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## **On the Relationship between Digitalization and the National Model of the Smart Economy to Achieve Strategies for Innovative Progress**

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**Abstract:** The transition of the national economy to a smart economy model is accompanied by several measures aimed at creating basic conditions for a soft transition. Modern economic conditions are often in dissonance with the opportunities available in countries. A study was conducted and presented to readers to study the basic conditions for the functioning of the smart economy in EU countries. The significance of the study lies in the fact that it shows the strengths and weaknesses of the formation of information infrastructure in the EU countries, indicates specific areas in which good results have been achieved and where the basic conditions for reasonable development have been created, and where the economy is taking a form that is not effective enough to form a basis smart economy. The study was conducted using Eurostat data from 2015 to 2021 in various areas that determine the functioning of the smart economy. The study analyzes EU projects aimed at integrating statistical and geospatial information, which is one of the most important basic components of the formation of information infrastructure. For the first time, an analysis has been carried out and the connection between information infrastructure factors and the level of digitalization of the economy has been proven. The scientific novelty of the study lies in developing a methodology for analyzing the effectiveness of measures to develop information support, taking into account the resulting characteristic - the number of operations carried out using digital tools. Investments, their volumes, and structure were also studied. The results show that in 4 countries there was no investment in software at all, and in 13 countries the share of total investment in software ranged from 3% to 12.1%. The study identified several infrastructure problems, the solution of which will ensure the free development of the smart economy.

**Keywords:** statistical and geospatial information, information and communication skills, investments, percentage of digitalized operations, smart economy.

## **Introduction**

In recent years, digitalization has become an integral part of life. To successfully promote economic ideas, it is necessary to take into account digitalization methods and their application in practice to obtain a reliable basis for reformatting the traditional economy into a smart economy, which should contribute to the achievement of strategies for innovative progress since modern innovations have a significant digital component (Lee & Cronin, 2016). However, the conditions that allow the functioning of a smart economy are not always created at the level of the national economy, which slows down the process of transition to a smart economy (Saini, Sayal, Govardhan, & Buyya, 2018). The main obstacle to the transition to a smart economy is the lack of full-fledged information infrastructure and an orderly program for the formation of this infrastructure due to a lack of understanding of the relationship between infrastructure development and the digitalization of the economy (Boland, 2014).

Research in recent years has shown that there is no full understanding of the impact of digitalization on the formation and development of a smart national economy model (Frankerberger, de Brito, & Filho, 2019). Thus, the works of Brehm, Tidd, and Dime (2019), and Nagaraj (2021) trace the connections of digitalization with individual components of the economy without analyzing the interrelations of the various components or searching for cause-and-effect relationships. These researchers are limited to presenting facts that appear in various areas of the economy caused by the use of digital tools. Neither the information infrastructure, nor its components, nor the methods of their formation and development are dissipated. Studies by Camilleri (2021) and Hunukumbure, Kuhn, Allen, and Vernon (2021) provide some evidence of the existence of a relationship between digitalization and innovation but given the demands for digitalization from the developing smart economy model, they have not been fully studied, which motivates the study of this relationship (Shiraishi & Sonobe, 2018). The literature does not present an analytical apparatus for analyzing the influence of information infrastructure components on the digitalization of the economy, which indicates the need for such a study. The authors of this article make a modest attempt to consider the relationship between the formation of information infrastructure at the level of the European Union and the response of the labor market in EU countries in the form of an increase in demand for specialists with skills in working with information and communication technologies, the share of operations performed in the real sector of the economy using digital tools (Camilleri, 2021). Also, the formation of an innovative information infrastructure in this study is examined through an analysis of the investment component in each country of the European Union (Patti & Trizzino, 2019). The main purpose of the study is to check the presence of a correlation between the number of specialists required by the economy with skills in working with information and communication technologies and the percentage of operations carried out in the real sector of the economy using digital tools (Constantinescu, 2017). The study allows us to assess the degree of readiness of the national economies of the European Union countries for transformation into smart economies and the readiness to implement measures to achieve innovative progress strategies by increasing the provision of the economy with specialists with ICT skills, revising investment flows to develop digitalization, and expanding the integration of statistical and geospatial information (Kroll & Capello, 2018).

## **Research Problem**

The formation of information infrastructure is constantly happening at present, which constantly creates requests for scientific research in the field of theorizing the processes that form the smart economy. The processes occurring with the use of digital technologies do not have a clear description, and the features of the mechanisms for the formation of capital flows under the influence of digital processes have not been fully studied.

Studying the relationship between digitalization and national smart economy models will allow society to correctly distribute existing digital resources, as well as labor resources for the effective use

of existing digital resources and the development of new resources using digital technologies. Rational allocation of resources will lead to greater implementation of innovative progress strategies.

Currently, investment in smart economy components is shockingly low, hindering the expansion of smart economy functions. The conducted research motivates to reconsider the direction of investment flows, as well as redistribution within investment portfolios in favor of software, investments in digital technologies, and the development of new technical means, which should create the basis for the formation and development of information infrastructure and the growth of smart economy components.

In the scientific community, much attention is paid to the study of tools for the formation and development of the information space, but the set of actions used in the economies of various countries to achieve strategies for innovative progress is not sufficiently considered. Even within the European Union, different countries have different approaches to creating conditions for national smart economy models, which leads to different levels of digitalization of the economy. Based on the results of the study, it will be possible to eliminate the imbalance within the European Union to equalize the preconditions for the functioning of the smart economy.

The study examined statistical data on requests for specialists with skills in working with information and communication technologies in the context of the integration of statistical and geospatial information, the percentage of operations in the real sector of the economy performed using digital technologies. Particular attention is drawn to the analyzed statistical data on the direction of investment in the context of the formation of a smart economy in each EU country for 2021. When studying all of the above data, the main new fact for the authors of the study was the obvious lack of funding for processes that contribute to the formation of basic conditions for the transition from a conventional economy to a smart economy.

### ***Research Focus***

Based on studies of statistical information, a hypothesis is put forward about the presence or absence of a positive correlation between the number of workers with information and communication skills and the percentage of operations carried out in the real sector of the economy using digital tools, since this indicator is the main one for achieving a strategy of innovative progress in the conditions of formation and development of a national smart business model of the economy. The selected indicators are relevant since the share of transactions in the economy carried out using digital tools depends on the number of specialists proficient in ICT.

### ***Research Aim and Research Questions***

The purpose of the study is to identify the relationship between infrastructural changes in the national economies of the countries of the European Union and the digitalization of the economy, which determines the degree of readiness of the economy for the transition to the smart economy model.

To establish this relationship, it is necessary to conduct a study on the development of information infrastructure in the European Union through the integration of statistical and geospatial information. It is also necessary to take into account the dynamics of demand in the labor market of EU countries for specialists with skills in working with information and communication technologies since the level of digitalization of the economy depends on the quality of labor resources. The reaction of the economy to digitalization is the percentage of transactions carried out in the real sector of the economy using digital tools, the level of which in the EU countries also needs to be studied. To assess readiness for active innovation, it is necessary to study the structure of investments, paying special attention to investments aimed at developing and purchasing software. The main purpose of the study is to test the presence or absence of a correlation between the number of workers employed in the economy of each EU country with skills in using information and communication technologies and the percentage of transactions carried out in the real sector of the EU economy.

In 2020 and 2021, for the first time, the countries of the European Union recorded the number of transactions in the real sector of the economy carried out using digital tools, but the dynamics of digitalization and the reasons on which this indicator depends have not been fully studied. The presented study is carried out to obtain basic information for correcting measures for the digitalization of the EU economy.

## **Literature Review**

With the growth of information flows, many authors consider the problems arising in the economy under the influence of increasing digitalization, studying ways to adapt the economy (Krykavskyy, Semchuk, & Moskvik, 2021). For example, Hilty and Aebischer (2014), Fagerberg, Mowery, & Nelson (2006) are considering the possibility of obtaining additional benefits from the introduction of innovative processes based on digital technologies (Aram, Baxter, & Nutkevitch, 2019). Other authors, such as Hilty and Aebischer (2014) assess the possibilities of forming the components of a smart economy as an objective necessity, which gives them reason to study national smart economy strategies as separate economic categories (Camilleri, 2021).

When studying the literature, it should be noted that such authors as Altman, Bayar consider the national model of the digital economy in isolation, without taking into account the mutual influence of economies in modern integration associations; the influence of globalization processes is also not taken into account, which does not allow for a detailed study of the formation of the national model of the smart economy (Altman, 2020). The authors Pascalau (2018), Gonzalez (2015), Trachenko et al. (2021) study the impact of digitalization on innovation processes without considering the prerequisites for the formation of the basis of a smart economy in the format of information infrastructure. In general, the literature does not provide an integrated approach to the process of creating basic conditions for the formation and development of a national smart economy model, which leads to the need to conduct such a study.

## **Materials and Methods**

Since the subject of the study is the relationship between digitalization and the smart economy model using the example of the European Union countries, the main source of data for the study is the data provided by these countries to the European Commission for subsequent processing and analysis. placement in the public domain (Chowdhry, Verma, & Mathur, 2020). All information used to conduct the study was obtained from open sources, and the study is a data analysis to establish the connection between digitalization and the national smart economy model that takes into account innovation processes (Bayar, 2019). Since digitalization and components of information infrastructure have been studied for a short period, the study examined all available data in this area, namely European Union projects on the integration of statistical and geospatial information from 2016 to 2020, the level of digitalization of operations in the real sector of the economy for 2020 and 2021. Data on the number of specialists with ICT skills were studied from 2015 to 2020, which was because when studying the correlation between the number of hired specialists and the level of digitalization of operations in the real sector of the economy, it is necessary to study the correlation between the number of hired workers in one year and the level of digitalization next year, and in 2020, some EU countries did not study the percentage of transactions in the economy using digital tools from the total number of transactions in the economy (Dias, Salmelin, Pereira, & Dias, 2018).

The study was carried out in several stages. The first stage of the study was the collection of information about European Union projects aimed at implementing the integration of statistical and geospatial information, since in a “smart” economy the necessary support for innovation processes is the availability of high-quality and accessible statistical data for prompt business decision-making (Yamarone, 2017). Since the study is aimed at comparing the conditions for the functioning of the smart economy in the European Union, all projects carried out in the EU were examined (Markovic & Alcchi, 2019). At the same stage, the needs of enterprises in all EU countries for specialists working with

information technology were studied for the period from 2015 to 2020. Based on the results of the study of the number of required specialists, a general analysis was carried out for all EU countries (Annushkina and Regazzo, 2020). According to Eurostat, an analysis was carried out of the number of transactions in the business sector in the countries of the European Union carried out using digital means, using ranking to identify countries in which the average level of digital transactions is below the average for the European Union, and countries in which this indicator is higher (Wilson, 2016). At the next stage, data on various areas of costs for investment activities, including the purchase of software, were studied (Hunukumbure, Coon, Allen, & Vernon, 2021). The percentage of the gross domestic product allocated to investment activities has been determined, and countries have been identified that have overcome the percentage barrier in the cost of purchasing software from the total level of investment costs.

At the third stage of the study, using the standard “correlation” tool of Microsoft Excel software (Tsounin & Vlachvei, 2020), the correlation was checked between the data array on the number of information technology specialists hired in 2020 and the data array on the share of operations performed at enterprises in 2021 with using digital technologies (Jung, 2014). When conducting a correlation analysis, the correlation coefficient is determined for two given data sets; therefore, when conducting similar studies, it is not fundamental to select the specified arrays strictly in the order in which they are described above (Yanokovyi, Koval, & Dudka, 2021).

### ***Sample and Participants***

The selection of information was carried out according to two types. To carry out the first stage of the study, an analysis was carried out of European Union projects aimed at integrating statistical and geospatial information separately for 2016, 2017, 2018, and 2020. Since no projects were initiated in 2019 due to restrictions caused by the COVID-19 pandemic, the data on projects is not continuous. The selection was carried out according to information from the European Commission. Data for studying the staffing of digitalization processes at enterprises in the countries of the European Union were obtained from open sources of information, namely from Eurostat, for the period from 2015 to 2020 for each country separately, and then general data were studied for all countries of the European Union. Similarly, data was obtained on the percentage of operations performed at enterprises in the European Union using digitalization tools for 2020 and 2021. Data on the gross domestic product of all countries of the European Union for 2021 were obtained from the World Bank website in US dollars (GDP (current US\$), n.d.). To obtain a percentage of the gross domestic product of investment costs, the gross domestic product was converted into euros. Data on the costs of various areas of investment activity were obtained from the Eurostat website.

### ***Instruments and Procedures***

The statistical observation method was used to collect data. Statistical observation was carried out in different time periods. The European Union's initiation of projects aimed at integrating statistical and geospatial information was monitored from 2016 to 2020. Observation of how enterprises in the countries of the European Union arose the need for specialists with skills in working with information technology was carried out over the period from 2015 to 2020. Observation of the percentage of transactions that are carried out in enterprises in the European Union using digital means. was conducted for the period 2020 and 2021. The study of cost structures in national economies for investments, including smart ones, was carried out based on the results of 2021, as well as monitoring the resulting gross domestic product.

### ***Data Analysis***

Data were processed using tools such as summation, finding the average, and constructing ordered series. Since the study is carried out to identify the strengths and weaknesses of preparation for the transition to a smart economy for the countries of the European Union, the selected methods will make

it possible to fully carry out this comparison. Taking into account the fact that the study uses the maximum possible volume of data, the study will provide complete and reliable information on the state of preparation of the economies of the European Union countries for the transition to a smart economy. The study presents infographics obtained from the analysis of statistical information (Gonzalez, 2015). The infographics were created using standard Microsoft Excel tools (Trachenko et al. 2021). Since the selected methods are not forecasting in nature, but concentrate on processing data provided by countries independently at the disposal of the European Commission for subsequent free publication, the level of confidence in the research results is comparable to the level of confidence in statistical information in the European Union (Kryvovyazyuk, Vakhoviych, Kaminska, & Dorosh, 2020). To establish the presence or absence of a correlation between the number of hired workers with information and communication technology skills in 2020 and the share of production operations performed using digital tools in 2021, the “correlation” function in Microsoft Excel was used.

## Results

To ensure the functioning of national smart economy models, it is important to have an appropriate information infrastructure in the state. An important task for any state is information support for the functioning of the economy, which makes it possible to make decisions in the field of innovation. Information infrastructure is a set of information coming from its sources, means of storing and processing information. To streamline the development of information infrastructure within the European Union, 29 projects were initiated between 2016 and 2020 (Table 1). Finland became the leader in the number of projects aimed at integrating statistical and geospatial information. in which 4 projects are being implemented, three projects each are being implemented in the Netherlands and Norway, two each in Denmark, Poland, and Sweden, and the rest of the EU countries are implementing one project each.

**Table 1**

*Projects to integrate statistical and geospatial information*

Year	Country	Total number of ICT workers, 2015-2020	Expected completion date of the project					
			2018	2019	2020	2021	2022	2023
1	2	3	4	5	6	7	8	9
2016	Greece	39.3	Oct.					
	Italy	32.8	Oct.					
	Netherlands	66.3	Dec.					
	Finland	64.2		Jan.				
	Slovakia	34.6		Feb.				
2017	Netherlands	66.3		Oct.				
	Denmark	75.8		Dec.				
	Croatia	46		Dec.				
	Poland	30.7		Dec.				
	Finland	64.2		Dec.				
	Norway	41		Dec.				
	Estonia	49.1			March			

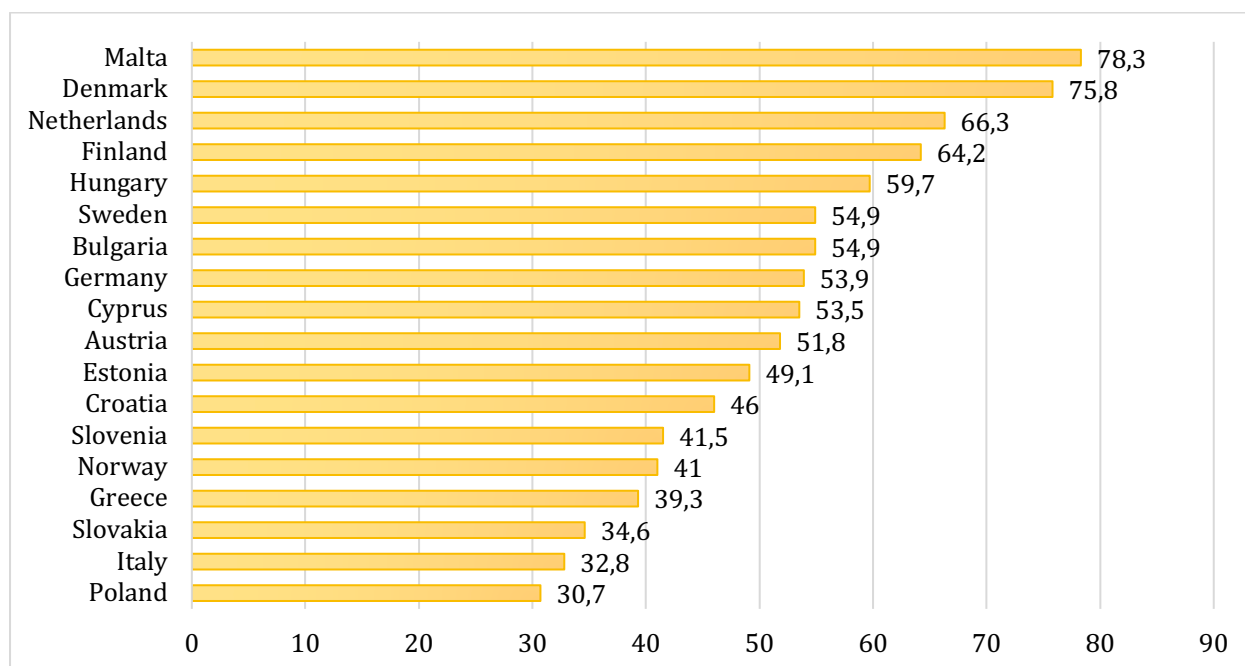
	Austria	51.8			March			
2018	Cyprus	53.5			July			
	Poland	30.7			Dec.			
	Finland	64.2			Dec.			
	Norway	41			Dec.			
	Sweden	54.9				Feb.		
	Denmark	75.8				June		
2020	Austria	51.8					July	
	Finland	64.2					Oct.	
	Germany	53.9					Dec.	
	Slovenia	41.5					Dec.	
	Sweden	54.9					Dec.	
	Norway	41					Dec.	
	Malta	78.3					Dec.	
	Bulgaria	54.9						Jan.
	Netherlands	66.3						Jan.
	Hungary	59.7						Feb.

*Source:* Author's development by (Eurostat, Enterprises that recruited or tried to recruit ICT specialists by size class of enterprise, 2021).

Table 1 shows the results of studying the timing of project implementation, which indicates the desire within the European Union to create complete information support for the functioning of the smart economy model. In the process of formation and development of the information structure, personnel changes are necessary, and therefore enterprises in the real sector of the economy will need specialists with skills in working with information and communication technologies. Having examined the number of requests for specialists in countries participating in projects for the integration of statistical and geospatial information, it was found that during the period from 2015 to 2020, the number of requests for relevant specialists was generated, shown in column 3 of Table 1. Figure 1 shows the ranking of countries by the number of requested specialists with information and communication technology skills.

**Figure 1**

*General request for the number of workers with ICT skills in project countries for 2015-2020*



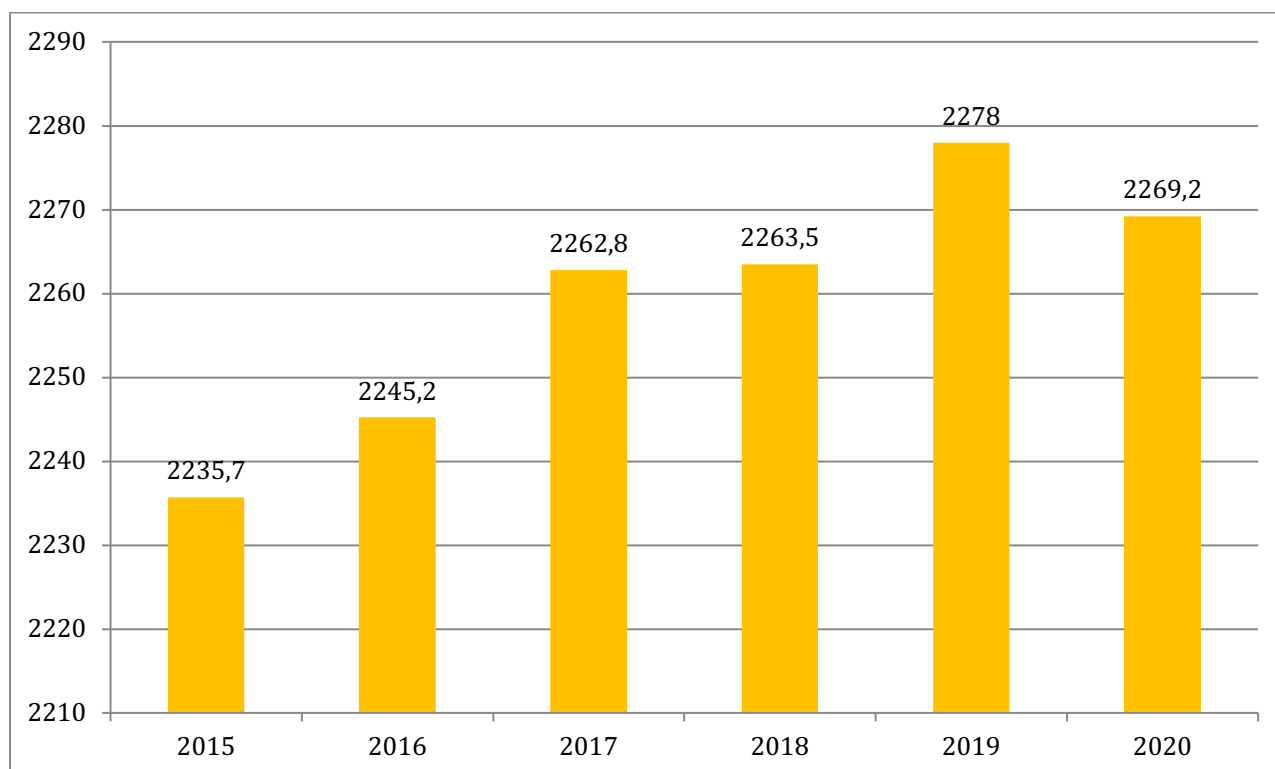
*Source:* Author's development by (Eurostat, Enterprises that recruited or tried to recruit ICT specialists by size class of enterprise, 2021).

During the period from 2016 to 2020, only 16 countries of the European Union participated in projects to integrate statistical information and geospatial information, which indicates that the foundations of the smart economy are partially formed within the European Union. In these 16 countries, based on the results of observation for 20115-2020, the largest number of specialists with skills in working with information and communication technologies was required in Malta (78.3 thousand workers), and the smallest number in Poland (30.7 thousand workers), and in Poland, which has an area 990 times larger than Malta, 2.55 times fewer specialists are required than in Malta. Consequently, there is a disproportion between the level of development of information infrastructure within the European Union.

In total, all countries of the European Union are experiencing ambiguous changes in the demand in the labor market for specialists with skills in working with information and communication technologies. Figure 2 presents general data for all countries of the European Union, both those participating in projects to integrate statistical and geospatial information and those not participating in them.

**Figure 2**

*General request for the number of workers with ICT skills in EU countries for 2015-2020*



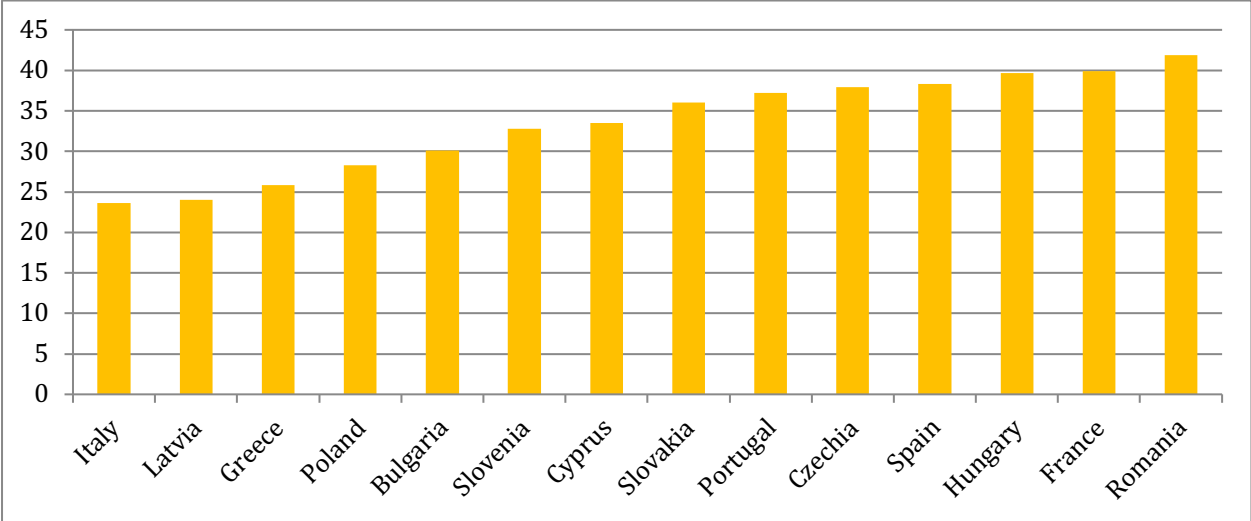
*Source:* Author's development by (Eurostat, Enterprises that recruited or tried to recruit ICT specialists by size class of enterprise, 2021).

During the period from 2015 to 2019, there was an increase in demand for specialists with skills in working with information and communication technologies, and in 2020 there was a decrease in demand compared to 2019 by 2%. Taking into account the fact that there is a constant expansion of the information field and improvement of the information infrastructure, in the absence of appropriate staffing, the processes of forming the foundations of a smart economy will not proceed with the necessary intensity, which gives grounds for reducing innovative components, due to the lack of adequate information support for strategic innovative activities.

Another important component of the impact of digitalization on national smart economy models is operations carried out in the economy using digital tools. In the European Union, until 2020, and in some countries until 2021, no research was carried out on the digitalization of manufacturing operations. If we consider the share of transactions carried out using digital means, we can determine the degree of involvement of digital tools in the real sector of the economy. In 2021, the average percentage of transactions in the European Union economy carried out using digitalization tools was 43%. Several European Union countries have this indicator much lower, as shown in Figure 3.

**Figure 3**

*EU countries in which the share of transactions carried out using digital tools is below the EU average*



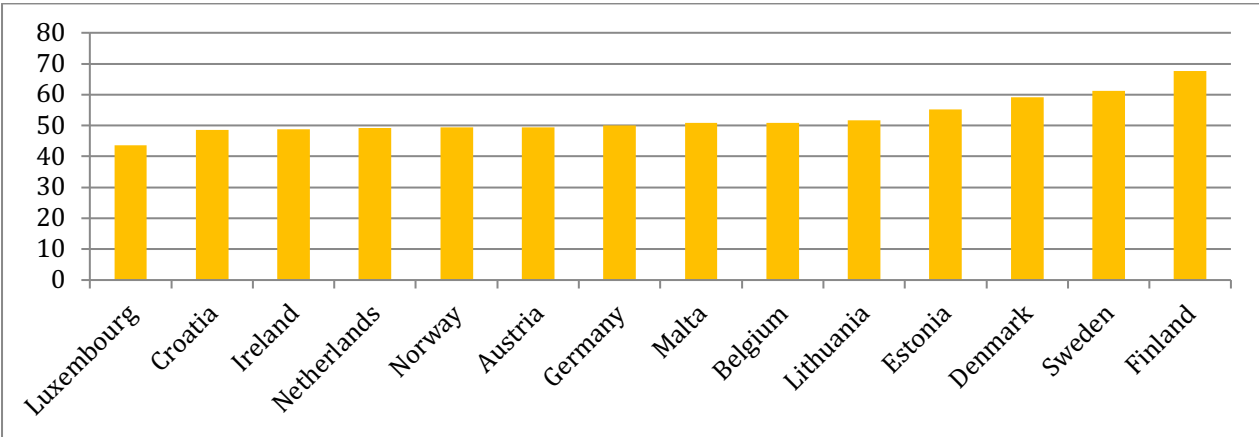
*Source: Author’s development by (Eurostat, Enterprises - ICT functions performed by size class of enterprise, 2021).*

Among those countries that have a lower percentage of digitalization of operations in the economy. than the average for the European Union, countries that either have not initiated projects to integrate statistical and geospatial information at all or are working on only one project. Consequently, the information infrastructure of these countries is less prepared to achieve innovative progress within the framework of the smart economy, compared to those countries that pay more attention to the issues of creating a high-quality basis for the smart economy.

Figure 4 shows countries for which the share of transactions in the economy carried out using digital tools is higher than the European average. Among these countries, those that are actively working on the continuous improvement of information infrastructure are countries in which there is a constantly high demand in the labor market for specialists with skills in working with information and communication technologies, that is, those countries in which all the conditions have been created for achieving strategies innovative progress within the framework of national smart economy models.

**Figure 4**

*EU countries where the share of transactions carried out using digital instruments is higher than the EU average*



*Source: Author’s development by (Eurostat, Enterprises - ICT functions performed by size class of enterprise, 2021).*

The creation of conditions for the emergence and development of a smart economy is determined not only by the presence of information infrastructure components but also by the degree of willingness of investors to invest in the development of existing digitalization tools, including software development. In general, the formation of comfortable conditions for innovative progress is determined by the presence of free investments. To determine the level of investment support in the countries of the European Union, a study was conducted on the areas of investment that were made in the countries of the European Union in 2021. The following areas of investment were considered: Sales proceeds of tangible investment, Gross investment in intangible non-current assets, other than goodwill, Expenses of long term rental and operating leases, Investment in purchased software. Table 2 shows the research results. Column 2 of Table 2 shows the gross domestic product in billions of euros for 2021, columns 3-6 of Table 2 show the costs for each of the specified areas of investment, column 7 shows the total investment indicator for each country, and column 8 shows the percentage of investment costs from gross domestic product. It should be noted that the percentage of investment costs does not exceed 1%, which means little attention to investment activities to form the basis for a smart economy.

**Table 2**

*Investment costs in EU countries, 2021*

Country	GDP, bil.euro	Sales proceeds of tangible investment, mil.euro	Gross investment in intangible non-current assets, other than goodwill, mil.euro	Expenses of long term rental and operating leases, mil.euro	Investment in purchased software, mil.euro	Total investment, mil.euro	% from GDP	% investment in software from total investment
1	2	3	4	5	6	7	8	9
Belgium	508.24	10.76	3.44	15.4	4.04	33.64	0.007	12.01
Bulgaria	71.08	7.77	4.92	8.03	2.73	23.45	0.033	11.64
Czechia	238.34	21.64	74.33	37.92	7.25	141.14	0.059	5.14
Denmark	343.13	14.04	0.01	12.21	1.98	28.24	0.008	7.01
Germany	3620.02	106.76	10.63	127.38	7.56	252.33	0.007	3
Estonia	31.18	2.35	0.5	0	0	2.85	0.009	0
Ireland	434.23	88.93	0	1.91	9.34	100.18	0.023	9.32
Greece	181.57	4.22	4.64	5.69	0.46	15.01	0.008	3.06
Spain	1226.41	46.77	34.46	44.85	1.41	127.49	0.01	1.11
France	2503.57	313	0	56.47	0	369.47	0.015	0
Croatia	58.87	1.1	0.01	0.92	0.02	2.05	0.003	0.98
Italy	1818.47	23.54	0.34	6.02	3.99	33.89	0.002	11.77
Lithuania	56.5	3.09	2.59	1.2	0.2	7.08	0.013	2.82
Luxembourg	72.38	3.14	0.03	2.55	0.02	5.74	0.008	0.35
Hungary	154.03	4.33	0	0.46	0.1	4.89	0.003	2.04
Malta	15.33	0.04	0	0.03	0	0.07	0	0
Netherlands	871.17	12.9	11.31	138.18	5.17	167.56	0.019	3.09

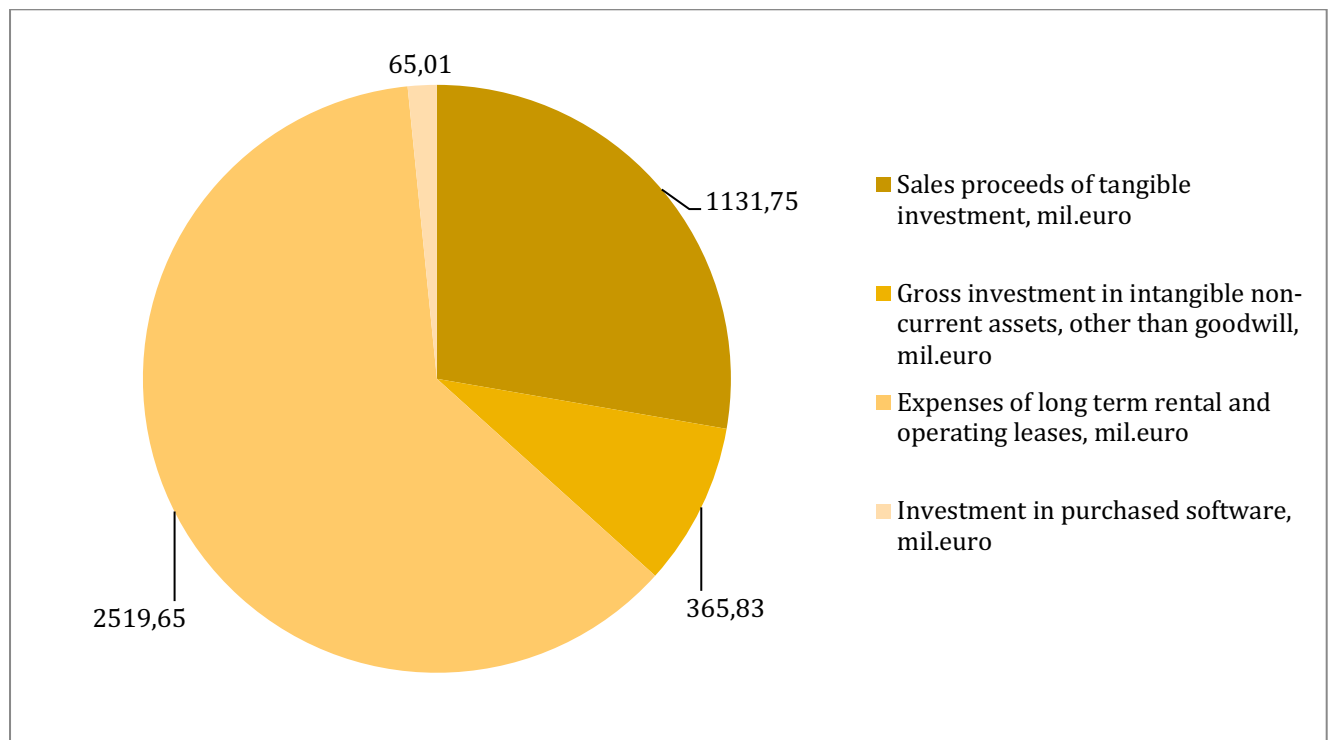
Austria	893.16	13.51	1.77	87.14	7.91	110.33	0.012	7.17
Poland	576.29	85.66	93.46	18.86	2.97	200.95	0.035	1.48
Portugal	216.13	27.88	0.66	0	0.05	28.59	0.013	0.17
Romania	241.74	6.51	7.11	0.32	0.93	14.87	0.006	6.25
Slovakia	100.28	3.59	-0.05	0.38	0.13	4.05	0.004	3.21
Finland	250.75	26.5	115.67	15.78	6.26	164.21	0.065	3.81
Sweden	541.07	14.82	0	-19.67	0	-4.85	0.001	0
Norway	425.75	288.9	0	1957.62	2.49	2249.01	0.528	0.11

Source: Author's development by (Eurostat, Investment, expenditure and purchases of enterprises by NACE Rev.2 activity, 2021).

When considering the total costs for these types of investment activities, as shown in Figure 5, the smallest amount of investments are directed to the development and purchase of software, which can create conditions for underfunding of digitalization operations, especially in terms of innovation activities.

**Figure 5**

Total investment costs, 2021

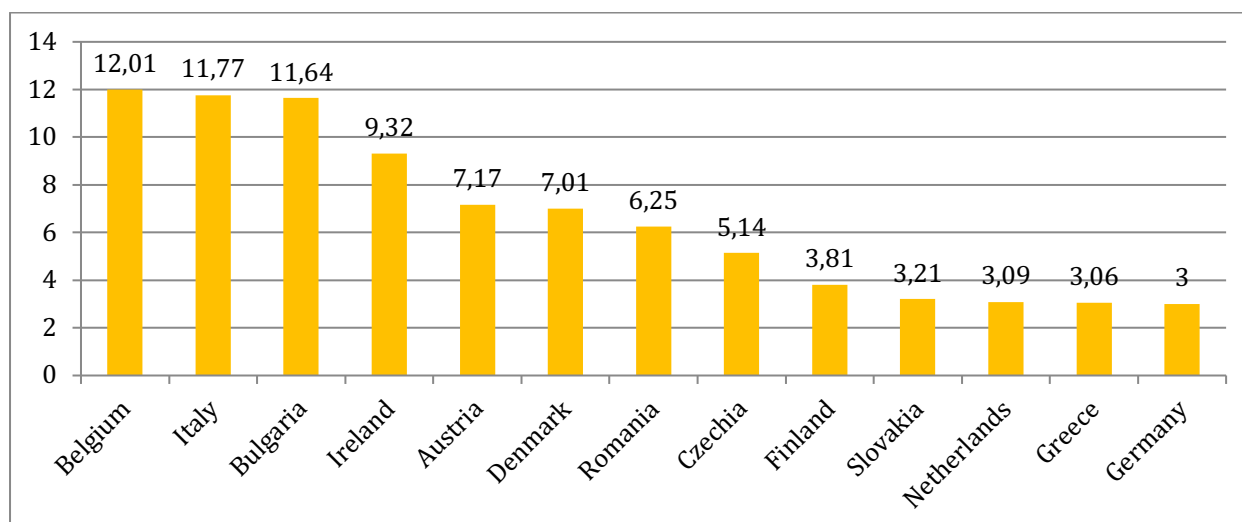


Source: Author's development by (Eurostat, Investment, expenditure and purchases of enterprises by NACE Rev.2 activity, 2021).

However, column 9 of Table 2 shows the percentage of total investments allocated to software development and procurement. Among the countries of the European Union, there is a mixed picture of the allocation of investment funds to software. Some countries did not allocate funds for the development and purchase of software at all in 2021 (Estonia, France, Malta, and Sweden). Other countries have different levels of funding in this area.

**Figure 6**

*Countries where more than 3% of investment costs go to software*



Source: Author's development.

Figure 6 shows those countries in which in 2021 the volume of investments aimed at the development and acquisition of software exceeded 3%. Consequently, these countries are considering a broader problem of forming the basis for national smart economy models.

The importance of creating conditions for the digitalization of the smart economy can also be demonstrated by determining the correlation between the number of specialists invited in 2020 with skills in working with information and communication technologies and the percentage of transactions that were performed using digital technologies in the countries of the European Union in 2021. According to the previously reviewed data, this correlation coefficient was 0.58, which means there is a direct and moderate relationship. Thus, increasing the involvement of digital components in national smart economy models is possible only if there is a well-prepared information infrastructure.

## Discussion

The presented study was aimed at identifying a positive relationship between the number of hired ICT specialists and the number of operations in the real sector of the economy performed using digital tools. As a result, a positive correlation coefficient (0.58) was obtained, which indicates the reliability of the hypothesis put forward.

According to the results obtained, the degree of formation of the basic conditions for the transition to national smart economy models in the European Union countries has a number of significant differences in countries with different approaches to digitalization and innovation (Chan, 2015). Overall, when determining the correlation between the number of people hired with information and communication technology skills in all EU countries in 2020 and the percentage of transactions carried out in the real economy using digital tools in 2021, a moderate positive result was obtained. connection, since the correlation coefficient was 0.58. The resulting correlation coefficient indicates that the increased digitalization of the economy is a consequence of the development of information infrastructure.

The study showed that in the period from 2016 to 2020, infrastructural preparations were underway in the European Union for the transition to a "smart" economy, which consisted of initiating and implementing projects aimed at integrating statistical and geospatial information. Over the 4 years from 2016 to 2018 and in 2020, 29 projects were initiated in 16 EU countries, which made it possible to create basic conditions for a comfortable transition to national smart economy models. The initiation of infrastructure projects is the goodwill of EU governments, and the unevenness in the initiation of

projects to modernize information infrastructure indicates a difference in the understanding of priorities in different countries. The development of information infrastructure also occurs through the development of information and communication skills of labor resources. During the period from 2015 to 2020, 13,551.4 thousand specialists with information and communication skills were hired in the European Union, which indicates that the basis of national smart economy models is supported by labor resources capable of achieving the goals set by national strategies. for innovative progress.

A study of the components of investments that are carried out in all countries of the European Union, it should be noted that they do not meet the needs of a modern smart economy, especially in the field of software development and acquisition. At the end of 2021, four EU countries recorded a lack of investment in software, and in 13 countries, investment in software ranged from 3% to 12.1% of total investment. Thus, despite the systematic attraction of information and communication skills into the economy of labor resources, there is insufficient funding for the development of specialized software, which can become the main direction of innovation activity to achieve the goals outlined by the strategy of innovative progress. If we evaluate the degree of preparedness of the basis for the free functioning of the national smart economy model, then, according to the results of the study, the most prepared in terms of the creation and development of information infrastructure, providing it with labor resources and investments are EU countries such as Luxembourg, Croatia, Ireland, the Netherlands, Norway, Austria, Germany, Malta, Belgium, Lithuania, Estonia, Denmark, Sweden and Finland, in which the level of economic development and awareness of the problems of the need for transformation in the information infrastructure is higher than in other countries.

Considering the degree of development of systems for integrating various sources of information, the level of provision of personnel qualified in the field of information and communication technologies, based on the results of an analysis of the structure of investments and readiness to use digital technologies in economic processes, EU countries such as Italy are the least prepared for the normal functioning of the smart economy , Latvia, Greece, Poland, Bulgaria, Slovenia, Cyprus, Slovakia, Portugal, Czech Republic, Spain, Hungary, France and Romania. Although the current state of the economy of some of these countries is very successful, there are structural threats to the prospects for the smart economy in these countries, which may manifest themselves in insufficient resources to support the smart economy. or in their low quality, which can manifest itself both in the workforce in the form of insufficient knowledge of information and communication technologies, and in the technical side in the form of untimely investments in intelligent systems.

Having considered the results obtained, it should be noted that authors such as Christiansen, Sysoeva, Udovikina, and Ketova (2018) focused on the lack of investment in software in the countries of the world as a whole. In turn, authors such as Popkova, Ragulina, and Bogoviz (2018) argued that one should not focus on the information and communication skills of workers, since this requirement corresponds to modern times, however, due to the specificity of information and communication skills in the field of real production, the authors of this article focus on that these skills are specific to different industries and should be studied more carefully(Popkova, Ragulina, & Bogoviz, 2018).

The conducted research can be used to analyze the readiness of national economic systems for an active transition to a smart economy model; it is also possible to use the research results to adjust the information infrastructure available in the countries of the European Union, which must be done to achieve innovative development strategies (Stefan, 2021).

Since the study was conducted on various statistical data from 2015 to 2021, the limitations made in this study are due to the COVID-19 pandemic; When analyzing the relevant data, it was taken into account that in a number of cases data for 2019 were missing. If measures to modernize the information infrastructure had not been interrupted in 2019, the level of preparedness for the transition to a smart economy in the countries of the European Union would have been higher, which could have a positive impact on the level of digitalization of operations in the real sector of the economy in all countries of the

European Union. In the future, the presented research needs to be continued, since significant disproportions have been identified in the formation and development of the information infrastructure of the national economies of the European Union countries, which does not contribute to a smooth transition to a smart economy.

### **Conclusions and Implications**

The study revealed that there is a direct positive relationship (0.58) between the component of providing information infrastructure, namely the number of hired specialists with skills in working with information and communication technologies, and the component resulting from the formation of a smart economy, namely the percentage of transactions performed in real sector of the economy using digital tools. The scientific novelty of the research is the development of methodology for determining the relationship between the components of the information infrastructure and digitalization in the economy. Consequently, the development of information infrastructure will contribute to a smooth transition from the traditional economic model to the “smart” economy.

Limitations of this study include the narrow time frame from which the study was informed. Since the amount of data obtained does not make it possible to obtain a correlation between the number of specialists hired with information and communication technology skills and the percentage of transactions in the real sector of the economy carried out using digital tools.

### ***Suggestions for Future Research***

Considering the prospects for further expansion of the study, emphasis can be placed on expanding the research base of information infrastructure components. Official statistics of the European Union, as well as statistics of many countries, do not take into account virtual products, which also can influence the functioning of the smart economy. When considering a smart economy, two sectors of the economy are subject to research: real and virtual. The virtual sector of the economy is much more involved in the formation and development of information infrastructure than the real one, which motivates a broader study of their mutual influence.

Another potential direction for expanding the conducted research could be the study of ways to modernize information infrastructure to maintain an optimal quality level for the functioning of national smart economy models. This direction of research is because technologies in the field of information and its processing are rapidly updated, which makes it necessary to constantly update existing information resources.

When conducting further research, it is also necessary to expand the research base for the investment activities of countries, since in addition to investments in the development and purchase of software, investments in technology are subject to research, used in virtual sectors of the economy, which are often not considered in official statistics.

In general, the formation and development of a smart economy will always be accompanied by the need for innovation, which will lead to a constant need to study the mutual influence of current digitalization tools and the level of implementation of the smart economy.

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