, movies, TV or games, obtaining media-rich information or engaging in online social interaction), through modern communication activities (e.g., performing video-calls), or through e-commerce. Nowadays this mix of activities can only be enjoyed to its fullest using the high-speed connectivity provided by a broadband subscription. Hence, these content-rich activities are among the drivers of the development of broadband networks. On the demand side, it is the possibility to perform these activities that drives users to subscribe to broadband connections. On the supply side, it is the need for the network capacity and speed to support such services that drives the supply of faster networks and better content delivery facilities.

The Use of Internet dimension is divided into three sub-dimensions.

2.3.1 Content

The Content sub-dimension measures the extent to which a country's Internet users get online content via their broadband connections. It uses four indicators to portray the country's consumption of content online: the percentage of Internet users that read news online (News indicator); the percentage of Internet users that consume music, videos or games online (Music, Videos and Games indicator); and the percentage of internet users that watch Video on Demand (Video on Demand indicator).

2.3.2 Communication

The Communication sub-dimension measures the extent to which a country's Internet users communicate and interact online using their broadband connections. To do so, it

uses two indicators: the percentage of Internet users that do video or audio calls using the Internet (Video Calls indicator) and the percentage of Internet users that use social networks (Social Networks indicator).

2.3.3 Transactions

The Transactions sub-dimension captures the propensity of Internet users to perform transactions online. It concentrates on two indicators: whether users go online to fulfil their banking needs (eBanking indicator), or to purchase products or services (Shopping indicator).

2.4 Integration of Digital Technology Dimension

On the business side, digitization is one of the main contributors to enhanced economic growth. Adoption of digital technology (among which are new technologies such as Cloud, Big Data, or the Internet of Things) to enhance efficiency, reduce costs or allow for closer engagement with customers, collaborators or business partners is becoming a mandatory requirement for being competitive. This, together with the ability to use the Internet as a sales outlet, can contribute significantly to the modernisation of businesses and, ultimately, to their success. However, the integration of these technologies in the business sector cannot happen without the appropriate infrastructure, whether it is the availability of fast Internet or the availability of skilled workers in the labour market.

The Integration of Digital Technology dimension is divided into two sub-dimensions.

2.4.1 Business digitization

The Business digitization sub-dimension takes stock of the level of adoption of digital technologies by a country's businesses. It focuses on five technologies: the sharing of information electronically inside companies via ERP (Electronic Information Sharing

indicator), the use of Radio-frequency Identification technologies (RFID indicator), the engagement with clients, partners and other stakeholders via social media (Social Media indicator), the use of e-invoices (eInvoices indicator)[2] and the use of Cloud services of at least medium complexity (Cloud indicator).

2.4.2 E-commerce

The e-commerce sub-dimension focuses on the exploitation of the online sales channel by a country's small and medium enterprises. It captures this via three indicators: the percentage of SMEs that have sold online during the previous year (SMEs Selling Online indicator), the average turnover they realised from online sales (E-commerce Turnover indicator), and the percentage of SMEs that sold online to other EU countries (Selling Online Cross-border indicator). It is important to note that the for the above e-commerce indicators the questionnaire asks about figures related to the previous year, i.e. the data shown as of 2017 relates to figures for 2016.[3]

2.5 Digital Public Services Dimension

Business and citizen interaction with the Public Sector can be improved and made significantly more efficient through the use of digital technologies. Such efficiency gains materialise both on the side of the Public Administration as well as on the business side. Public Administration can take advantage of technology to better address an ever more demanding set of business and citizen needs while at the same time realising significant cost reductions. With better and more streamlined Public Services, citizens

---

[2] Data shown as of 2017 relates to 2016 for the same reason as in case of e-commerce indicators, See e-commerce section for explanation

[3] This is in line with the publication practices of Eurostat.

and businesses gain in efficiency, both due to more functionality as well as to reductions in time spent. Furthermore, the use of electronic systems in areas such as public procurement or taxation can lead of significant gains by streamlining processes and increasing efficiency, improving transparency, and reducing the room for corruption or evasion.

The Digital Public Services dimension is composed of two single sub-dimension.

2.5.1 eGovernment

The eGovernment sub-dimension captures the level of development of a country's eGovernment services. It does so using five indicators:

- eGovernment users measured as the percentage of Internet users needing to submit forms to the public administration (eGovernment Users indicator);
- the level of sophistication of a country's eGovernment services (using the Pre-filled Forms indicator, which measures the extent to which data that is already known to the public administration is pre-filled in the forms that are presented to the user);
- the level of completeness of a country's eGovernment offer (using the Online Service Completion indicator, which measures the extent to which the various steps in an interaction with the public administration – life event – can be performed completely online),
- Digital Public Services for Businesses, a new indicator that broadly reflects the share of public services needed for starting a business and for conducting regular business operations that are available online for domestics as well as for foreign users and

- the government commitment to open data (by means of the Open Data indicator).

2.5.2 eHealth

This new sub-dimension captures the percentage of people who used health and care services provided online without having to go to the hospital or doctors surgery (for example, by getting a prescription or a consultation online)

2.6 Changes compared to DESI 2017

The current publication of the DESI includes improvement in comparison to the version published by the European Commission in 2017.

As for Connectivity, several changes were made. The Ultrafast Broadband sub-dimension was added measuring Ultrafast Broadband coverage (the combined footprint of Fibre to the Premises and Cable Docsis 3.0., measured as the percentage of homes) and Ultrafast Broadband Take-up (percentage of homes subscribing to at least 100 Mbps). Fast Broadband Take-up is measured as the percentage of homes in DESI 2018 instead of the percentage of subscriptions used in earlier publications. Spectrum was removed from the index. Finally, a more robust methodology was used for the calculation of fixed broadband prices, assessing 12 consumption baskets and household income (1e1 Broadband Price Index). This resulted in changes in the historical data, which were re-stated.

In the Human capital dimension, the historical data were revised by Eurostat for the indicator 2b2 STEM graduates.

The Use of Internet Services and the Integration of Digital Technology dimensions were not affected by any change.

Regarding Digital Public Services, a new sub-dimension (eHealth) was introduced with one indicator measuring the percentage of people who used health and care services provided online. Under eGovernment a new indicator was added on digital public services for businesses.

In addition, a limited number of historical data points were revised for other indicators, too. As a result of the above changes, the rankings for the previous years have slightly changed.

3 Methodological considerations

3.1 Indicator Requirements

Indicators used in the DESI comply with the following requirements:

- *Must be collected on a regular basis*. In order to fulfil the monitoring function, the indicators used in the index must be collected <u>ideally</u> on a yearly basis (or at least with a pre-defined regularity).

- *Must be relevant for a policy area of interest*. All indicators in the index must be accepted as relevant metrics in their specific policy areas.

- *Must not be redundant*. The index should not contain indicators that are redundant, either statistically or in terms of interpretation.

3.2 Data updates and corrections

Updates and corrections are part of the lifecycle and nature of statistical data. It is typical that the values for one indicator suffer small amendments and only stabilise completely months or even years after the indicator was originally computed. This is the case with a significant number of indicators used in the construction of the DESI.

At each publication, historical data are also reviewed to accommodate such changes. It is to be noted that the current report takes account of changes notified to the European Commission before 15 February 2018. Any modification made after this date will be included in the next report, which is expected in 2019.

3.3 Normalisation

In order to aggregate indicators expressed in different units into the sub-dimensions and dimensions of the DESI, those indicators were normalised. In DESI, normalisation

was done using the *min-max* method, which consists on a linear projection of each indicator onto a scale between 0 and 1. For indicators with positive direction (i.e., where higher is better), the 0 value in the normalised scale was anchored to the minimum value in the indicator original scale, and the value 1 in the normalised scale was anchored to the maximum value in the indicator's scale.

To allow for inter-temporal comparisons of index scores, the minima and maxima for the normalisation of each indicator were fixed and will be used for normalisation in the future versions of the DESI. Table 2 presents the values that were chosen as the minimum and maximum of each indicator for normalisation purposes.

Due to the choice of normalisation minima and maxima that are fixed over time, the values of one or another indicator may surpass the indicator's normalisation maximum or fall below its minimum in the future. The score for such values will become, respectively, higher than 1 or lower than 0. While this fact does not present a major methodological concern, the choice of minima and maxima was performed carefully taking into account the likely evolution of each indicator and the balance between indicators, so as to try to minimise the occurrence of such events.

Indicator	Unit	Min	Max
1a1 Fixed BB Coverage	% households	80%	100%
1a2 Fixed BB Take-up	% households	50%	100%
1b1 4G coverage	% households	0%	100%
1b2 Mobile BB Take-up	Subscribers per 100 people	25	150
1c1 Fast BB (NGA) Coverage	% households	0%	100%
1c2 Fast BB Take-up	% households	0%	100%
1d1 Ultrafast BB coverage	% households	0%	100%
1d2 Ultrafast BB Take-up	% households	0%	100%
1e1 Fixed BB Price	Score (0 to 100)	0	100
2a1 Internet Users	% individuals	40%	100%
2a2 Basic Digital Skills	% individuals	0%	100%
2b1 ICT Specialists	% individuals	0%	7%
2b2 STEM Graduates	Graduates in STEM per 1000 individuals (20-29 yo)	0	40
3a1 News	% individuals who used Internet in the last 3 months	33%	100%
3a2 Music, Videos and Games	% individuals who used Internet in the last 3 months	50%	100%
3a3 Video on Demand	% individuals who used Internet in the last 3 months	0%	60%
3b1 Video Calls	% individuals who used Internet in the last 3 months	20%	100%
3b2 Social Networks	% individuals who used Internet in the last 3 months	40%	100%
3c1 Banking	% individuals who used Internet in the last 3 months	0%	100%
3c2 Shopping	% internet users (last year)	0%	100%
4a1 Electronic Information Sharing	% enterprises	0%	60%
4a2 RFID	% enterprises	0%	15%
4a3 Social Media	% enterprises	0%	50%
4a4 eInvoices	% enterprises	0%	50%
4a5 Cloud	% enterprises	0%	50%
4b1 SMEs Selling Online	% of SMEs	0%	33%

4b2 E-commerce Turnover	% turnover	0%	33%
4b3 Selling Online Cross-border	% of SMEs	0%	25%
5a1 eGovernment Users	% internet users (last year) needing to submit forms	0%	100%
5a2 Pre-filled Forms	Score (0 to 100)	0	100
5a3 Online Service Completion	Score (0 to 100)	40	100
5a4 Digital Public Services for Businesses	Score (0 to 100)	20	100
5a5 Open Data	% of the maximum score	0	100%
5b1 eHealth Services	% of individuals	0%	100%

Table 2. Minima and Maxima used in indicator normalisation

3.4 Imputation of missing observations

Some indicators presented missing observations for some countries. Values for those observations were estimated using different methodologies. If a value from a previous year was available, this value was used. In certain indicators (e.g. 4a4 eInvoices and 4a5 Cloud) 2015 data was missing for several countries, but 2014 and 2016 values were available. In these cases the 2015 values were estimated as the average of 2014 and 2016 data. In some other cases, more recent data was used to estimate data points for earlier years. For indicators, where no time series were available for all the five years presented in the current report, the missing years were estimated based on the data for the available years.

In DESI 2018, 4% of all observations were imputed. As for the whole data set (DESI 2014-2018) imputations concern 16% of data points.

3.5 Weights

Some dimensions, sub-dimensions and individual indicators are more relevant than others, and for such a reason they were given higher weight in the computation of the final index score for each country.

Table 3 presents the overall weights attributed to the main DESI dimensions, which reflect the EU's digital policy priorities.

Dimension	Weight
1 Connectivity	25%
2 Human Capital	25%
3 Use of Internet Services	15%
4 Integration of Digital Technology	20%
5 Digital Public Services	15%

Table 3. Weights attributed to the DESI dimensions

Connectivity and Human Capital can be considered the most relevant dimensions because they represent the infrastructure of the digital economy and society. Hence, they were given higher weights. Integration of Digital Technology captures the use of ICT by the business sector, which, according to growth accounting theories is one of the most important drivers of growth. It was given a high weight, but not as high as the previous two dimensions. Finally, Use of Internet Services (by citizens) and Digital Public Services are enabled by the infrastructure and their contribution is strengthened by the quality of such infrastructure. For this reason, they were weighed less.

Weights were also assigned at the sub-dimension and individual indicator level.
Weights used at the sub-dimension level are summarised in table 4[4].

Within Connectivity, Fixed Broadband, Fast Broadband and Ultrafast Broadband have a
weight of 20% each, while Mobile Broadband weighs 30% and the Broadband Price
Index 10%. All the sub-dimensions within the Human Capital and Use of Internet
dimensions are considered of equal importance and are therefore weighted equally.
When it comes to Integration of Digital Technology, the Business Digitisation dimension
is more important than the E-commerce one, and therefore weighted higher at 60%.
Under Digital Public Services eGovernment is weighted at 80% and eHealth at 20%.

Sub-Dimension	Weight
1 Connectivity	
1a Fixed Broadband	20%
1b Mobile Broadband	30%
1c Fast Broadband	20%
1d Ultrafast Broadband	20%
1e Broadband Price Index	10%
2 Human Capital	
2a Basic Skills and Usage	50%
2b Advanced skills and Development	50%
3 Use of Internet Services	
3a Content	33%
3b Communication	33%
3c Transactions	33%

[4] Since the weight assignment for sub-dimensions is local to the dimension that they are part of,
then the sum of weights of the sub-dimensions within each dimension should add up to
100%.

4 Integration of Digital Technology	
4a Business digitization	60%
4b E-commerce	40%

5 Digital Public Services	
5a eGovernment	80%
5b eHealth	20%

Table 4. Weights attributed to the DESI sub-dimensions

For simplicity, all individual indicators within each sub-dimension were considered of equal importance and therefore weighted equally within the respective sub-dimension.

3.6   Method of Aggregation

In DESI, the aggregation of indicators into sub-dimensions, of sub-dimensions into dimensions, and of dimensions into the overall index was performed from the bottom up using simple weighted arithmetic averages following the structure of the index (table 1).

As an example, the top-level DESI score for country C was calculated using the formula:

$$DESI(C) = \ Connectivity(C) * 0.25 + Human\_capital(C) * 0.25 + Use\_of\_Internet\_Services\ (C) * 0.15 + Integration\_of\_Digital\_Technology(C) * 0.2 + Digital\_Public\_Services(C) * 0.15$$

Where $Connectivity(C)$ is the score obtained by country C in the Connectivity dimension, and so on for the remaining dimensions in the formula.