ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

Publisher
http://jssidoi.org/esc/home

HOW TO EVALUATE THE DIGITAL ECONOMY SCALE AND POTENTIAL?*

Roman Chinoracky [1], Tatiana Corejova [2*]

[1,2] University of Žilina, Faculty of Operation and Economics of Transport and Communications, Univerzitná 8215/1 010 26 Žilina, Slovakia

E-mails: [1]roman.chinoracky@fpedas.uniza.sk ; [2] tatiana.corejova@fpedas.uniza.sk (Corresponding author)*

Received 15 February 2021; accepted 21 April 2021; published 30 June 2021

Abstract. Technological progress is synonymous with current and past changes. In the past these changes led to increased efficiency of production. Driving forces behind today's technological progress are digital technologies. Emergence of digital businesses significantly contributes to a new type of economy, which acquires the adjective digital. Building on the experience gained from the technological advances of past centuries, digital technologies, which make the digital economy by the mass use of them, are and will be an important factor influencing economic growth. Therefore, the aim of this article is to propose the measure of the scale and potential of digital economy. Measurements are realized in the form of composite indicator designed for the policymakers that deal with the creation of strategies for further growth and the direction of national economies. This composite indicator consists of individual indicators related to tree areas – economy, labour and skills, that can be used to determine the scale and the potential of the digital economy. The scale of the digital economy varies across the examined countries. An interesting finding is the fact that the scale of the digital economy is not conditioned by the geographical or economic scale of the state.

Keywords: Digital transformation; digital economy; composite indicators; scale of digital economy

Reference to this paper should be made as follows: Chinoracky, R., Corejova, T. 2021. How to evaluate the digital economy scale and potential? *Entrepreneurship and Sustainability Issues*, 8(4), 536-552. http://doi.org/10.9770/jesi.2021.8.4(32)

JEL Classifications: O14, O33, O52

* *This publication was realized with support of Operational Program Integrated Infrastructure 2014 - 2020 of the project: Innovative Solutions for Propulsion, Power and Safety Components of Transport Vehicles, code ITMS 313011V334, co-financed by the European Regional Development Fund.*

1. Introduction

Digital technologies are the driving force behind today's technological progress. Digital technology can be understood as all types of electronic devices and applications that use information in the form of numerical codes. Microprocessor-based devices that process and use digital information include personal computers, cell phones, and communications satellites. Digital applications such as the Internet, operating systems, and enterprise resource management information systems are dependent on such devices (Urbinati et al. 2020; Khin, Ho 2019).

The use of digital technologies leads to the digitization of processes (Brennen, Kreiss 2014). While digitization represents the conversion of multiple streams of information within a part of a certain process, by digitalisation we speak of the conversion of all streams of information within the whole process. Digitalisation, simply put, represents the introduction and use of a specific digital technology by companies, or the entire industry in a single project (Wachal 1971). The company can carry out a series of digitalisation projects: from the digitization and subsequent automation of production processes, the introduction of information systems for customer relationship management, transition from classic marketing tools to new digital marketing tools, changed use of data, including offering new digital services, to the retraining of employees using digital technologies (Corejova, Chinoracky, Valicova 2020; Genzorova, Corejova, Stalmasekova 2018; Corejova, Rovnanova, Genzorova 2016; Tengler, Kolarovzski, Kolarovzska 2017; Madlenak, Madlenakova 2015; Madlenak, Madlenakova 2017). Collectively, the series of digitalisation projects is referred to as digital transformation. Digital transformation is a strategic transformation that requires not only the implementation of digital technologies, but also cross-cutting organizational changes, a shift in corporate culture and business models (Strenitzerova 2016; Strenitzerova, Garbarova 2016). The digital part of this transformation involves the transition from existing systems, enterprise infrastructure and the business models to upgraded platforms and software, which is often delivered as a cloud-based service instead of traditional desktop applications. Changes in corporate culture involve the adoption of digital technologies by employees, which make their work more efficient and easier (Reis et al. 2018; Verhoef et al. 2019; Ebert, Duarte 2018; Williams, Schallmo 2018; Corejova, Rostasova 2015).

The digital transformation is not only changing the way businesses operate. Changes are present in a way the customers behave. Together, these two entities form the basis of the functioning of the economy. Emergence of new digital technologies and their integration into all spheres of society creates a new kind of paradigm of the economy. The new economy received new adjective "*digital*" (Zimmermann 2000; Akaev et al. 2018; Genzorova, Corejova, Stalmasekova 2018).

Digital technologies allow traditional industries to grow. In this context, digital transformation provided businesses with opportunity to expand, address additional demand and thus create an increased need for inputs, in particular capital and labour. (ITU 2017) The development and growth of companies leads to economic growth of entire industries, which can also lead to the growth of the entire state economies. Specific examples of impacts of digital technologies on the economic growth are in:

- increase of productivity through the introduction of more efficient business processes supported by information and communication technologies and the optimization of supply chains. (Atkinson, Castro, Ezell 2009)
- increase in corporate revenues from expanded market coverage. Digital technologies can attract labour to certain regions of countries as a result of information processing and the provision of services at a distance. The most affected services are in the areas of outsourcing and deployment of virtual customer care centres. (ITU 2017)
- growth of some service sectors. For example, in software development and business processes outsourcing. (Crandall, Lehr, Litan 2007)

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

Assuming that the mass adoption of digital technologies (such as artificial intelligence, machine learning, robotics and blockchain etc.) will take place within ten or twenty years, it can be concluded that their economic impact will be significant. If operating costs are significantly reduced and thus the price of products is reduced, at least part of this reduction will be felt by consumers, who will benefit from the increased efficiencies caused by digital technologies. Digital technologies could reverse the offshoring trend of multinational companies and dramatically change global production chains (ITU 2017). The effects of digital transformation and the use of new technologies do not only affect economic growth. Changes of the nature of work in all sectors and professions are and will be present (IMF 2018, Schwab 2017).

Taking into account that digital technologies are driving the technological advances of today and they are behind the emergence of digital economy which can cause economic growth and change of labour market some questions are certain: What is the scope of digital economy and what are the options for measuring the digital economy?

2. Theoretical background

If we want to measure the outputs of the digital economy, it is necessary to examine which companies make up the digital economy, and therefore, fall under the theoretical framework of digital economy. This problem was addressed by Buhkt and Heeks, in their study "Defining, Conceptualising and Measuring the Digital Economy". The scale of the digital economy can be determined from its core representing the digital (ICT) sector to the digital economy from a narrower perspective and the digitized economy from a broader perspective (Bukht, Heeks 2017). The core of digital sector includes the production of information technology hardware, software production, the provision of information services, IT consulting services and the provision of ICT products (OECD 2002; Madudova, Corejova 2019).

The digital economy in the narrower perspective takes into account the overall range of applications of digital technologies. This includes the core of the digital economy, the provision of digital services and applications as well as digital platforms as a supporting tool of business processes. The way of providing some long-term services as a result of large-scale application of IT technologies into practice is changing. This means that new services are emerging. These services are provided due to the penetration of new technologies on the market. Therefore, a narrower definition of the digital economy encompasses a wide range of activities, taking into account the fact that not all digitized activities are part of the digital economy (Bukht, Heeks 2017).

From a broader perspective, the digital economy embraces also e-commerce and e-business, algorithmic economy, the use of digitally automated technologies in industry (industry 4.0) and agriculture (precision agriculture) (Bukht, Heeks 2017). Algorithmic economy is synonymous with algorithmic businesses. Algorithmic businesses deal with the industrial use of mathematical algorithms, which are applied in companies to acquire knowledge that can be used repeatedly and easily, for the purpose of improving and subsequent implementation of important business decisions (Meulen van der 2016). The term Industry 4.0 represents the integration of complex physical machines and devices with network sensors and software that is used to predict, control and plan not only better business but also social results (Germany Trade & Invest 2014). Businesses providing precision farming services, using digital technologies from GPS, sensors, robotics, autonomous vehicles, drones, automated hardware, telematics and software, enable farms and other agricultural companies to collect, process and analyse temporal, spatial and individual data. These data in combination with the information available to the farm or agricultural company supports its decisions to improve resource efficiency, productivity, quality, profitability and the sustainability of agricultural production (Schmaltz 2017).

The transition between the narrow and broader perspectives of digitalised economy is represented by gig and sharing economy platforms. The economic activity of companies providing gig platforms and the shared economy platforms is realized exclusively through digital technologies by connecting users using these platforms through

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

the Internet. Conversely, the exchange of certain goods or services between end-users of a given platform takes place outside the digital environment. That's why, gig and the sharing economy are indirectly part of not only the broader scope of digital economy but also the narrower scope of digital economy (Hamari, Sjöklint, Ukkonen 2016; Mukhopadhyay, Mukhopadhyay 2020; Stalmasekova, Genzorova, Corejova 2017).

If we can say what forms the framework of the digital economy, it is appropriate to look at the possibilities of measuring the digital economy. The performance of economic entities is quantified by specific indicators (Kovanicova 2005). A number of studies have been devoted to the question of which indicators should be measured in the digital economy. A comprehensive framework following these studies was published by the G20 in 2018 in its "Toolkit for measuring the Digital Economy" study, which was followed up and supplemented by new findings of the OECD in 2020 in the study "A roadmap toward a common framework for measuring the digital economy". The demand for new data, new indicators and tools to measure the digital economy is acute due to the growing role that digital technologies play in the economies of the world and the rapid pace of development that characterizes these technologies. OECD, in the study "A roadmap toward a common framework for measuring the digital economy", and the G20, in the study "Toolkit for measuring the Digital Economy", did not develop new indicators to measure the performance of economic entities belonging under the framework of digital economy. Existing indicators and methodological procedures were selected for the measurements of digital economy in an effort to compile basic, standardized and comparable indicators of the digital economy (G20 2018, OECD 2020). These individual indicators are thematically grouped into three areas, which are:

- the skills needed for individuals involved in the production of goods and services;
- jobs, in the sense of a workforce that is one of the factors of production influencing the output of companies in the digital economy;
- growth generated in some way by the activities of businesses in the digital economy.

Even if there are groupings of individual indicators with which it is possible to measure the digital economy, it is appropriate to add that individual indicators alone cannot specifically measure the digital economy. The application of digital technologies to business practice, from the digitization of information flows, digitalisation of business processes to the digital transformation of entire companies is a multidimensional phenomenon, which is commonly quantified with the help of composite indicators. There are more than 20 composite indicators that, from a certain point of view, deal with various measuring of the digital economy. These composite indicators mainly focus on areas such as electronic services of the state (or so called e-Government), digital skills in society, telecommunications infrastructure, use of digital technologies and digital innovations in society (Konovova 2015, Moroz 2017).

If the focus of these composite indicators is oriented in this way, a question arises. Is it possible to create a new way of measuring the digital economy? The answer to this question may be the use of already mentioned composite indicators, because the digital transformation is a multidimensional phenomenon that cannot be explicitly measured by individual indicators. However, if composite indicators for measuring the digital economy already exist, what new approaches need to be applied? The answer is in the dimensions defined by the study "A common framework for measuring the digital economy".

3. Research objective and methodology

If the study "A common framework for measuring the digital economy" defines the three dimensions of measuring the digital economy, it is possible to create a new approach to measuring the digital economy. If we also know the theoretical framework of the digital economy and specific indicators that can be used to quantify digital economy, it is possible to measure the scale of digital economy. Therefore, research results presented in this article combine the theoretical framework, OECD's findings on individual indicators and dimensions suitable

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

for measuring the digital economy and the findings that the digital economy, as a multidimensional phenomenon, is examined in the form of composite indicators. If the composite indicators of measuring the digital economy focus on specific areas of electronic services of the state, digital skills in society, telecommunications infrastructure, use of digital technologies and digital innovations in society, then it possible to propose and create composite indicator which will be based on the individual indicators proposed for measuring the digital economy by the OECD which will expressed on one hand digital skills and on the other hand will complement existing composite indicators by expressing what the analysed indicators do not examine – growth and jobs. So it is possible to say that the dimensional orientation of the proposed composite indicator defined in this way represents a new form of measuring the digital economy.

The proposed composite indicator will measure the scale of the digital economy and the potential that can arise from changes of the measured values over time. Name of the composite indicator is *Digital economy scale index*. Digital economy scale index is composed out of individual indicators which are derived from already mentioned OECD's study "A framework for measuring the digital economy". Set of individual indicators was modified for the needs of created composite indicator. Same applies for the names of the areas (or dimensions) of individual indicators. Methodologically, the composite indicator was constructed according to the methodological and user guide "Handbook on Constructing Composite Indicators" from OECD (OECD, 2008). To make the measurements comprehensive in terms of available data Digital economy scale index was quantified for 19 OECD members' countries within the time frame of eleven years (2008-2018).

3.1 Structure of the proposed composite indicators

Digital economy scale index measures to which extent the values of individual indicators contribute to the total values of these indicators at the state level. The individual indicators that make up the Digital economy scale index express the economic side of the performance of companies that fall under the theoretical framework of digital economy and the investment of all companies in digital technologies, including their import and export. If the Digital economy scale index is set to measure the digital economy from broadest possible way, the companies that were examined fall under the ICT sectors' detailed definition and high digital intensive industries. Both groups are named according to the classification of companies that OCED uses in its own OECD STAN database (ISIC rev.4).

The economic area is included in the Digital economy scale index. It is its dimension, and is named as *economy*. Indicator of investment in digital technologies represents capital, as a production factor or input into the production of goods and services, which is necessary for a company to make a profit. Achieving the required profit is conditioned by the growth of business performance. If the performance of companies grows, so does the performance of the state's economy.

The performance of an economy depends on labour, which is related to an individual's effort to bring a good or service to the market (Hanink 2017). An important characteristic of work is its quality, which means knowledge, education, qualification of work and its productivity. The rapidly changing structure of the economy, triggered by digital technologies, places increased demands on the quality of work and its ability to adapt to these changes. Therefore, the quality of work is an essential part of the digital economy (Lisý 2005). Respecting the basic features of quality of work, *labour* is another dimension, which is included in the Digital economy scale index. Dimension *labour*, in the form of other individual indicators, quantifies employment and labour productivity in ICT and high digital intensive industries, the number of specific jobs affected by digital technologies and the demand for these jobs (that is being created by companies).

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

The performance of a certain work and its quality is influenced not only by the knowledge and competencies, but also by the skills that the workforce has or should have at its disposal. The digital transformation creates a demand for knowledge and skills in two lines. The first line concerns the production of products such as software, websites, e-commerce and e-business systems, cloud technologies and big-data analytics. The production of these products requires a comprehensive knowledge of ICT, which is specific and related to the programming, application development and management of telecommunications and computer networks. The second line points out that workers in a wide range of occupations need to acquire general ICT skills in order to be able to use these technologies in their daily work. Taking into account both lines of demand for specific and general knowledge and skills, this demand should be met by supply created by a highly skilled workforce. Graduates who will be employed as scientists, engineers and ICT professionals will form and also form the core of the demand for a highly qualified workforce. These graduates will be primarily university graduates who have studied the fields of natural sciences, mathematics and statistics, information and communication technologies and technology, production and construction, where there is a presumption that these fields of study with their curriculum are capable of preparing these graduates for specific jobs as scientists, engineers and ICT professionals (OECD 2020). Therefore, individual indicators relating to graduates of a given fields of study, which are included in the Digital economy scale index, are categorized under another dimension, which is called the *skills*.

As in the case of individual indicators for the dimension of *economy*, indicators of dimensions' *work* and *skills* express the extent to which the values of individual indicators contribute to their overall values at the state level. By determining the share of the values of individual indicators in the total values of indicators at the state level, it will be possible to compare countries with each other, regardless of their geographical, population and economic scale.

By knowing the development of the values of Digital economy scale index, it is also possible to assess the potential over time. Development of values of the index points out to the long-term potential of the digital economy to be a significant part of national economy. Whether this potential is declining or increasing, it is possible to examine if digital economy will be an important part of the overall economy of the state or not.

The choice of individual indicators for Digital economy scale index was influenced by the fact that not all indicators can be quantified for all 19 countries for a period of eleven years. It should be emphasized that there are a number of individual indicators that could complement Digital economy scale index. Therefore, proposed set of individual indicators is a set of selected individual indicators. Individual indicators include in the Digital economy scale index are listed in Table 1.

Individual indicators were derived from databases OECD STAN, OECD National Accounts, OECD Information and Communication Technology, OECD Education and Training, UNCTAD Information Economy, Eurostat Digital Economy and Society, Eurostat Education and Training. On many occasions the data for particular year or country were missing. These data were refiled using the linear regression method with which the values of individual indicators were predicted. If it was possible, some missing data were replaced. For example, data in some countries were missing for ICT investments, but data for investments in machinery (which ICT investments is a part of) were available. Therefore, ICT investments were, for some countries, substituted by investments in machinery. Another instances of missing data occurred due to the changes in methodology of measurements. This was the case of individual indicators of dimension *skills* where two different classifications of education had to be used (ISCED 1997 and ISCED 2011).

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

Table 1. Individual indicators of index of the scale of the digital economy.

	Dimension	Individual indicator
Index of the digital economy scale	Economy	Share of value added of the ICT sector and high digital intensity industries on GDP (%)
		Share of ICT investment on GDP (%)
		Share of imports of ICT products on total imports (%)
		Share of exports of ICT products on total exports (%)
	Labour	Share of employment in ICT sectors and high digital intensity industries in total employment (%)
		Labour productivity in the ICT sector and the high digital intensity industries (millions of €)
		Share of employees performing ICT specialist work in total employment (%)
		Share of companies looking for ICT specialists on the total number of companies (%)
	Skills	Share of graduates with bachelor's degree of natural sciences, mathematics and statistics to the total number graduates with bachelor's degree of all university study programs (%)
		Share of graduates with master's degree of natural sciences, mathematics and statistics to the total number of graduates with master's degree of all university study programs (%)
		Share of graduates with doctoral degree of natural sciences, mathematics and statistics to the total number of graduates with doctoral degree of all university study programs (%)
		Share of graduates with bachelor's degree of information and communication technologies to the total number of graduates with bachelor's degree of all university study programs (%)
		Share of graduates with master's degree of information and communication technologies to the total number of graduates with master's degree of all university study programs (%)
		Share of graduates with doctoral degree of information and communication technologies to the total number of graduates with doctoral degree of all university study programs (%)
		Share of graduates with bachelor's degree of engineering, manufacturing and construction to the total number of graduates with bachelor's degree of all university study programs (%)
		Share of graduates with master's degree of engineering, manufacturing and construction to the total number of graduates with master's degree of all university study programs (%)
		Share of graduates with doctoral degree of engineering, manufacturing and construction to the total number of graduates with doctoral degree of all university study programs (%)

Source: Authors.

3.2 Normalization

As we can see in table 1, Digital economy scale index is compiled out of 17 indicators. Almost all of them are expressed in the same unit of measure except for the individual indicator of labour productivity in the ICT sector and high digital intensity industries. This means that values of individual indicators had to be normalized. For the needs of normalization, the Min-Max method was used. Min-Max method normalizes all individual indicators so that their values range from 0 to 1.

Each individual indicator $x_{q,c}^{t}$ for the country c at time t was transformed to $I_{q,c}^{t}$ – the normalized value of the individual indicator q for country c at time t where $q = 1, \dots ,Q$ and $c = 1, \dots ,M$.

Formula which we used for calculation of normalized value is:

$$I_{q,c}^{t} = \frac{x_{q,c}^{t} - min_c(x_q^t)}{max_c(x_q^t) - min_c(x_q^t)} * 100$$

In this formula $min_c(x_q^t)$ and $max_c(x_q^t)$ are the minimum and maximum values of individual indicators $x_{q,c}^{t}$ across all countries c at time t. Values of $I_{q,c}^{t}$ are in percentages. For all individual indicators $I_{q,c}^{t}$, the higher their measured value, the more favourable their measured result. Therefore, values converging to 0 are expressed by minimum $min_c(x_q^t)$ and values converging to a value of 1 by maximum $max_c(x_q^t)$.

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

3.3 Weighing and aggregation

After normalization of the values of individual indicators of the Digital economy scale index, it was necessary to recalculate these values with the assigned weight. Why we used weight in our calculations? The real values of some indicators may be greater than the values of other indicators. We perceive all individual indicators equally. That's why normalized values of individual indicators were multiplied by the weight *v* which was calculated as a percentage of each individual indicator on the total number of 17 individual indicators:

$$v = \frac{1}{\sum_{i=1}^{n} x_i} * 100 = \frac{1}{\sum_{i=1}^{17} x_i} * 100 = \frac{1}{17} * 100 = 5{,}882$$

It should be added that, recognizing the limits of the equal weights of each individual indicator, not all dimensions have the same share in the total value of the composite indicator. The recalculation of the weights by determining the same proportions for each dimension represents an option for modifying the Digital economy scale index.

Values expressed by multiplication of the normalized value of an individual indicator $I_{q,c}{}^{t}$ with weight *v* were aggregated into the final value of the Digital economy scale index for country *c* at time *t*:

$${I_{SDE}}_c^t = \sum_{i=1}^{n} {I_{q,c}^t}_i * v = \sum_{i=1}^{17} {I_{q,c}^t}_i * 5{,}882$$

4. Results

The values of the Digital economy scale index in percentages are presented in Table 2. Heat map used in this table graphically differentiates values from each other to distinguish those countries in which the scale of the digital economy is larger or smaller. Used heat map is based on a four-point scale in which the measured percentages are divided into four groups. The four-level scale groups were set up according to the scale of the digital economy. This scale is at low, medium low, medium high or high level. Countries are not naturally at the stage of complete or rather 100 % digital transformation. Respecting this fact, the values of the specified intervals, divided on a scale into four groups, are based on the measured values of the Digital economy scale index for each country and each year. The first group should consist of values, highlighted in white, from the range from 0 to 15%. No values for this interval were measured and therefore there are no such highlighted values in the table. The second group, highlighted in light grey, consists of values ranging from 15% to 30%. The third group, highlighted in light blue, consists of values from 30% to 45%. The fourth group, highlighted in dark blue, includes values from the range of 45% to 60%.

According to the measured values of the Digital economy scale index there are five countries – Czech Republic, Estonia, Finland, Luxembourg and Germany – where a high level of the digital economy was measured in year 2018. In countries such as Luxembourg and Germany, the scale of the digital economy has been high for a long time. In Finland, between 2011 and 2015, there was some decline in the scale of the digital economy, but ultimately its scale is high. Estonia has seen continuous growth of its the digital economy. While in 2008 it was at the level of 38.77% and its scale was medium high, in 2018 it already has a value of 47.56% and its scale is at a high level. In the Czech Republic, a gradual growth of the digital economy was recorded, and while in the years 2008 to 2017 its level was moderately high, in 2018 its level is already high. For the measured lower values, the medium scale of digital economy for year 2018 was in countries such as Latvia, Lithuania, Portugal and Spain. In Latvia, Lithuania and Portugal the scale of the digital economy has long been medium low. Portugal is the opposite of Estonia. In 2008, the scale of its digital economy was at a medium high level, reaching 39.07%. In ten years, the scale of Portugal's digital economy has steadily decreased by 11.29% to 27.78%. Significant decline for

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

Portugal was recorded between years 2011 and 2012. The same is true for Spain, where between 2011 and 2012 there was a significant decline in the scale of its digital economy. In other countries, such as Belgium, Denmark, France, Netherlands, Hungary, Poland, Austria, Slovakia, Slovenia and Italy, the scale of the digital economy was recorded at a medium high level.

Table 2. The heat map of the digital economy scale index

State	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Belgium	34.13	34.06	33.82	34.99	33.47	31.76	32.31	31.25	30.36	30.00	33.93
Czech Republic	43.98	44.19	42.95	41.48	41.99	42.67	44.15	41.70	42.21	43.49	47.33
Denmark	36.63	37.54	36.53	38.23	38.52	38.64	37.97	38.52	40.04	39.43	41.41
Estonia	38.77	34.30	40.49	40.80	43.64	46.43	45.42	43.74	49.95	49.60	47.56
Finland	50.00	46.47	46.27	43.63	42.39	43.87	44.60	44.49	45.56	42.91	46.60
France	44.06	43.79	43.90	41.30	38.66	40.43	40.20	41.05	40.50	40.55	42.21
Netherlands	33.50	33.37	29.30	37.19	38.62	36.04	37.38	36.96	39.56	38.93	42.00
Latvia	21.24	20.84	27.81	26.81	29.51	26.73	31.16	30.60	29.23	26.11	27.52
Lithuania	26.18	24.71	22.99	23.95	24.01	22.61	23.67	20.83	20.42	27.35	25.95
Luxembourg	53.62	55.34	53.38	52.87	54.12	44.67	42.55	42.30	48.85	43.68	52.56
Hungary	33.13	33.86	39.24	37.32	33.21	35.91	36.21	34.40	36.16	35.32	37.78
Germany	46.40	44.27	46.91	47.83	53.44	50.64	51.55	50.41	49.35	48.24	50.28
Poland	32.00	31.24	31.20	30.54	30.63	28.50	29.85	30.64	31.00	30.60	30.31
Portugal	39.07	35.41	31.20	32.11	26.93	28.13	29.05	26.66	29.44	27.67	27.78
Austria	43.53	43.93	42.70	43.57	39.33	40.37	43.91	40.40	41.97	38.78	39.85
Slovakia	36.63	36.83	35.69	35.28	34.83	35.45	34.70	35.23	36.34	34.38	34.76
Slovenia	24.38	23.16	25.12	23.36	26.99	29.94	31.43	27.97	23.60	29.77	31.70
Spain	34.20	33.56	37.90	33.42	27.24	32.99	31.32	32.71	29.26	25.35	27.22
Italy	27.23	28.72	28.76	29.35	26.20	30.63	29.46	33.63	31.99	30.09	31.90

Source: Authors.

Taking into account the fact that not all countries are equal in terms of its wealth, the assumption arises that the scale of the digital economy should be higher in those countries that are more economically developed and have a higher GDP per capita. The opposite is true, countries across Europe are differently grouped according to the size of the digital economy.

Among the countries, Luxembourg, Germany, Czech Republic and Finland are the leaders in terms of scale of their digital economy, placing themselves at the top almost every year. Estonia is also a leader, where the scale of its digital economy had grown to such an extent that since 2012 it has been one of the countries for which the highest values of Digital economy scale index were measured. There was also a significant shift in Netherlands, where continuous growth has also been recorded. On the contrary, the countries with the smallest scale of the digital economy have long been Lithuania, Latvia, Portugal and Spain. In other countries, there were no significant shifts in their position.

We may ask ourselves: Was there no fundamental shift due to the fact that the scale of the digital economy in all countries had grown or fell? The evolution of the measured values of the Digital economy scale index, presented in Table 3, show us how the values of the Digital economy scale index had changed over the examined time period. The largest progress was recorded in Estonia. In Estonia, as it was mentioned, the scale of the digital economy grew to such an extent over the time (+ 8.79%) that it is one of the leaders in terms of the scale of Digital economy. The same applies for the Netherlands, which digitally grew from 2008 to 2018 by 8.51 % into a

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

country where relatively large value of the Digital economy scale index was measured. High growth also occurred in Slovenia and Latvia, where the scale of the digital economy grew by 7.32% in Slovenia and by 6.28% in Latvia. Growth was also measured in Italy, Hungary and Denmark, with each of these countries growing by more than 4.5% in the scale of their digital economies. In the Czech Republic and Germany, digital economy risen by more than 3% in its scale.

Table 3. Changes in the values of the digital economy scale index for a selected period of time

State	2008	2018	2018 – 2008
Belgium	34.13 %	33.93 %	-0.20 %
Czech Republic	43.98 %	47.33 %	3.35 %
Denmark	36.63 %	41.41 %	4.77 %
Estonia	38.77 %	47.56 %	8.79 %
Finland	50.00 %	46.60 %	-3.4 %
France	44.06 %	42.21 %	-1.85 %
Netherlands	33.50 %	42.00 %	8.51 %
Latvia	21.24 %	27.52 %	6.28 %
Lithuania	26.18 %	25.95 %	-0.23 %
Luxembourg	53.62 %	52.56 %	-1.06 %
Hungary	33.13 %	37.78 %	4.65 %
Germany	46.40 %	50.28 %	3.88 %
Poland	32.00 %	30.31 %	-1.69 %
Portugal	39.07 %	27.78 %	-11.29 %
Austria	43.53 %	39.85 %	-3.67 %
Slovakia	36.63 %	34.76 %	-1.88 %
Slovenia	24.38 %	31.70 %	7.32 %
Spain	34.20 %	27.22 %	-6.98 %
Italy	27.23 %	31.90 %	4.67 %

Source: Authors.

The scale of the digital economy decreased most markedly in Portugal (-11.29%) and Spain (-6.98%). More than 3% declines were recorded in Finland and Austria. In Slovakia and France, the decline was at -1.85% in Slovakia, respectively -1.88% in France. The decline was also recorded in Poland and the digital economy of Poland fell by -1.69%. There was a relatively small decline in countries such as Belgium, Lithuania and Luxembourg. In Belgium it was a decrease by -0.20%, in Lithuania by -0.23% and in Luxembourg by -1.06%.

In Estonia and the Netherlands, it can be assumed that the potential of digital technologies had been exploited to such an extent that the digital economy had grown significantly over the years. Conversely, in Portugal and Spain, the potential of digital technologies has been exhausted at some point. The scale of the digital economy declined along with the decline of potential of digital technologies.

From the point of view of the dimensions forming the Digital economy scale index, it is possible to see in which specific areas the biggest changes took place (Table 4). In the case of Belgium and Lithuania, there was a small decline in the overall scale of the digital economy (up to -0.3%). Belgium's digital economy shrunk due to a decline in the share of the skills dimension. In the case of Lithuania, the impact of the labour dimension on the overall scale of the digital economy declined.

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

In countries where the scale of the digital economy decreased to -2%, the share of the labour dimension decreased in Poland and Slovakia. In France and Luxembourg, there was a decline in the proportions of dimensions of labour and skills. In Finland and Austria, where the scale of the digital economy fallen up to -4%, the share of the impact of the labour dimension decreased. In addition to the labour dimension, the impact of the economic dimension declined in Finland and the impact of the skills dimension declined in Austria. Decreases in the range of -4% to -12% occurred in Spain and Portugal. In these countries, in particular, the skills dimension declined. It was followed by the economic dimension, and Portugal also saw a decline in the labour dimension.

Table 4. Shares of dimensions in the total value of the digital economy scale index

State	2008			2018			Differences		
	Economy	Labour	Skills	Economy	Labour	Skills	Economy	Labour	Skills
Belgium	2.94%	13.20%	17.99%	3.21%	15.97%	14.75%	0.28%	2.77%	-3.24%
Czech Republic	10.38%	7.13%	26.47%	14.22%	6.47%	26.64%	3.85%	-0.66%	0.17%
Denmark	3.60%	14.54%	18.49%	4.49%	13.48%	23.44%	0.90%	-1.07%	4.94%
Estonia	4.20%	6.63%	27.94%	7.34%	7.19%	33.04%	3.14%	0.56%	5.10%
Finland	8.62%	15.77%	25.61%	3.71%	14.78%	28.12%	-4.91%	-0.99%	2.51%
France	4.06%	10.72%	29.27%	4.56%	9.86%	27.78%	0.50%	-0.86%	-1.49%
Netherlands	9.69%	10.72%	13.09%	11.15%	16.42%	14.43%	1.46%	5.71%	1.34%
Latvia	2.82%	5.90%	12.53%	6.78%	1.11%	19.64%	3.96%	-4.79%	7.11%
Lithuania	1.29%	5.16%	19.73%	2.45%	2.82%	20.68%	1.17%	-2.35%	0.95%
Luxembourg	6.75%	22.39%	24.49%	7.26%	21.63%	23.67%	0.51%	-0.76%	-0.81%
Hungary	14.00%	11.45%	7.68%	10.74%	8.21%	18.83%	-3.26%	-3.25%	11.16%
Germany	6.40%	12.27%	27.73%	7.19%	9.88%	33.21%	0.79%	-2.39%	5.48%
Poland	9.99%	5.77%	16.24%	11.73%	1.93%	16.64%	1.74%	-3.83%	0.40%
Portugal	5.13%	5.29%	28.65%	2.90%	3.98%	20.90%	-2.23%	-1.31%	-7.76%
Austria	3.52%	11.44%	28.56%	3.65%	9.02%	27.19%	0.13%	-2.43%	-1.38%
Slovakia	10.26%	7.82%	18.56%	12.05%	3.28%	19.43%	1.79%	-4.54%	0.87%
Slovenia	2.30%	7.52%	14.56%	1.97%	6.83%	22.90%	-0.34%	-0.69%	8.34%
Spain	3.23%	9.20%	21.77%	2.18%	8.84%	16.20%	-1.05%	-0.36%	-5.57%
Italy	3.31%	7.44%	16.48%	3.60%	6.45%	21.86%	0.29%	-1.00%	5.38%

Source: Authors.

The increase in the scale of the digital economy at the level of up to 4% was in the Czech Republic and Germany. In the Czech Republic, the dimension of economy was the main contributor to growth. In Germany, it was a skill dimension. Growth in the scale of the digital economy in the range of 4% to 7% was recorded in Hungary, Denmark, Latvia and Italy, where the skills dimension in particular contributed to this growth. In the case of the Netherlands, Estonia and Slovenia, growth in the scale of the digital economy was above 7%. The skills dimension in Estonia and Slovenia in particular contributed to this growth. In Estonia, the scale of the economy dimension also played a relatively high role in the scale of its digital economy. The scale of the Dutch digital economy was influenced by all three dimensions, and the labour dimension contributed most to this growth.

According to the measurements the dimensions and the scale of digital economy changed across all countries. But what is the prospect for the future? The answer is to examine the development of year-on-year differences in the measured values of the Digital economy scale index (Table 5). The development of values is expressed by the regression coefficient *a*. Regression coefficient determines the slope of the regression line and shows the trend.

The growth of the scale of the digital economy over time, expressed by a positive non-zero value of the regression coefficient *a*, represents the potential for increasing the scale of the digital economy and thus its impact on the economy of a certain state. On the contrary, its decline, expressed by the negative value of the regression coefficient *a*, indicates the potential for reducing the impact of the digital economy on the state economy. If the value of the regression coefficient converges to zero, it is possible to speak of a very low or almost zero potential for changing the impact of the digital economy on the state economy.

It should be noted that column names in Table 5, expressed as the two digits of the years surveyed, represent the annual periods that were the subject of the survey. The values given in Table 5, except for the column with the values of the regression coefficient *a*, are expressed as a percentage.

Table 5. Prediction of the growth of the scale of the digital economy

State	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	*a*
Belgium	-0.20	-0.72	3.46	-4.34	-5.12	1.73	-3.29	-2.85	-1.17	13.11	0.0058
Czech Republic	0.48	-2.81	-3.43	1.24	1.61	3.47	-5.55	1.22	3.03	8.84	0.0073
Denmark	2.47	-2.69	4.66	0.75	0.31	-1.74	1.45	3.96	-1.53	5.01	0.0022
Estonia	-11.5	18.04	0.76	6.96	6.39	-2.16	-3.71	14.21	-0.70	-4.10	-0.002
Finland	-7.05	-0.44	-5.70	-2.83	3.47	1.67	-0.25	2.41	-5.82	8.60	0.0091
France	-0.62	0.26	-5.91	-6.40	4.58	-0.57	2.13	-1.36	0.14	4.08	0.0051
Netherlands	-0.38	-12.2	26.95	3.84	-6.69	3.72	-1.12	7.04	-1.59	7.88	0.0027
Latvia	-1.88	33.44	-3.60	10.09	-9.44	16.57	-1.81	-4.45	-10.7	5.41	-0.016
Lithuania	-5.62	-6.98	4.20	0.26	-5.82	4.66	-12	-1.99	33.91	-5.09	0.0142
Luxembourg	3.20	-3.53	-0.96	2.36	-17.5	-4.75	-0.60	15.49	-10.6	20.35	0.0116
Hungary	2.19	15.90	-4.91	-11	8.11	0.85	-4.99	5.11	-2.31	6.95	-0.001
Germany	-4.60	5.96	1.97	11.73	-5.23	1.80	-2.22	-2.10	-2.24	4.23	-0.002
Poland	-2.36	-0.14	-2.10	0.27	-6.94	4.73	2.64	1.19	-1.30	-0.93	0.0024
Portugal	-9.38	-11.9	2.89	-16.1	4.46	3.27	-8.24	10.43	-5.99	0.38	0.0115
Austria	0.93	-2.80	2.03	-9.73	2.64	8.77	-7.97	3.89	-7.62	2.78	0.0002
Slovakia	0.55	-3.11	-1.13	-1.28	1.76	-2.10	1.51	3.15	-5.38	1.09	0.0009
Slovenia	-5.00	8.47	-7.00	15.52	10.92	5.00	-11	-15.6	26.16	6.48	0.006
Spain	-1.87	12.92	-11.8	-18.5	21.12	-5.07	4.45	-10.5	-13.4	7.36	-0.003
Italy	5.49	0.13	2.03	-10.7	16.93	-3.83	14.14	-4.86	-5.96	6.05	-0.001

Source: Authors.

According to the values in Table 5, the scale of the digital economy could potentially grow in countries such as Lithuania and Portugal. Both countries show greatest potential for further growth. Relatively high potential for growth in the scale of the digital economy was also recorded in Luxembourg. If we look back, for these three countries, the scale of the digital economy has declined over time (Table 4). But the outlook is positive, which may indicate that some impulses might have been created to increase the potential of digital technologies.

In the case of Luxembourg, the measured positive potential might mean an increase in the scale of the digital economy. This also may lead to the rise of digital economy’s impact being further strengthened. Luxembourg’s digital economy may be gradually forming an integral part of the Luxembourg overall economy. In the case of Lithuania and Portugal the measured potential may not only lead to growth of the impact of the digital economy on their national economies but might even potentially change from medium to medium high.

The same situation as in Lithuania, Portugal and Luxembourg occurred in Belgium, Finland, France, Poland, Austria, Slovakia and Italy. Scale of digital economies of these countries declined over time, but the outlook is positive and potential for the growth of the digital economy emerges. Digital economy of these countries may

ENTREPRENEURSHIP AND SUSTAINABILITY ISSUES
ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

grow its influence on the national economies. The potential of digital technologies, which was exhausted over the years, received further impulses, which may lead to the gradual growth of the scale and level of the digital economy of these countries.

In the case of the Czech Republic, Denmark and Slovenia, the digital economy grew. At the same time, a positive value of the regression coefficient *a* was recorded for all three countries, which suggests that there is potential for the scale of the digital economy of these countries to continue to grow.

The highest value for the potential decline in the scale of the digital economy was recorded in Latvia, a country where the scale of the digital economy is at a medium low level. While the scale of the digital economy had grown over the years in this country, the scale of the digital economy can be expected to decline in the future. The measured decline may indicate that the potential of digital technologies was fulfilled and has not received further impulses, so in the future it is possible to expect a decline in the scale of the digital economy and its impact on Latvia's national economy.

In the case of Estonia and Germany, it can be stated that both countries are leading countries with a high level of digital economy. In examined time period, their digital economy grew. The potential of digital technologies had been fulfilled and had not received any new impulses. Therefore, a slight decline in the scale and impact of the digital economy in the national economies of Estonia and Germany can be expected in the future. The same situation as in the case of Estonia and Germany occurred in Netherlands, Hungary and Italy, where the potential of digital technologies did not receive a new impulses and it is possible to expect a decline in the scale and impact of the digital economy on their national economies.

Conclusions

The digital economy, which is the product of application of digital technologies and subsequent digital transformation of business, is becoming one of the bearers of economic growth. That’s why the measurements of digital economy are needed more than ever before.

There are several approaches to measure digital economy. One option is in the use of specific individual indicators. However, the digital transformation is not a one-dimensional phenomenon. Therefore, another possibility to measure digital economy is in the composite indicators, which are directly used for the needs of studying multidimensional phenomena. Currently, there are a number of individual indicators and composite indicators that can measure the digital economy. Therefore, the question was formulated in this article: Are there other ways to measure the digital economy?

Taking into account the theoretical basis and analysis of the possibilities of measuring the digital economy, the Digital economy scale index was proposed, created and measured. After these measurements we can say that the values of index can represent a certain basis for formulating the policies focused on the dimensions of the economy, labour and skills. These policies can contribute to the development and growth of individual indicators forming the Digital economy scale index.

If the scale of the digital economy (through the Digital economy scale index) is high, it means that the digital economy’s share in certain state can grow. This can ultimately lead to the growth of the state’s entire economy. Conversely, if the level of its scale is low, the impact of the digital economy in the state decreases. If the state’s economy grows, the digital economy may not contribute to this growth.

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

The scale of the digital economy varies across the examined countries. An interesting finding is the fact that the scale of the digital economy is not conditioned by the geographical or economic scale of the state. By scale, the digital economy is at a high level in countries such as the Czech Republic and Estonia. On the contrary, it is at a medium low level, for example in Spain.

In countries where the positive value of the regression coefficient of year-on-year differences was measured, there is potential for future growth of the digital economy and thus growth in its overall impact on the state's economy. Where a negative value of the regression coefficient was measured, there is a potential for a decrease in the scale of the digital economy and thus a decrease of its impact on states economy.

References

Akaev, A., Sarygulov, A., Sokolov, V. (2018). "Digital economy: backgrounds, main drivers and new challenges", SHS Web of Conferences. https://doi.org/10.1051/shsconf/20184400006

Atkinson, R., Castro, D., Ezell S. (2009). "The Digital Road to Recovery: A Stimulus Plan to Create Jobs, Boost Productivity and Revitalize America", The Information Technology & Innovation Foundation. https://www.itif.org/files/roadtorecovery.pdf

Brennen, S., Kreiss, D. (2014). "Digitalization and Digitization", Culture Digitally https://culturedigitally.org/2014/09/digitalization-and-digitization/

Bukht, R., Heeks, R. (2017) "Defining, Conceptualising and Measuring the Digital Economy", Development Informatics Working Paper no. 68, http://dx.doi.org/10.2139/ssrn.3431732

Corejova T., Chinoracky R., Valicova A. (2020). "University processes and digital transformation", INTED 2020 Proceedings paper. pp. 1873-1877.

Corejova T., Rovnanova A., Genzorova T. (2016). "Digital transformation and its impact on brand", Marketing identity: Brands we love, PT II, proceedings paper. pp. 54-65.

Corejova T., Rostasova M. (2015). "Local impacts of university in supporting creativity, invention and development of innovation", 2015 International Conference on Information Technology Based Higher Education and Training (ITHET). https://doi.org/10.1109/ITHET.2015.7217960

Crandall, R., Lehr, W., Litan, R. (2007) "The Effects of Broadband Deployment on Output and Employment: A Cross-sectional Analysis of U.S. Data", Issues in Economic Policy – The Brookings Institution https://www.brookings.edu/wp-content/uploads/2016/06/06labor_crandall.pdf

Ebert, C., Duarte, C. H. (2018). "Digital Transformation", IEEE Software. no. 35(vol. 4). pp. 16-21. https://doi.org/10.1109/MS.2018.2801537

G20. (2018). "Toolkit for measuring the digital economy", G20 DETF – Measurement of the Digital Economy https://www.oecd.org/g20/summits/buenos-aires/G20-Toolkit-for-measuring-digital-economy.pdf

Genzorova T., Corejova T., Stalmasekova N. (2019). "How digital transformation can influence business model, Case study for transport industry", Transportation Research Procedia vol. 40. pp. 1053-1058. https://doi.org/10.1016/j.trpro.2019.07.147

Genzorova T., Corejova T., Stalmasekova N. (2018). "Comparing the use of digital platforms in tourism", CBU International conference proceedings 2018: Innovations in science and education. pp. 152-158. https://ideas.repec.org/a/aad/iseicj/v6y2018i0p152-155.html

Germany Trade & Invest. (2014). "Industrie 4.0 – smart manufacturing for the future", Germany Trade and Invest – Gesellschaft für Außenwirtschaft und Standortmarketing mbH https://www.manufacturing-policy.eng.cam.ac.uk/documents-folder/policies/germany-industrie-4-0-smart-manufacturing-for-the-future-gtai/at_download/file

Hamari, J., Sjöklint, M., Ukkonen, A. (2016). "The Sharing Economy: Why People Participate in Collaborative Consumption", Journal of the Association for Information Science and Technology. vol 67. pp. 2047-2059. https://doi.org/10.1002/asi.23552

Hanink, D. (2017). "Factors of Production", The International Encyclopedia of Geography. https://doi.org/10.1002/9781118786352.wbieg0013

IMF. (2018). "Measuring Digital Economy", https://www.imf.org/en/Publications/Policy-Papers/Issues/2018/04/03/022818-measuring-the-digital-economy

ITU. (2017). "Social and economic impact of digital transformation on the economy", Global Symposium for Regulators (GSR-17) – discussion paper. https://www.itu.int/en/ITU-D/Conferences/GSR/Documents/GSR2017/Soc_Eco_impact_Digital_transformation_finalGSR.pdf

Khin, S. and Ho, T.C. (2019), "Digital technology, digital capability and organizational performance: A mediating role of digital innovation", International Journal of Innovation Science, vol. 11, no. 2, pp. 177-195. https://doi.org/10.1108/IJIS-08-2018-0083

Kononova, K. (2015). "Some Aspects of ICT Measurement: Comparative Analysis of E-Indexes", Proceedings of the 7th International Conference on Information and Communication Technologies in Agriculture, Food and Environment. https://www.semanticscholar.org/paper/Some-Aspects-of-ICT-Measurement%3A-Comparative-of-Kononova/ad1031c4000c2c8c5c425d7bb82fa1172b473f11

Kovanicova, D. (2005). "Finanční účetnictví, světový koncept, IFRS/IAS", Prague: Polygon. p. 544. ISBN 80-7273-129-7.

Lisý, J. (2005). "Ekonómia v novej ekonomike", Bratislava: IURA. p. 622. ISBN 80-8078-063-3.

Madudova E., Corejova T. (2019). "Trends of scale-up effects of ICT sector", Transportation Research Procedia vol. 40. pp. 1002-1009. https://doi.org/10.1016/j.trpro.2019.07.140

Madlenak R., Madlenakova L. (2015). "The Differences in Online Advertising Acceptance in China and Slovakia", 2015 International Conference on Management Engineering and Management Innovation (icmemi-15). Atlantis Press. https://dx.doi.org/10.2991/icmemi-15.2015.9

Madlenak R., Madlenakova L. (2017). "Viral marketing as part of effective university marketing strategy", INTED 2017 Proceedings paper. pp. 5629-5634.

Meulen van der, R. (2016). "The Algorithm Economy Will Start a Huge Wave of Innovation", Gartner https://www.gartner.com/smarterwithgartner/the-algorithm-economy-will-start-a-huge-wave-of-innovation/

Moroz, M. (2017). "The Level of Development of the Digital Economy in Poland and Selected European Countries: A Comparative Analysis", Foundations of Management https://doi.org/10.1515/fman-2017-0014

Mukhopadhyay, B., Mukhopadhyay, B.K. (2020). "What is the Gig Economy?", Tripura Times, Post-Editorial. https://www.researchgate.net/publication/340583864_What_is_the_Gig_Economy

OECD. (2002). "Measuring the Information Economy 2002", OECD publications: Paris. http://www.oecd.org/sti/ieconomy/measuringtheinformationeconomy2002.htm

OECD. (2008). "Handbook on Constructing Composite Indicators – Methodology and user guide", OECD publications: Paris. https://www.oecd.org/sdd/42495745.pdf

OECD. (2020). "A roadmap toward a common framework for measuring the Digital Economy", Report for the G20 Digital Economy Task Force. http://www.oecd.org/sti/roadmap-toward-a-common-framework-for-measuring-the-digital-economy.pdf

Reis J., Amorim M., Melão N., Matos P. (2018). "Digital Transformation: A Literature Review and Guidelines for Future Research", In: Rocha Á., Adeli H., Reis L.P., Costanzo S. (eds) Trends and Advances in Information Systems and Technologies. WorldCIST'18 2018. Advances in Intelligent Systems and Computing, vol 745. Springer, Cham. https://doi.org/10.1007/978-3-319-77703-0_41

Schmaltz, R. (2017). "What is Precision Agriculture?", AgFunderNews https://agfundernews.com/what-is-precision-agriculture.html

Schwab, K. (2017). "The Fourth Industrial Revolution", Crown Business: New York, ISBN 9780241300756. p. 192.

Stalmasekova N., Genzorova T., Corejova T. (2017). "The Impact of Using the Digital Environment in Transport", Procedia Engineering vol. 192. pp. 231-136. https://doi.org/10.1016/j.proeng.2017.06.040

Strenitzerova M. (2016). "HR marketing in terms of HR managers and employees - Application E-marketing tools", Marketing identity: Brands we love, PT I, proceedings paper. pp. 463-473.

Strenitzerova M., Garbarova M. (2016). "Impact of globalization on human resource management in the information and communication sector", Globalization and its socio-economic consequences, 16th International scientific conference proceedings, PTS I-V.

Tengler J., Kolarovzski P., Kolarovszká Z. (2017). "Identification and Localization of Transport Units for Selected Company", Procedia Engineering vol. 178. pp. 491-500. https://doi.org/10.1016/j.proeng.2017.01.092

Urbinati, A., Chiaroni, D., Chiesa, V. and Frattini, F. (2020), "The role of digital technologies in open innovation processes: an exploratory multiple case study analysis", R&D Management, vo. 50, pp. 136-160. https://doi.org/10.1111/radm.12313

Verhoef, P., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J., Fabian, N., Haenlein, M. (2019). "Digital transformation: A multidisciplinary reflection and research agenda", Journal of Business Research. https://doi.org/10.1016/j.jbusres.2019.09.022

Wachal, R. (1971). "Humanities and Computers: A Personal View", The North American Review, vol.256, no.1, pp. 30-33. http://www.jstor.org/stable/25117163

Williams, C., Schallmo, D. (2018). "History of Digital Transformation", https://www.springerprofessional.de/en/history-of-digital-transformation/15362112

Zimmermann, Hans-Dieter. (2000). "Understanding the Digital Economy: Challenges for New Business Models", SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2566095

Acknowledgements

This publication was realized with support of Operational Program Integrated Infrastructure 2014 - 2020 of the project: Innovative Solutions for Propulsion, Power and Safety Components of Transport Vehicles, code ITMS 313011V334, co-financed by the European Regional Development Fund.

EUROPEAN UNION
European Regional Development Fund
OP Integrated Infrastructure 2014 – 2020

MINISTRY
OF TRANSPORT
AND CONSTRUCTION
OF THE SLOVAK REPUBLIC

ISSN 2345-0282 (online) http://jssidoi.org/jesi/
2021 Volume 8 Number 4 (June)
http://doi.org/10.9770/jesi.2021.8.4(32)

Roman CHINORACKY is a doctoral student at the Faculty of Operation and Economics of Transport and Communications at the University of Žilina. His dissertation and research focuses on assessing the potential of digital technologies in the transformation of businesses, the economy and society.
ORCID ID: https://orcid.org/0000-0003-4183-5883

Tatiana COREJOVA is a university professor at the Faculty of Operation and Economics of Transport and Communications at the University of Žilina. Her scientific, pedagogical and publishing activity is focused on interaction of technological development and economy and management of network industries, optimization and rationalization of postal network and services, diagnostics of business environment including diagnostics of technological procedures, research of sectoral clusters of companies and network processes knowledge of global processes in the development of information and communication technologies and transport at regional level, in the business environment, regional dimensions of the knowledge economy and the creative economy.
ORCID ID: https://orcid.org/0000-0003-0775-940X **ResearcherID: R-3145-2019**