

# **Economic consequences of artificial intelligence and labor automation: employment recovery, transformation of labor markets, and dynamics of social structure in the context of digital transformation**

ANASTASIYA TOKUNOVA<sup>1\*</sup>, VIKTOR ZVONAR<sup>2</sup>, DMYTRO POLOZHENTSEV<sup>3</sup>,  
VALENTYNA PAVLOVA<sup>4</sup>, OLESIA FEDORUK<sup>5</sup>

<sup>1</sup>Department of Economic and Legal Research of Economic Security Issues, State Organization "V. Mamutov Institute of Economic and Legal Research of the National Academy of Sciences of Ukraine", Kyiv  
UKRAINE

<sup>2</sup>Department of Economic Theory and Competitive Policy, Faculty of Economics, Management and Psychology, State University of Trade and Economics, Kyiv  
UKRAINE

<sup>3</sup>Department of Personnel Management, Labor Economics and Public Administration, Interregional Academy of Personnel Management, Kyiv  
UKRAINE

<sup>4</sup> Department of Entrepreneurship, Alfred Nobel University, Dnipro  
UKRAINE

<sup>5</sup> Department of Information and Document Communications, National University of Ostroh Academy, Rivne region, Ostroh  
UKRAINE

\*Corresponding Author: [anastasiya.to@gmail.com](mailto:anastasiya.to@gmail.com), <https://orcid.org/0000-0002-5870-2473>

*Abstract:* - Globalization, industrialization, and digitalization have led to structural changes in the economy and labor markets, affecting their internationalization, flexibility, labor mobility, and the emergence of new forms of employment. The purpose of the academic paper is to identify the economic consequences of digital transformation and automation of labor markets in the example of the EU-27 countries for the period 2013-2022. The structural-functional analysis was used in the academic paper to characterize and systematically study the economic consequences of digitalization and automation in the labor markets of the EU-27 countries. The functioning of the labor market in various EU-27 countries in the context of digital transformation is characterized by several features. The EU-27 labor markets are characterized by rapid employment recovery, especially during the pandemic and economic downturn in 2020, and employment revival in 2021-2022. In the Member States, a stable level of employment is generally observed; there is a decrease in the share of people with 0-2, and 3-4 educational attainment levels, while the share of people with 5-8 educational attainment levels is growing, and there is a stable growth in wages and incomes. Changes in the social structure of the employed by vocational and educational levels and qualifications in favor of increasing the importance and role of higher education have been revealed. Changes in forms of employment and the emergence of new forms of employment (sharing of workers and workplaces, temporary management, casual labor, ICT-based mobile work, voucher work, portfolio work, crowd employment, and collaborative work) have been identified.

*Key-Words:* - Digital transformation, Forms of employment, Labor automation, Labor markets, EU employment, Transformation of the EU labor market.

Received: March 5, 2023. Revised: November 2, 2023. Accepted: December 4, 2023. Published: January 25, 2024.

## 1 Introduction

The globalization of the world economy, advances in technology, and industrialization have influenced the internationalization of labor markets, their flexibility, increasing labor mobility, and the emergence of new forms of employment. Globalization, industrialization, and digitalization have led to structural changes in the economy, and increased demands on employees in the context of the permanent need to develop competencies. An additional factor in changes in the EU regional labor markets is the aging of the population, which has led to the need to attract labor resources from other countries as well as the need to develop a policy for attracting human capital.

The foregoing indicates the need for studying the following issues:

1. The impact of digital transformation and automation of labor through the introduction of technology on the functioning of the EU labor markets.

2. The impact of digitalization on the transformation of the EU labor markets, in particular, forms of employment, and social structure of labor markets (educational and qualification level, professions, employment by type of activity).

## 2 Literature Review

### 2.1 Labor market

In the research, the labor market will be considered as a system of social relations related to the purchase and sale of labor and the exchange of labor for remuneration, which includes institutions and social norms of ensuring generally established rights and freedoms of the individual, determined by the supply and demand of labor in the market [1]. The labor market is also defined as follows: “a system of relations between the employer and the working-age population on the conclusion of labor agreements (contracts) on the quantity, conditions, and remuneration of labor; between the population and public administration bodies on ensuring the right to carry out any economic activity, protection against discrimination in the field of labor, assistance and unemployment compensation” [2]. The labor market is also interpreted as a system of labor relations that reflects the level of social development and the balance of interests achieved at a given period between the subjects participating in the labor market: employers, employees, the state, trade unions, and intermediaries [3]. The allocation and reallocation of labor resources by the demand and

supply of labor is determined by the level of employment in the labor market; it is the phase of labor recovery. Labor force recovery involves providing the working-age population and the country’s labor resources with jobs and their employment.

The major factors in developing the labor market are as follows: demographic characteristics of the population, gender and age structure, professional and sectoral structure of the labor force, development of the labor market, labor motivation, and mobility of employees. The labor market is influenced by institutional support, including the infrastructure of the employment system, the network of employment centers, the system of training and retraining, the social protection of employees, and the system of social partnership, charitable foundations, and organizations [4].

Various models are used in practice to explain the structure and functioning of the labor market. The most famous of them are the classical (neoclassical) theory of the labor market, Keynesian, monetarism as an alternative to Keynesianism, and the model of a flexible labor market.

In the context of studying the digital transformation of the labor market and the dynamics of the social structure, it is expedient to consider in more detail the model of a flexible labor market. This model emerges due to the imperfection of the free labor market, which provides for territorial and sectoral labor mobility, remote flexibility (optimal concentration of labor resources of production and enterprises), and employment flexibility (maneuverability and flexibility of organizational forms of labor activity and employment), functional flexibility (interchange of employees with different professional skills) [5].

### 2.2 Digital transformation of the labor market

Digitalization as a process of digital transformation of the economy and society influences the movement of labor resources both within the country and on an international scale. The development of the knowledge-based economy and information society thanks to digital technologies has led to the dynamic development of technological sectors of the economy, the penetration of ICTs in all industries, and as a result, new professions, new forms and methods of employment. Digitalization has significantly affected traditional methods of job search, hiring, and working conditions, expanding the potential for international labor migration in certain sectors of the economy. Digitalization processes have changed the global geography and distribution of labor, as well as the patterns of staff

mobility and migration. Labor mobility has been significantly transformed, acquiring new qualities due to the spread of digital technologies around the world. Digitalization is a significant factor in the modern transformation of labor and its mobility. Digital technologies and infrastructure have changed existing jobs and created new ones, and these changes are occurring with spatial and temporal transformations that influence labor mobility. Digital technologies accelerate the processes of population movement; they change the job search process, forms of employment, and working hours.

The concept of digitalization is defined as the practical transformation of processes or objects that are initially (partially or fully) physical or analog into their full or partial conversion into digital ones, that is, those based on discrete signals. The effect of digital transformation, in addition to potentially increasing efficiency, lies in the fact that it makes the facility more adaptable and flexible to the current conditions of technological development, which allows for an increase in customer satisfaction and the availability of any services [6].

Tul [7] defines the global digitalized labor market in her scientific work as a globally integrated digital space. Within its framework, buyers and sellers of the labor force interact based on the functioning of an interstate mechanism for regulating labor supply and demand through online bulletin boards, job search sites, and web portals of recruitment agencies, electronic labor exchanges, company websites, and social networks. It follows from the definition that digitalization has contributed to the formation of an integrated digital labor market, in which the interaction of buyers and sellers of the labor force is accelerated by technology at the national and international levels.

Despite the significant impact of digitalization on labor markets, this influence is differentiated depending on the structure of the economy and job requirements in a particular sector.

In general, digitalization influences labor markets in the following ways:

- creation of jobs: new sectors, new products, new services;
- changing jobs: digitalization, human/intelligent machine interface, new forms of management;
- lack of need for specific professions due to automation;
- shifts in employment due to the development and spread of digital platforms, crowdsourcing, and the “sharing” economy (share economy).

## **2.3 Economic consequences of the digitalization of the labor market**

### *2.3.1 Employment recovery*

Increasing digitalization of the economy and automation, and the introduction of technology in the private and public sector have led to new forms of employment, labor organization, and greater flexibility for employees and firms [8]. New forms of labor are flexible and structured, project-based, more open to ecosystems, more efficient, and more innovative. Accordingly, jobs are also more flexible; new professions are emerging, and traditional ones are becoming less and less in demand and popular among the population. The subordination between the employee and the employer has also changed: the staff has a greater level of freedom, and, therefore, migration flows may increase; the level of self-employment and temporary employment on fixed-term contracts is growing [9].

New forms of labor organization (self-employed and freelance workers) are especially popular in the United States, the Netherlands, Germany, France, and other EU countries. Currently, the concept of employment quality includes decent wages, health, and safety, acceptable working conditions, training, and promotion opportunities.

### *2.3.2 Social structure and digitalization of the labor market*

The concept of “social structure” has several interpretations in the scientific and social-political literature. In a broad sense, it is a set of interconnected and interacting social groups and social institutions. Social structure is a set of social (class, labor collective, group, stratum), social-demographic (youth, pensioners), professional and qualification, territorial (type of settlement), and ethnic communities (nations, nationalities) connected by relatively stable relations. The social structure of the labor market should be considered as a set of social, social-demographic, professional, and qualification and territorial communities of employees, employers, intermediaries, trade unions, and other institutions, including state institutions, which determine its main characteristics and features.

## **3 Methodology**

The structural-functional analysis was used in the academic paper to characterize and systematically study the economic consequences of digitalization and automation in the labor markets of the EU-27 countries.

The structural analysis is conducted to study the static features of the system by identifying

subsystems and elements of different levels and the links between them. The structural analysis is used to identify the peculiarities of employment recovery in the EU-27 labor markets, and the social structure of the EU labor market.

The functional analysis is applied to determine the dynamic features of the system (dynamics of the social structure, transformation of the labor market) by studying the processes of changing its states over time.

The parametric analysis was used to determine the necessary and sufficient set of generalized and partial indicators of the EU labor markets, which form the hierarchical structure of the EU labor markets and make it possible to characterize their most essential properties as a system (Table 1). “Working age” is defined based on the Eurostat classification: 20-64 years.

Table 1. Structure of Employment and activity in the EU-27 by sex and age – annual data

Dimension	Position
Time-frequency	Annual
Employment indicator	1. Total Employment (resident population concept – LFS), %. 2. Employed persons working part-time, %. 3. Employed persons with a temporary contract, %. 4. Underemployed persons working part-time, %. 5. Total Employment by educational attainment level (1 000). 6. Total Employment by economic activity (1 000). 7. Total Employed persons by detailed occupation (ISCO-08 two-digit level)
Sex	Total
Age class	From 20 to 64 years
Unit of measure	Percentage of total population
Geopolitical entity (reporting)	The European Union – 27 countries (from 2020)
Time	2013 – 2022

Source: generalized by the author based on Eurostat data [10-14].

## 4 Results and Discussion

### 4.1 Features of transformation of labor markets in the EU-27 and their economic consequences

The functioning of the labor market in different EU-27 countries in the context of digital transformation is characterized by several features. Taking into account the desire to create a unified labor and employment market in the EU, constant optimization of legal and regulatory frameworks is taking place to reform labor markets, especially after the 2008-2009 crisis. It is conducted to implement legislative initiatives on deregulation, reduction of fiscal pressure; strengthening political activity in various areas of the EU employment policy [17].

In the scientific literature, scholars argue that, especially after the economic recession of 2008, the EU labor market is in a constant and rapid state of change, which requires the development of a skilled workforce capable of responding flexibly to market needs [18]. Before the 2008 crisis, employment regulation policies were rigid and required conducting policies to ensure the flexibility of labor markets [19].

Since 2009, the EU-27 labor markets have undergone reforms aiming at enhancing their performance in the post-crisis period. Changes were introduced in the taxation system; convenient wage limits were established; financial assistance programs and employment protection mechanisms were developed to promote job creation and overcome segmentation, and facilitate the remuneration of employees, which encouraged the unemployed to seek employment.

In general, a stable level of employment can be observed in the Member States [10]; there is a decrease in the share of people with 0-2, and 3-4 educational attainment levels, while the share of people with 5-8 educational attainment levels is growing [12], and there is a stable growth in wages and incomes [15, 16]. As a result, the social structure of the working population is changing by vocational and educational levels and qualifications in favor of increasing the importance and role of higher education. Within the EU-27, changes in employment patterns are also taking place, especially in the most developed EU countries in favor of part-time employment, and the length of the working week is increasing (Eurostat, 2021d), especially in

the most developed countries. Thanks to regulatory mechanisms, the unemployment rate in the EU-27 decreased by 11,4% in 2013-2019, which means that the reform of the EU labor markets after the 2008-2009 crisis was effective. In general, a significant impact of the level of education on employment and ensuring employment of young people with higher education can be observed. Member States have distinctive structural and institutional systems that ensure the flexibility of the EU labor markets. The net income of the people employed is growing by social group.

Within the EU, there are restrictions on the movement of workers between sectors, which reduces the social mobility of low-skilled workers, including many migrants. Demand for low-skilled labor is declining, and investment in education and training has been identified by the EU as a crucial factor in improving their employment prospects [20].

#### 4.2 Employment recovery

The dynamics of employment in the EU-27 countries make it possible to conclude the following features of the labor market: stable growth of the employed population over the past ten years; differences in labor markets and employment within the EU-27 countries, in particular, differentiation of volatility (it is especially evident in Bulgaria, the Czech Republic, Greece, Spain, Croatia, Cyprus, Lithuania, Hungary, Malta, Poland, Portugal, Romania, Slovenia, Slovakia); differences in the level of employment depending on the social-economic development of the country (thus, the highest employment levels are in the Czech Republic, Denmark, Germany, Estonia, Ireland, Hungary, Malta, the Netherlands, Austria, Sweden). In general, the EU-27 labor markets are characterized by rapid employment recovery, especially during the pandemic and economic downturn in 2020, and employment revival in 2021-2022.

Table 2. Total employment and activity in the EU-27 by sex and age – annual data, 2013-2022, %

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average, 2013-2022	Standard deviation, 2013-2022
EU-27	66,8	67,5	68,5	69,6	70,9	71,9	72,7	71,7	73,1	74,6	70,7	2,6
Belgium	67,2	67,3	67,2	67,7	68,5	69,7	70,5	69,7	70,6	71,9	69,0	1,7
Bulgaria	62,9	64,4	66,5	67	70,6	71,7	74,3	72,7	73,2	75,7	69,9	4,4
The Czech Republic	72,5	73,5	74,8	76,7	78,5	79,9	80,3	79,7	80	81,3	77,7	3,1
Denmark	74,3	74,7	75,4	76	76,6	77,5	78,3	77,8	79,1	80,1	77,0	1,9
Germany	76,3	76,7	76,9	77,6	78,2	78,9	79,6	78,2	79,4	80,7	78,3	1,4
Estonia	74,1	75	76,7	77	79,2	79,7	80,5	79,1	79,3	81,9	78,3	2,5
Ireland	66,5	68,1	69,8	71,3	72,9	74	75	72,1	74,9	78,2	72,3	3,5
Greece	52,5	53,1	54,8	55,9	57,4	59	60,8	58,3	62,6	66,3	58,1	4,3
Spain	58,6	59,9	62	63,9	65,5	67	68	65,7	67,7	69,5	64,8	3,6
France	69,7	70	70,3	70,7	71,3	72	72,3	72,1	73,2	74	71,6	1,4
Croatia	57,2	59,2	60,6	61,4	63,6	65,2	66,7	66,9	68,2	69,7	63,9	4,1
Italy	59,1	59,5	60,2	61,4	62,3	63	63,5	61,9	62,7	64,8	61,8	1,8
Cyprus	67,2	67,6	67,9	68,7	70,8	73,9	75,7	74,9	75,9	77,9	72,1	4,0
Latvia	69,5	70,6	72,5	73	74,6	76,8	77,3	76,9	75,3	77	74,4	2,8
Lithuania	69,9	71,8	73,3	75,2	76	77,8	78,2	76,7	77,4	79	75,5	3,0
Luxembourg	71,1	72,1	70,9	70,7	71,5	72,1	72,8	72,1	74,1	74,8	72,2	1,3
Hungary	65,2	68,7	70,9	73,7	75,4	76,7	77,6	77,5	78,8	80,2	74,5	4,8
Malta	66,2	67,9	69	71,1	73	75,5	76,8	77,3	79,1	81,1	73,7	5,0
Netherlands	76,7	76,3	77,2	77,9	78,9	80	81	80,8	81,7	82,9	79,3	2,3
Austria	74,6	74,2	74,3	74,8	75,4	76,2	76,8	74,8	75,6	77,3	75,4	1,1
Poland	63,2	64,9	66,3	68,2	70	71,4	72,3	72,7	75,4	76,7	70,1	4,4
Portugal	63,4	66,1	67,9	69,5	72,5	74,7	75,5	74,2	75,9	77,5	71,7	4,7
Romania	56,9	58	59,2	60,3	62,7	63,9	65,1	65,2	67,1	68,5	62,7	3,9

Slovenia	66,7	67,3	68,6	69,5	72,9	74,9	75,9	74,8	76,1	77,9	72,5	4,1
Slovakia	66,9	67,8	69,6	71,8	73,2	74,5	75,6	74,6	74,6	76,7	72,5	3,4
Finland	72,5	72,2	71,8	72,4	73,2	75,3	76,2	75,5	76,8	78,4	74,4	2,3
Sweden	79,2	79,4	79,9	80,6	81,2	81,8	81,5	80,1	80,7	82,2	80,7	1,0

Source: compiled by the author based on the Eurostat data [10].

Groups of countries by Total Part-time employment in the EU-27 by average values in 2013-2022 are highlighted in Table 3. In general, in the EU-27, the share of employed persons working part-time decreased from 19,1% in 2013 to 17% in 2022, with an average of 18,4%. The share of Employed persons with temporary contracts decreased from

12% in 2013 to 11,1% in 2022; the average value was 12,1% over the ten years. The share of Underemployed persons working part-time decreased from 4,3% in 2013 to 2,7% in 2022, with an average of 3,61% in 2013-2022. Therefore, forms of employment are changing within the EU-27.

Table 3. Total Part-time employment in the EU-27 (from 20 to 64 years), 2013-2022, %

Activity and employment status	Scale: Average for 2013-2022			
	0-10%	10-20%	20-30 %	Більше 30%
Employed persons working part-time	Slovenia, Greece, Portugal, Lithuania, Latvia, Poland, the Czech Republic, Croatia, Hungary, Romania, Slovakia, Bulgaria	Sweden, Ireland, Italy, France, Luxembourg, Spain, Finland, Malta, Cyprus, Estonia	Austria, Belgium, Denmark	Netherlands, Germany
	0-5%	5-10%	10-15%	15-20% or more than 20%
Employed persons with temporary contract	Slovakia, Bulgaria, Estonia, Latvia, Lithuania, Romania	Denmark, Belgium, Greece, Luxembourg, Hungary, Ireland, the Czech Republic, Malta, Austria	Croatia, Finland, Slovenia, Cyprus, Sweden, France, Italy, Germany	Netherlands, Spain, Poland, Portugal
	0-2%	2-4%	4-6%	More than 6%
Underemployed persons working part-time	Croatia, Romania, Malta, Lithuania, Poland, Hungary, Estonia, Slovakia, Bulgaria, the Czech Republic	Belgium, Italy, Sweden, Finland, Austria, Denmark, Slovenia, Latvia, Luxembourg, Germany	Greece, Ireland, Portugal	Spain, Cyprus, Netherlands, France

Source: compiled by the author based on the Eurostat data [11].

Recent employment trends in the EU-27 include a significant increase in the share of employed persons working from home as a percentage of total employment by gender, age, and occupational status (%). In 2013, the indicator was 4,9% on average within the EU-27, while in 2019 it was 5,5%, in 2020 – 12,2%, in 2021 – 13,6%, in 2022 – 10,3%. [21]. Thus, as a result of labor automation and the pandemic, an increase in the level of remote employment and telecommuting can be observed, indicating the emergence of new forms of employment.

The European Foundation for the Improvement of Living and Working Conditions [22] has analyzed

the “new forms of employment” that are developing in Europe, which to a greater or lesser extent radically transform the traditional relationship between employer and employee. Based on the European Foundation’s analysis, nine major trends in these new forms of employment have been identified, which have important implications for working conditions and the labor market, namely:

1) sharing of employees, where an individual employee is jointly hired by a group of employers to meet the needs of the HR department of different companies, which ensures the employee’s permanent full-time employment;

2) job sharing, where an employer hires two or more employees to perform certain tasks and work together, combining two or more jobs into one full-time job;

3) interim management, in which highly qualified experts are hired temporarily for a specific project or to solve a specific problem, thereby integrating external management capabilities into the company's work;

4) casual work, where the employer is not obliged to regularly provide work to the employee, but has the flexibility to hire the employee on demand;

5) ICT-based mobile work, where employees can perform work from anywhere at any time, supported by modern technologies;

6) voucher work, where the employment relationship is based on payment for services under a voucher purchased by an authorized organization that provides payment and social security;

7) portfolio work, where self-employed professionals perform individual work for a large number of clients, using online platforms to search for clients, creating jobs for each;

8) crowd employment, where an online platform connects employers and employees who fulfill employers' tasks;

9) collaborative work, where freelancers, self-employed or micro-enterprises work to overcome constraints and professional isolation by using a digital environment for job search.

Digital platforms for job search and employment are currently facilitating the development of a parallel labor market that is ultra-flexible, and regulated without the use of a contract. There is no longer any employment contract, no wage standards, working time rules, or regulations regarding the working day, workplace, training, access to trade unions, or collective action within this form of employment. The employee – or, rather, the “partner” – belongs to this virtual community and manages his or her employment on the basis of a self-employment

contract; he or she is responsible for his or her social protection (unemployment, pension, sickness benefits), and security. In addition, the status of labor remains informal, and employment depends solely on one's responsibility skills, and competence. This form of contractual employment is gaining popularity extremely fast. Tens of thousands of new freelance workers are registering on such platforms as Uber Airbnb, etc. The activities of a specialist are often outside the law, which requires legislative initiatives.

Digital platforms have led to the development of a new form of labor immigration – digital. After all, virtual borders are almost completely open, and workers with high levels of skills have the opportunity to be employed remotely. Examples include the digital trading platform Amazon, which allows you to do business remotely from anywhere in the world and is, therefore, a form of radical liberalization of the labor market. The growth of e-commerce may make digital platforms play a central role in the future of employment.

#### 4.3 Dynamics of the social structure

The share of employment by educational level is also changing within the EU (Table 4). In general, the number of employed people is growing across all educational levels: from 178935 thousand people in 2013 to 193457 people in 2022. At the same time, the share of employed people with higher education is growing significantly: from 31% in 2013 to 38% in 2022, which indicates a change in the social structure of the labor market and the professional and qualification characteristics of the employed. A strong correlation between unemployment and educational attainment is revealed in the scientific literature. Workers with the highest educational attainment level have the lowest unemployment rate, and vice versa, the highest unemployment rate is typical for workers without higher education [23, 28, 31-33].

Table 4. Employment in EU-27 by educational attainment level (EAL) (1 000), 2013-2022

EAL	2013	2019	2020	2021	2022	Average, %	Share 2013, %	Share 2022, %
All ISCED levels 2011	178935,70	191442,20	188644,10	189594,00	193457,80	187061,34	100%	100%
Less than primary, primary, and lower secondary education (levels 0-2)	33097,90	30804,70	29271,80	29042,70	29795,80	31073,27	18%	15%

Upper secondary and post-secondary non-tertiary education (levels 3 and 4)	89842,30	93105,50	90432,80	89144,00	90220,70	91324,39	50%	47%
Tertiary education (levels 5-8)	55674,50	67150,70	68598,10	71113,60	73193,30	64151,61	31%	38%

Source: compiled by the author based on the Eurostat data [12].

The employment structure by type of economic activity in the EU-27 has been changing over the period 2013-2022. In particular, the share of those employed in the agricultural sector is reduced from 5% to 3%; the share of those employed in professional, scientific and technical fields is increased from 5% to 6%; the share of those employed in the information and telecommunications

sector is increased from 3% to 4%. This change in the structure of employment by sector also indicates shifting employers' needs for employees' skills and a greater demand for specialists with technical and digital knowledge, skills, and competencies. Consequently, the structure of employment by type of activity is being transformed [26, 27].

Table 5. Employment in the EU-27 by economic activity (1 000), 2013-2022

	2013	2020	2021	2022	Average, 2013-2022	Standard deviation, 2013-2022	Share, 2013, %	Share, 2022, %
Total – all NACE activities	178 935,7	188 644,1	189 594,0	193 457,8	186 892,3	4 726,3	100%	100%
Agriculture, forestry, and fishing	8 931,9	7 564,2	6 831,5	6 768,2	7 948,8	748,5	5%	3%
Mining and quarrying	707,5	601,7	562,1	549,3	620,4	54,5	0%	0%
Manufacturing	29 487,8	31 292,3	31 009,8	31 195,0	30 857,9	737,	16%	16%
Electricity, gas, steam, and air conditioning supply	1 429,5	1 444,1	1 484,9	1 462,2	1 403,2	49,2	1%	1%
Water supply; sewerage, waste management, and remediation activities	1 425,0	1 597,6	1 606,0	1 626,8	1 528,9	79,6	1%	1%
Construction	12 307,5	12 420,3	12 624,7	13 095,9	12 537,3	320,2	7%	7%
Wholesale and retail trade; repair of motor vehicles and motorcycles	25 264,3	25 234,2	25 407,4	25 858,1	25 677,3	340,4	14%	13%
Transportation and storage	9 381,9	9 974,7	10 170,6	10 400,9	9 953,9	369,	5%	5%
Accommodation and food service activities	7 656,8	7 733,8	7 346,5	8 294,8	8 177,9	509,4	4%	4%
Information and communication	4 999,6	6 550,2	6 980,6	7 306,4	5 903,4	807,2	3%	4%
Financial and insurance activities	5 228,7	5 333,4	5 411,6	5 413,1	5 259,5	92,5	3%	3%
Real estate activities	1 362,7	1 554,0	1 595,2	1 674,8	1 468,9	103,1	1%	1%
Professional, scientific, and technical activities	9 044,9	10 440,9	10 779,2	11 234,2	10 092,5	682,5	5%	6%



Administrative and support service activities	7 090,9	7 311,5	7 469,6	7 912,0	7 585,1	291,7	4%	4%
Public administration and defense; compulsory social security	12 951,1	13 887,8	13 864,2	13 885,8	13 399,7	350,	7%	7%
Education	12 755,4	13 966,7	14 350,7	14 507,9	13 654,5	564,8	7%	7%
Human health and social work activities	18 536,6	20 489,5	20 999,2	21 404,5	20 014,9	909,7	10%	11%
Arts, entertainment, and recreation	2 652,8	2 913,4	2 855,1	3 142,1	2 901,2	139,5	1%	2%

Source: compiled by the author based on the Eurostat data [13].

Throughout 2013-2022, the structure of the employed by occupation in the EU-27 has also changed: the share of professionals has significantly increased (from 18% to 22%), which indicates a tightening of requirements for specialists' professional characteristics, the share of scientists and engineering specialists has increased (from 3% to 4%), and the share of information and

communication technology specialists has increased (from 1% to 2%). In the EU countries, there is a significant share of technical specialists and associate professionals (16%), science and engineering associate professionals (4%), and managers (5%). Thus, the dynamics of the social structure of the labor market and employment are characterized by minor transformations of professions [29, 30].

Table 6. Employed persons by detailed occupation in the EU-27 (1 000), 2013-2022

	2013	2020	2021	2022	Average, 2013-2022	Standard deviation, 2013-2022	Share, 2013, %	Share, 2022, %
Total	178 935,7	188 644,1	189 594,0	193 457,8	186 892,3	4 726,3	100%	100%
Managers	9 365,7	9 532,9	9 494,9	9 925,0	9 613,4	199,2	5%	5%
Chief executives, senior officials, and legislators	1 409,0	1 356,0	1 478,5	1 512,5	1 449	54,7	1%	1%
Administrative and commercial managers	2 452,5	2 470,4	2 504,2	2 666,8	2 496,7	82,7	1%	1%
Production and specialized services managers	3 216,8	3 470,0	3 170,4	3 307,5	3 409,3	138,7	2%	2%
Hospitality, retail, and other services managers	2 237,9	2 217,3	2 322,3	2 420,6	2 232,7	82,5	1%	1%
Professionals	31 680,3	39 021,1	41 269,0	42 483,7	36 272,9	3 713,9	18%	22%
Science and engineering professionals	5 282,1	6 235,4	6 781,0	6 979,9	5 924,4	593,7	3%	4%
Information and communications technology professionals	2 503,2	3 845,4	4 285,2	4 590,4	3 332,1	722,	1%	2%
Technicians and associate professionals	29 504,9	30 940,4	30 666,4	31 076,7	30 931,1	855,	16%	16%

Science and engineering associate professionals	7 179,5	7 443,7	6 781,4	6 805,3	7 253,8	291,2	4%	4%
Information and communications technicians	1 444,2	1 821,6	1 927,2	2 008,3	1 665,5	203,5	1%	1%

Source: compiled by the author based on the Eurostat data [14].

Taking into account the integration of technologies into various sectors of the economy and the development of the European digital economy within the EU-27, several features, challenges, and economic consequences of digital transformation arise. In particular, the following new features can be observed in the labor market:

1) There is a gap between the available skills of labor resources and the requirements for the competencies of employees in the labor market, which results in the need for their constant updating in the process of practical activity, training, and professional development [24].

2) Within the EU, a high level of ICT use by employees, a high share of enterprises with Internet access, a website, social networks, and enterprises that employ ICT specialists is observed [24]. Accordingly, the digitalization of workplaces contributes to the digitalization of workforce skills.

3) In general, the EU has an average level of development of digital skills of professionals: 29% of the EU population has a low level of digital skills, with a significant level of differentiation by country; however, 56% of citizens have basic or advanced digital skills [11, 25].

4) Employees' active use of the Internet and relatively high rates of remote work are both features of the EU labor markets in the context of digitalization, as evidenced by the share of persons who worked remotely at least once per week at 75% [24]. These trends have a significant impact on working conditions, allowing staff to work remotely and companies to attract specialists from countries where labor expenditures are much lower.

## 5 Conclusions

The functioning of the labor market in different EU-27 countries in the context of digital transformation is characterized by several features. The EU-27 labor markets are characterized by rapid employment recovery, especially during the pandemic and economic downturn in 2020, and employment revival in 2021-2022. In the Member States, a stable level of employment is generally observed; there is a

decrease in the share of people with 0-2, and 3-4 educational attainment levels, while the share of people with 5-8 educational attainment levels is growing, and there is a stable growth in wages and incomes. Changes in the social structure of the employed by vocational and educational levels and qualifications in favor of increasing the importance and role of higher education have been revealed. Changes in forms of employment and the emergence of new forms of employment (sharing of workers and workplaces, temporary management, casual work, ICT-based mobile work, voucher work, portfolio work, crowdsourcing, collaborative work) have been identified.

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#### **Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)**

The authors equally contributed to the present research, at all stages from the formulation of the problem to the final findings and solution.

#### **Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself**

No funding was received for conducting this study.

#### **Conflict of Interest**

The authors have no conflict of interest to declare.

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