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PERSPECTIVES OF DIGITAL AND IT DEVELOPMENT: MODELING FOR EU COUNTRIES

Digital Technologies radically change traditional business models and principles of work organization. Due to data of World Economic Forum [1], 85 % customer/citizent engagement in 2020 is done without human interaction. 65 % of today's children will work on new jobs types, that are currently don't exist yet. 57 % of jobs are at risk of automation. 80 % of business leaders pointed out, that the digital way of working is a main enabler to company success [1]. Successful companies at the current stage of development of mechanisms of digital transformation. Digital transformation changes the usual business models and affects changes in society.

The underlying technologies that have made all of this possible (such as mobile devices, cloud computing, sensors, analytics, the Internet of Things (IoT), or artificial

intelligence (AI) also cause combinatorial effects that accelerate progress exponentially. This is the context in which digital innovation is now disrupting business and operating models and having a profound impact on society.

European Union met significant challenges in global digital transformation: increase of competitiveness from third counties, defence and security risks, strategical dependency from third (North America and Pacific Asia) countries [2].

The new Industrial Strategy for Europe is based on dual green and digital transition. The dual transition will help industry reduce its carbon footprint by providing affordable, clean technology solutions and new business models. Taking into account the lessons of the COVID-19 pandemic, the Industrial Strategy is aimed at accelerating the green and digital transition, noting the leadership potential of companies striving for sustainability and digitalization [1].

The Information Technology area is a rather young industry for Ukraine. However, over 25 years of experience, IT-companies accumulated plenty of experience and gained a good reputation in the international market. This economy sector continues to show high growth dynamics (about 20% annually), develop, and deepen cooperation with customers from all over the world [3].

The IT sector of Ukraine is quite diverse: it consists large number of small and medium-sized companies – most of IT firms have less than 80 specialists. Half of the companies are service companies, and every third has its own product and provides services [4]. Global digitalization trends make it possible to cooperate with any industry. Outsourcing is very popular trend among Ukrainian IT sector.

Exports of IT services are growing faster than the exports of any other goods or services. In 2020, the IT sector in Ukraine generated: twice as much export revenue as the gas transmission system. 1.5 times more export revenue than the mechanical engineering industry. About a quarter of the export revenue of the agricultural sector (table1).

Export of computer services from Ukraine increases on average by 27% annually. For 4 years the receipts have doubled, and this trend continues. The main growth drivers are the USA (40% of exports) and Great Britain (10%)

Table 1 – Dynamics of IT export from Ukraine to defined countries

Partner country for IT export from Ukraine	Top IT services export partners for Ukraine, mln USD	
	2016	2020
USA	685	2007
Great Britain	153	503
Switzerland	127	111
Malta	110	304
Israel	94	238
Cyprus	70	205
Germany	67	197
Canada	65	98
Denmark	42	93
Netherlands	42	108

Source: constructed on data [3]

In 2020, the IT sector generated: Exports of IT services are growing faster than the exports of any other goods or services *forecast 24.7% 13.2% 8.9% 0.3% -0.8% -0.9% Computer services Mineral products Foods and raw materials Mechanical engineering products Metals and metal products Transport Twice as much export revenue as the gas transmission system. 1.5 times more export revenue than the mechanical engineering industry. About a quarter of the export revenue of the agricultural sector.

As of January 1, 2022, 54.2 % of households and 61.8% of enterprises in Ukraine had fixed access to the Internet. The share of lines with speed from 30 to 100 Mbit/s – 59.7%, from 100 to 1 Gbit/s – 24.7%, over 1 Gbit/s – 1.2 %. In the Speedtest Global Index rating (as of May 2022), Ukraine ranks 70th, in terms of (median) speed of fixed broadband access and 80th – mobile [4].

Before the full-scale offensive of Russia, the IT industry was in third place in terms of the growth rate of export turnover after the agro-industrial complex and metallurgy. At the same time, at the beginning of February 2022, the IT industry reached the highest monthly export rate in the history of the Ukrainian IT market – $839 million, which is 43% more than in the same period of 2021 ($480 million).

Of course, the war affects the economic characteristics of the IT industry. But, as we can see on the example of the results for the 1st quarter of this year, Ukrainian IT sector is one of the most stable. And now the whole industry is working to maintain and improve indicators [5].

Ukraine's IT sector has adapted, responding to these challenges. Since the invasion, Ukraine's Ministry of Ministry of Digital Transformation has pivoted to take the lead in cyber-defense. Many Ukrainian software developers have mobilized into an "IT Army" of several thousand strong that has begun targeting Russian institutions. And while the war has devastated the local economy and disrupted global supply chains, Ukraine's service-based software industry has remained resilient, turning to teleworking and relocating work abroad as and when needed [5].

But it is already necessary to plan actions for the post-war reconstruction and restoration of economic and social life. That is why many international agencies and institutions, including IMF, World Bank, Lugano conference proposed step-by-step strategies for Ukraine after the war, and the central place in these strategies is occupied by digitization as one of the main drivers of development and tool to perform better than even before.

On July 4-5, 2022, the Recovery Conference of Ukraine was held in Lugano, at which the Recovery Plan of Ukraine was presented. According to this plan, post-war reconstruction consists of three phases: reform, resilience and recovery. The main characteristics of planned recovery actions are shown at figure 3 [5].

Due to recovery vision, there are two strategic imperatives for post war reconstruction: EU integration & access to G7 markets and National Security. To realize these strategic objectives, two enablers are used: business-enable environment and macro-financial stability. Three transformation engines are: priority sector transformation, strong human capital and effective infrastructure. Also there are two strategic vectors of development: green deal and digitalization. The main priority sectors due to Recovery Plan are: defence and security sector, metallurgy and machinery, agriculture, IT [5].

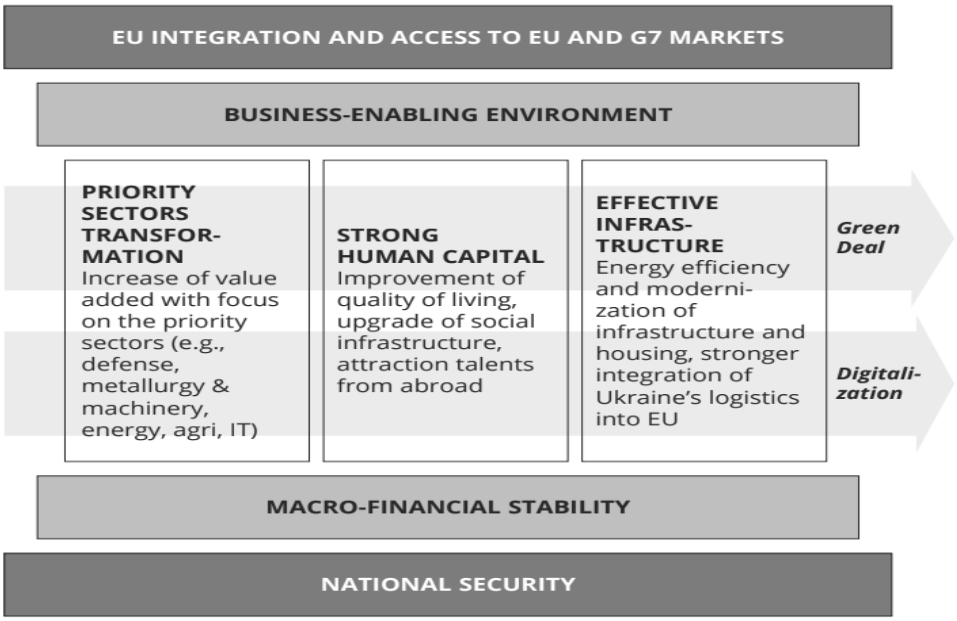


Figure 1 – The strategic vision of Recovery Plan

Source: [5]

Through this plan, social, economic, environmental and infrastructural recovery from the damage and loss caused by the war should take place. And one of key vector of development is digitalization, based on powerful Ukrainian IT sector.

Participance in «Digital Europe» Programm can support digital development in Ukraine. Ukraine joined the «Digital Europe» program until 2027. It provides financing

for the digitalization of European countries in various directions. The goal of «Digital Europe» is to accelerate economic recovery and digital transformation. Participation in the program will bring Ukraine closer to the EU's Single Digital Market.

But a lot of authors defined a difference in digital development of European countries. In studies [2-6] leading positions of North European countries in digital development is pointed out.

The purpose of current investigation is to model digital and IT-sector development on case of EU-countries for 2017-2021.

For modeling digital and IT development among EU-members the principal component analysis was used. The main function of PCA is to reduce the quantity of initial variables, defining the most significant ones, that explain most of total variance in data.

This method was chosen because of the large number of initial variables. PCA will allow to highlight the most important variables and evaluate the progress of individual countries not according to many separate criteria, but within several synthetic factors (main components) [7].

Indicators characterizing digital development and IT parameters of the sphere and sectors of high-tech production were selected as initial variables.

The data sample contains for EU countries for 2017-2021 (total 140 cases) on the basis of Eurostat data [8].

Initial variables includes: HSIC – high speed Internet coverage, % of households; FBC – share of households, that have fixed broadband connection,%; IntUs – Internet users, percentage of population, %; Mobsub – mobile subscribers per 100 inhabitant; DSbasic – percentege of individuals with basic or above basic overall digital skills; ITGDP% – share of IT sector in GDP, %; HTExp – exports of high technology products as a % of total exports; ITstaff – employed ICT specialists – total (in % of total employment).

To use PCA, the initial data was standardized. Calculation were provided by Statistica software.

Due to PCA, a new space (factor space) is generated onto which the cases and the variables can be projected and classified into categories. In PCA, basically, the straight lines are sought that best fit the clouds of points in the vector spaces (of variables and cases), according to the least squares criterion. This in turn yields the principal components (factors) that result into the maximum sums of squares for the orthogonal projections. Consequently, a lower dimensional vector subspace is recovered, that represents the original vector space. Although the first factor is extracted so as to capture the variance to the maximum extent. What remains should, therefore, be recovered by another (second) factor, third [7].

The main results of PCA modeling are representing at Fig. 1. The first factor explaine 48.18% of total variance and represent a combination of such variables (positively correlated with factor 1): DSbasic, IntUs, FBC, ITstaff. Two variable represent second and third factors: HSIC and Mobsub. Second factor explain 20.12% of total variance, third – 18.54%/ At sum? Three factor explain 86.85% of total variance of data. PCA defined two variables, that weakly correlate with factors 1,2 and 3 – ITGDP% and HTExp. Such variables explain the rest of variance and do not influence on general results.

Mathematically speaking, a principal component is a linear combination of the variables that are most correlated with it. This further implies that the factor coordinates of a variable are the correlations between the variable and the factor axes [7]. Accordingly, interpretation of the principal components must be done in terms of the correlation. On the basis of PCA results (Fig. 2), such interpretation of factors can be proposed:

– Factor 1: share of internet users and IT specialists with basic or above basic digital skills, that have fixed broadband internet connection;

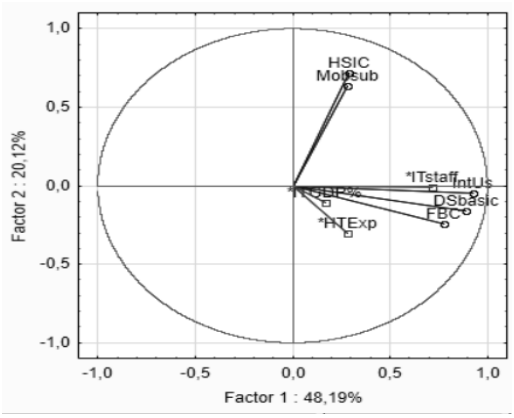
– Factor 2: high speed internet coverage and mobile subscription;

– Factor 3: high speed internet coverage, excluding mobile internet subscribers

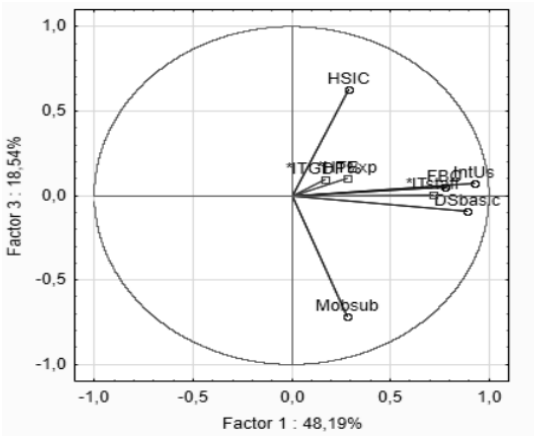
At Figure 2 Projection of cases on the factor-plane is shown/ Due to standardized data, the positions of cases represent greater than EU average or less than EU average

value of factors. On graph, each country has its own trajectory, associated with her data 2017-2021 projections on factor-plane. An arrow indicate the direction to the last case for 2021.

But projection of cases on the factor-plane (Fig. 3) creates a clouds of data without identification of progress for defined countries. On the basis of projection of cases on factor-plane trajectories of individual European countries regarding digitization and IT development were defined (Fig 4).



a)



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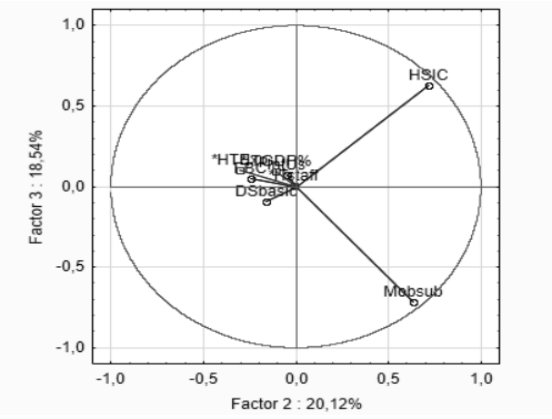

c)

Figure 2 – Projection of variables on factor-plane for combination of factors: Factor 1 with Factor 2 (a), Factor 1 with Factor 3 (b), Factor 2 with Factor 3 (c)

The factor-plane is divided on 4 quadrants. First – leading countries with values of factor 1 and factor 2 greater than EU average value. Second quadrant II have value of factor 1 (combination of IntUs, DSbasic, FBC and ITstaff) greater than EU mean, but value of Factor 2 (HSIC and Mobsub) less than EU mean. Quadrant III is the place for countries with Factor 1 less than EU mean, but factor 2 greater than average. Quadrant IV is assigned to EU-members with both Factors less than EU mean.

As represented at Figure 3, most of European countries improved their positions. Dynamics of the countries can be associated with 3 possible scenarios: vertical, horizontal or diagonal moving.

Horizontal moving indicate that a country change its value of variables, correlated with Factor 1: share of internet users and share of population with basic and above basic digital skills. Horizontal moving belongs to Bulgaria, Greece, Croatia, Romania, Slovenia and Slovakia

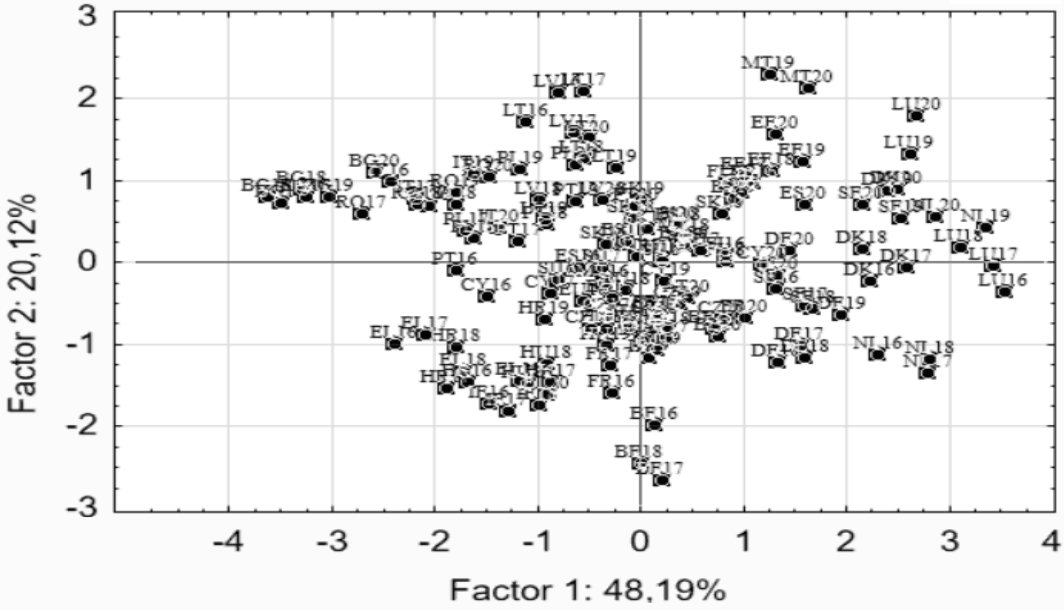

Figure 3 – Projection of cases on the factor-plane

Vertical moving indicate the progress of the country in improvement of variables of the second factor: HSIC (high-speed internet coverage) and Mobsub – quantity of

mobile subscribers per 100 inhabitants. Vertical moving is shown by Germany, Belgium, Netherlands, Luxemburg, Denmark, Finland.

Diagonal moving is characterized by improvement of two factors: associated with Digital competences (factor 1) and internet connectivity (factor 2). Countries, that have diagonal moving are: Malta, Ireland, Poland, Czechia, Cyprus, Sweden, Portugal. EU average value (red line) also represent such type of movement.

Most of European countries improved their positions at factor-plane during analyzed period. The most significant progress belongs to Ireland and Cyprus, who moved from IV quadrant in 2017 to the border of I and II quadrants. Among 8 countries, located at IV quadrant in 2017, only Croaria, Romania and Greece remain at it in 2021. This progress corresponds with the average EU level, that also moved through IV, II and I quadrants during 2017-2022.

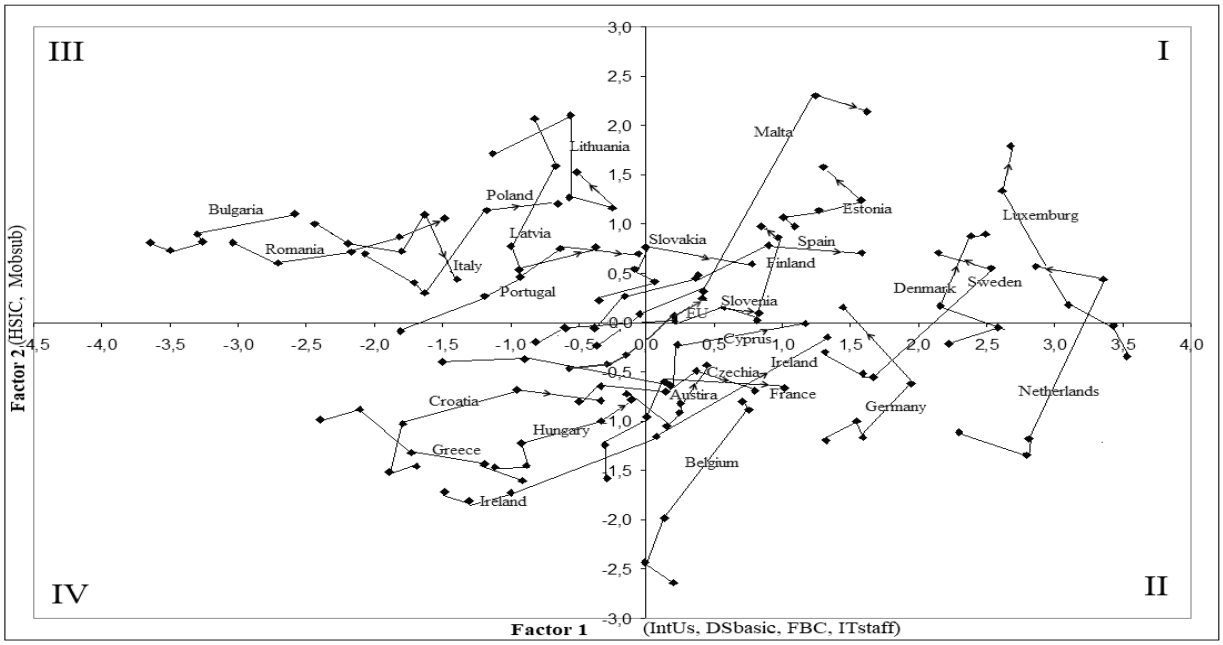

Figure 4 – Trajectories of individual European countries regarding digitization and IT development

On the basis of investigation some important conclusion should be made. An analysis of digital and IT sector development at European Union and Ukraine has

shown, that digitalization became a main driver for innovations and economic development, and plays an important role in nation strategies of post-pandemic recovery. For Ukraine digitalization can be the one of the key drivers of post war reconstruction in terms of balanced Ukrainian regulatory framework.

To model digital and IT development in European Union the principal component analysis was used. PCA allowed to define 3 groups of factors, that explain more then 80 % of total variance. Correlation of each variable with each factor define the structure of factors. Factor 1 can be interpreted as Digital competences and IT staff share, factor 2 – internet coverage with mobile subscription.

On the basis of PCA results the trajectories of individual European countries regarding digitization and IT development. Most of European countries improved their positions at factor-plane during analyzed period. This progress corresponds with the average EU level that also passed through IV, II and I quadrants during 2017-2021.

On the basis of analysis some conclusions about importance of such IT parameters as digital knowledge of population and infrastructure existence for Ukrainian post-war recovery.

According to the State Special Communications Service (as of the first half of June 2022), more than 20% of the electronic communications infrastructure was destroyed or damaged as a result of the war. Rebuilding infrastructure is also an opportunity to «build better», in particular according to the standards of the European Green Deal. It should be noted that international support tools, in particular the EU, such as Team Europe Initiatives (TEI), can be used to develop and restore broadband Internet access networks. The National Economic Strategy for the period until 2030 defines the goal of 95% of active high-speed Internet users among citizens.

IT sector can be a driver for economic development of the country and basis for digital transformation of industry, fintech, infrastructure and agriculture spheres. But IT sector needs balanced stable and constant legal and investment support.

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