



TRENDS IN WORKFORCE QUALIFICATION IN THE CONTEXT OF NEW DIGITAL AND ECOLOGICAL TRANSFORMATIONS OF THE ECONOMY

Cătălin Ghinăraru ¹, Daniela Pașnicu ², Mihaela Ghența ³, Aniela Matei ⁴,
Elen-Silvana Crivoi⁵

^{1),2,3,4,5)} National Scientific Research Institute for Labour and Social Protection (INCSMPS), Bucharest, Romania
²⁾ Spiru Haret University (USH), Bucharest, Romania

e-mails: ¹catalin.ghinararu@incsmeps.ro, ²daniela.pasnicu@incsmeps.ro, ³mihaela.ghenta@incsmeps.ro,
⁴aniela.matei@incsmeps.ro, ⁵silvana.crivoi@incsmeps.ro

Received: 18 Oct 2024 Accepted: 16 Dec 2024 Online Published: 23 December 2024

ABSTRACT

Understanding future skills needs is essential to ensure a just and socially equitable transition to the green and digital economy and to stimulate rapid economic recovery due to the COVID-19 pandemic.

Objectives: The purpose of the article is to contribute to the knowledge of labour supply and demand forecasts according to skill levels in order to achieve a balance in labour market in the context of new economic changes. **Methods/Approach:** In this regard, a secondary forecast analysis was made at the 2030 horizon point regarding the change in the structure of the employed population in Romania by occupational groups, qualification level and broad occupational groups according to total demand, net change and demand for replacement and a comparative analysis of the workforce forecast by qualification levels in the period 2018-2030, at the level of 12 EU countries. The analyzed data come from the CEDEFOP center. The secondary data analysis was supplemented with information on new occupations and new skills needed in the perspective of 2030-2040. A Delphi methodology was applied for this purpose. **Results:** The data analysis highlights new occupations that will appear in the context of digital transformations, and also new skills to which the education system will have to adapt. **Conclusions:** In the period 2018-2030, most jobs will appear as a result of the demand for replacement, which illustrates that the potential for creating new jobs remains low.

Keywords: digitization, labour market, skill level, occupational group, demand, supply

JEL classification: J30, J50, J60

Paper type: Research article

Citation: Ghinăraru, C., Pașnicu, D., Ghența, M., Matei, A., Crivoi, E-S. (2025). Trends in workforce qualification in the context of new digital and ecological transformations of the economy. *Access to science, business, innovation in digital economy*, ACCESS Press, 6(1), 141-158, [https://doi.org/10.46656/access.2025.6.1\(8\)](https://doi.org/10.46656/access.2025.6.1(8))

INTRODUCTION

The European Green Pact is a new economic growth strategy through which the European Union (EU) aims to achieve its goal of sustainability and competitive cohesion. Through this medium-term strategic framework, reforms will be supported and developed to meet the challenges of climate and environment. These reforms are designed to determine a fair and equitable transition in terms of social and inclusive growth, which puts people at the forefront and allows EU citizens and businesses to benefit from the transition to a green and sustainable economy. Particular emphasis will be placed on investing in green technologies, sustainable

¹ Corresponding author, **Mihaela Ghența** – mihaela.ghenta@incsmeps.ro



solutions and the development of new businesses adapted to the new growth model. Companies will contribute to these EU goals through the appropriate, green use of digital networks, technologies and applications to deliver environmental and climate benefits and to transform the European Union into an innovative, sustainable and resilient society and economy. For this, companies need an update of existing businesses and technological models focused on training and adapting workforce qualifications to market requirements. In this regard, the European Skills Agenda aims for a skills revolution to ensure that people can thrive in the transition to the green and digital economy and to stimulate the rapid economic recovery from the COVID-19 pandemic (European Commission, 2020b).

The analyzes undertaken in the article provide an estimate of the structure of the employed population by occupational groups, skill level and broad occupational groups in the 2030 horizon point for a better understanding of how new digitalisation-focused business models will influence the labour market balance in terms of qualifications and how intersectoral reallocations can be made. The first two sections of the article capture theoretical aspects of the transition to the digital economy and the connection between new business models and occupations and skills. The secondary analysis of statistical data, together with the applied Delphi methodology contributes to the identification of new occupations and skills that will appear in the 2030-2040 perspective.

The transition to the digital economy: concept and policies

In order to ensure people's prosperity during the transition period, the European Skills Agenda 2020 aims at: 1. achieving sustainable competitiveness through the achievement of the European Green Agreement and the implementation of digital and industrial strategies; 2. Ensuring social equity by implementing the principle of the European Pillar of Social Rights, respectively access to education, training and continuing education for anyone and everywhere in Europe; and 3. Achieving resilience to crisis response, based on lessons learned during the COVID-19 pandemic (European Commission, 2020b).

The European objectives for the next five years are: to increase by 32% (120 million) the number of adults participating in learning activities each year; increase by 67% (14 million) of low-skilled adults who participate annually in learning activities; an increase of 82% (2 million) in jobseekers with recent learning experience and an increase of 25% (230 million) in adults with basic digital skills. The qualification level of a job was defined by the average salary, tasks or education involved. It has been observed recently a polarization of jobs, respectively the decrease of the share of medium-skilled jobs and the increase of the share of high and low-skilled jobs, as a result of the introduction of new technologies and automation (Acemoglu & Author, 2011; Goos et al., 2009). There are concerns in the literature about the possible effects of declining medium-skilled employment as a result of automation and digitization, such as suffering, insecurity, and the replacement of people in such jobs (Cortes, 2016; Acemoglu & Restrepo, 2018).

Automation and globalization have reduced employment opportunities for medium-skilled workers, without higher education, as they had jobs that usually included routine tasks (Author & Dorn, 2013).



Education will play a key role in finding a highly qualified job, noticing lately a decline in the share of low- and middle-educated workers (without higher education) who manage to take such a job. However, there are exceptions in the Nordic countries that have strong social dialogue institutions and practices, as well as a high-quality training and education (VET) system that manages to adapt vocational training to labour market requirements and mitigate the adverse effects of job polarization. (OECD, 2020). Experts have noted that the share of high and low-skilled occupations has increased in most countries, while the share of medium-skilled occupations has decreased.

Context analysis of the connection between ecological transformation and occupations and qualifications of the workforce

In recent decades, digitalization, information and communication technologies have transformed the way people access knowledge and information. In the context of digital transformations, a series of transformations are identified in the literature that will mark most sectors of economic activity.

For the Agricultural sector, the emergence and consolidation of the occupation of digital entrepreneur (Food and Agriculture Organization of the United Nations, 2019) is a certainty, and this requires the creation of groups of digitally qualified employees (ReSkill Project, 2021). In overcoming the challenges of digitizing agricultural activities, it is appreciated that young people will play a key role, as they are connected to the digital and technological transformations produced in society and show speed in adapting to change. Other new occupations that are forecast to appear as an effect of technological transformations are occupations that involve the management of multiple data in the agricultural field (Food and Agriculture Organization of the United Nations, 2019). International organizations (ILO, 2019) are considering the emergence of hybrid occupations that create new job profiles by combining different fields of expertise, such as occupations related to the expansion of the green economy (e.g agricultural meteorologist who combines expertise in both meteorology, as well as in agricultural sciences, specialists in environmental restoration and conservation of soil and water resources, specialists in water resources management). Urbanization will lead to the emergence of urban agricultural occupations, amid the trend that is already manifesting (for example in Norway), that some individuals or some enterprises cultivate their own vegetable gardens in indoor environments within urban agglomerations (European Anti-Poverty Network, 2018).

Similar trends are identified for the Extractive Industries occupations. Increasing interest and concerns for the green economy will contribute to the emergence of new occupations, such as research and development occupations related to the design of greener mining systems (ILO, 2019). Amid the transformation of mining into geothermal energy sources, the geothermal industry could absorb workers in the mining sector following retraining, such as geologists and engineers, geophysicists, geochemists, technicians, maintenance and drilling consultants (European Commission, 2018). The existence of large amounts of data and the expansion of renewable energy sources will lead to increased demand for occupations involving data management (data analysts) (European Commission, 2018).



A recent report accomplished by the European Commission (2020a) highlights that the transition to the green economy has led to a number of positive effects on employment, and these positive effects are expected to lead to continued employment growth in this sector. Increasing interest and concern for the protection and conservation of the environment in the context of the digitalization of economic activities will contribute to the emergence of new occupations, such as occupations related to the expansion of the green economy (European Commission, 2020a; 2020b), occupations related to waste recovery and reuse, expansion of the circular economy (e.g. environmental engineering technicians, soil and water conservation specialists, environmental science and protection technicians, including health and environmental engineering technicians, climate change analysts, environmental restoration planners, environmental certification, specialists in water resources and water / wastewater engineers) (ILO, 2019), occupations related to the development of specific regulations regarding the efficient use of resources (CEDEFOP, 2018b), occupations related to the analysis of large data sets (ILO, 2019).

Development of sustainable constructions (European Commission, 2016) and European policies in the field of efficient use of resources and management of resulting waste, reduction of carbon emissions, etc. are just some of the challenges in the Construction sector. Against the background of technology and digitalization, we appreciate the increase in demand for the following occupations in the perspective of 2030-2040 (Construction Blueprint, 2019; European Commission, 2020a): (1) occupations that occur due to the digitization of the sector (2) occupations related to the transition towards a sustainable and environmentally friendly sector, (3) occupations related to the efficient use of resources and waste from the construction process.

The main factors influencing the evolution of the Information and Telecommunications Domain are social factors (willingness to pay for telecommunications services, competition for highly specialized employees, changing workforce, acceptance of large-scale digitization, management methods adopted), technological factors (robotics, blockchain, 5G and 6G technologies, IoT, over-the-top service providers, augmented reality, voice recognition, computer technologies, digital security, artificial intelligence, Big Data), economic factors (telecommunications mergers, vertical integration, globalization, general development of the sector) and political factors (market regulations, public financing, internal market structure). The occupations for which job creation is anticipated in the horizon 2030-2040 are the occupations of (1) software developers, (2) network technicians and (3) engineers specializing in modern telecommunications technologies (Deloitte, 2017, CEDEFOP, 2018a), which indicates that the trend with the highest influence on the labour market is technological development.

The main factors influencing the evolution of the field Financial intermediation and insurance are automation, robotics and cognitive technologies, which include machine learning, neural networks of deep learning, natural language processing, rules-based systems, automation of robotics processes and combinations for high-level applications.



METHODOLOGY

Objectives

In this paper we aimed to:

O1. Estimate the structure of the employed population by occupational groups, skill levels, and broad occupational categories by 2030, in Romania to better understand how the transition to a green and digital economy will impact the labor market balance in terms of qualifications and how intersectoral reallocations can be made.

O2. To identify new occupations that will appear in the economic domains / sectors (NACE) of the Romanian economy, in the perspective 2030–2040.

Methods

To achieve the established objectives, a mix of research methods was employed, allowing for a detailed analysis of the labor market.

To estimate the trends in the structure of the employed population by occupational groups, skill levels, and broad occupational categories through 2030, a secondary analysis of data provided by the econometric forecasting model of the European Centre for the Development of Vocational Training (CEDEFOP) was conducted. This analysis used methods such as comparative graphical analysis and tabular analysis, both of which are essential for examining complex data.

These methods offer a clear understanding of variable relationships and enable the identification of differences, similarities, and emerging trends in the labor market. The authors estimated the replacement rate of the employed population based on the replacement demand in Romania's labor market by 2030, using the following formula:

$$\text{Replacement Rate} = \frac{\text{Estimated Number of Replacements Needed}}{\text{Total Number of Employees}} \times 100$$

Where:

- The replacement rate represents the percentage of workers who need to be replaced during the period 2018–2030 to maintain the total employment level.
- The estimated number of necessary replacements, or the replacement demand, refers to the number of jobs that must be filled due to retirements, departures from the company, or other changes.

The total labor demand was determined by adding the eliminated and newly created jobs to those required for replacing employed individuals, particularly due to retirement or job changes. Thus, the combined methodology provides a solid foundation for evaluating labor market dynamics and workforce demand through 2030, contributing to a better understanding of employment trends in Romania. Indicators from Table 1 were used for the secondary data analysis.



Table 1. Indicators regarding the secondary forecast analysis at the 2030 horizon, of the change in the structure of the employed population in Romania

Dimensions	Code	Indicator	Year	Source of data
Forecasts on the structure of the employed population by occupational groups, skill level and broad occupational groups and comparative analysis of the labour force by skill levels	1.1	Demand for total, new / replaced jobs in Romania by occupational groups (thousands of people)	2018-2030	CEDEFOP
	1.2	Demand for total, new / replaced jobs in Romania by large occupational groups (thousands of people)	2018-2030	CEDEFOP
	1.3	Demand for total, new / replaced jobs in Romania by qualification levels (thousands of people)	2014-2030	CEDEFOP
	1.4	Share of the workforce by skill levels in the total workforce at EU level and in 12 EU countries (Romania, Austria, Sweden, Germany, Slovenia, Spain, France, Finland, Hungary, Bulgaria, Croatia and Slovakia)	2018-2030	CEDEFOP

Source: developed by the authors

The secondary data analysis was supplemented with information on new occupations and skills needed in the perspective of the horizon 2030-2040. For this purpose, a Delphi methodology was applied with the participation of representatives of the National Employment Agency, trade union representatives / trade union confederations, employers' representatives, labor market experts, employers. This is a method that uses iterative data collection steps to highlight the positions of experts on a studied issue, having relevant knowledge about it (de Loë et al, 2015) and is a research methodology applied in economics, health, education, social protection, but also in business environment analyses (Manley, 2013). The Delphi exercise took place between 20th-30th of October 2020, with two online rounds. The experts were contacted by phone and e-mail, and invitations to participate were sent. The consent of the participation experts was registered individually, and during the online rounds the condition of anonymity required by the application of the methodology was observed, as well as the condition regarding the minimum number of participants for the mini Delphi sessions. The total number of participants in the two rounds was 28 experts.

The first round of interviews had the following objectives: (1) Identifying new occupations that will appear in the fields / sectors of the national economy, in the perspective of the horizon 2030–2040; (2) Identification of competencies / qualifications to which the education system must adapt, in the perspective 2030-2040.

The total number of questionnaires completed in the first round was 17. The second round of interviews had the following objectives: (1) Validation of new occupations that will appear in the NACE domains / sectors of the national economy, in the perspective 2030–2040 (Delphi Round 1 results); (2) Validation of competencies / qualifications to which the education system must adapt, in the perspective 2030-2040 (Delphi Round 1 results).

The total number of questionnaires completed in the second round was 11. These questionnaires were analyzed in order to generate the taxonomies of new occupations / skills for the horizon 2030-2040 presented



in this article. The questionnaires from both rounds were programmed in a CAWI (Computer Assisted Web Interviewing) interview software.

The economic activity codes were grouped following the scheme of grouping occupations / competencies:

I. Primary sector: A. Agriculture, forestry, fishing; B. Extractive industry, Energy and environmental protection (D. Production and supply of electricity, heat, water, gas and air conditioning, E. Water distribution, sanitation, waste management)

II. Manufacturing: Food, Beverage, Tobacco, Automotive and Components, Other Manufacturing

III. Services Sector: G. Wholesale and retail trade, repair of motor vehicles and motorcycles, I. Hotels and restaurants, H. Transport and storage

IV. Construction sector which includes: F. Construction

V. Health Services and Social Assistance Sector: Q. Health and Social Assistance

VI. Education Sector: P. Education

VII. Public Administration and Defense Sector: O. Public Administration, Defense

VIII. Business Sector: J. Information and telecommunications, K. Financial intermediation and insurance, R. Other services, including visual arts, performing arts and cultural heritage.

RESULTS AND DISCUSSION

Estimation of the change in the structure of the employed population by occupational groups according to total demand, net change and demand for replacement, 2018-2030

Table 2 shows that between 2018 and 2030, the majority of new jobs will result from replacement demand, accounting for 81% of total demand. This indicates that net change remains relatively low during the analyzed period. Certain occupational groups, such as Professionals and Service and Sales Workers, are on the rise, reflecting a steadily expanding demand. In contrast, other groups, like agriculture, are showing a noticeable decline. The digital and green transformations will affect not only the volume of work but also the demand for certain skills. New technologies and the transition to a green economy will continue to favor skills related to digitalization, green technologies, data analysis, and sustainable innovation management, while traditional skills may become less relevant as industries adapt to environmental requirements. The education sector and employment policies will need to focus on developing the skills necessary for the future of work, fostering technological and digital skills, as well as "soft" skills such as critical thinking and adaptability.

The occupational group projected to have the highest replacement demand and the largest number of eliminated jobs compared to newly created ones by 2030 is Skilled Agricultural and Fisheries Workers. This trend is explained by the current overemployment in agriculture and the transition to more sustainable and market-oriented agricultural practices, in line with the requirements of the green economy and climate neutrality goals, which demand increased competitiveness and productivity. Another occupational group



expected to see a greater reduction in eliminated jobs compared to newly created ones is Craft and Related Trades Workers, with a projected net decrease of 62,000 employed individuals. A possible explanation for the job decline in this category is the increasing use of advanced technologies, such as automation and digitalization. As a result, many manual or repetitive tasks previously performed by craft workers are being taken over by machines or automated systems.

The labor market is evolving due to economic, technological, and green economy transitions. Certain occupations, particularly those in traditional and energy-intensive industries, will disappear, while new jobs will emerge in sectors such as renewable energy, green infrastructure, and the circular economy. The highest total labor demand during the analyzed period is in the Professionals occupational group (76%), highlighting not only a constant need for workforce replacement but also significant demand for new job creation. Professionals in fields like IT, healthcare, education, and science play a crucial role in driving innovation and economic growth and are deeply influenced by digitalization.

Another occupational group undergoing continuous transformation is Service and Sales Workers, with a replacement rate of 67%. These sectors are impacted by automation and the expansion of online commerce, fundamentally changing traditional customer interactions. This trend suggests that while many employees will need to be replaced, new employment opportunities will arise as demand for digital, technological, and green skills grows, especially in the context of the transition to a green economy. Among Machine and Plant Operators, a 57% replacement rate reflects the impact of industrial automation and robotics, which take over many traditional tasks, leading to workforce replacement. However, this trend does not eliminate the demand for new jobs, as more advanced skills are required to operate and maintain automated equipment. The 52% growth rate in total demand for public sector workers highlights the urgent need for reform in the public sector. The digitalization of public services is becoming essential to improve efficiency, accessibility, and transparency, but progress has been limited so far (European Commission, 2023; CEDEFOP, 2020a).

Table 2. Structure of the employed population by occupational groups, 2018-2030

Occupational groups	Net change		Replacement request		Total demand	
	Thousands of people	%	Thousands of people	%	Thousands of people	%
Armed forces	-7	-10.5	8	11.2	1	0.7
Legislators, members of the executive and senior leaders of the public administration	15	9.6	65	41.0	80	50.6
Specialist	525	38.8	506	37.4	1030	76.2
Associated technicians and specialists	89	17.2	166	32.1	254	49.3
Public workers	78	19.9	128	32.6	206	52.5
Service and sales workers	401	32.1	438	35.0	840	67.0
Skilled workers in agriculture and fishing	-536	-30.9	1000	57.7	464	26.8
Craftsmen and related trades	-62	-4.5	502	35.9	439	31.4
Machine and installation operators	230	23.3	331	33.4	561	56.7
Elementary occupations	68	8.4	261	32.4	329	40.8
All occupations	800	9.2	3403	39.3	4204	48.5

Source: authors' processing, CEDEFOP, 2020b



In all these sectors, the major challenge remains the reskilling of the workforce to meet the demands of new technologies and industrial developments. This is especially necessary as Romania lags behind other EU member states in acquiring digital skills, according to the European Commission (2023) report.

By broad occupational categories, the total labor demand for the period 2018-2030, as shown in Table 3, is highest for groups involving Skilled Manual Occupations and Highly Skilled Non-Manual Occupations, suggesting the presence of a dual economy. This highlights the continued need for labor in fields requiring both technical and physical skills, as well as in those involving advanced knowledge and academic specializations. At the same time, it is noted that the high total demand in skilled manual occupations is mainly driven by replacement demand. It's important to emphasize that this occupational group is expected to see a net decline in jobs due to the elimination of positions—a phenomenon linked to automation and technological innovations that reduce the need for manual labor. On the other hand, the net change is positive for highly skilled non-manual occupations, indicating that, despite the natural replacement of the workforce, more job opportunities are emerging in this sector. In contrast, the demand for workers in elementary occupations is lower, likely due to the trend of automating repetitive and routine tasks.

This development suggests that, in the future, the labor market will increasingly require skilled workers, especially in the emerging sectors of the green and digital economies. Advanced skills will be essential for implementing sustainable technologies and ecological solutions. In this context, it becomes crucial to develop the skills needed in areas such as renewable energy, energy efficiency, the circular economy, and sustainable resource management, which will underpin the creation of new jobs and drive economic innovation.

Moreover, the literature raises concerns about the link between new technologies and skills, emphasizing that these technologies favor certain specific skills while devaluing or eliminating others, leading to reduced labor demand in companies that adopt these technologies. This phenomenon is described in the literature as "skill-biased technological change" (Dachs, 2018). Other authors argue that new technologies increasingly replace routine tasks in both manual and cognitive/administrative occupations, a phenomenon known as "routine-biased technological change" (Dachs, 2018). Acemoglu and Autor (2011) showed that demand for routine tasks has significantly decreased in the U.S., whether they are cognitive or manual in nature. These two mechanisms, "skill-biased technological change" and "routine-biased technological change," can contribute to growing income inequalities.

Table 3. Changing the structure of the employed population by large occupational groups regarding the qualification, 2018-2030, thousands of people

	Net change	Replacement request	Total demand
Highly qualified non-manual occupations	629	736	1365
Qualified non-manual occupations	480	566	1046
Qualified manual occupations	-368	1832	1464
Elementary occupations	68	261	329
All occupations (except armed forces)	740	3134	3874

Source: authors' processing,, CEDEFOP, 2020b



However, just transition policies and professional training in green sectors should be prioritized to reduce the risk of marginalizing low-skilled workers and ensure an equitable distribution of the benefits of the green economy.

Estimation of the change in the structure of the employed population by type of qualification according to total demand, net change and demand for replacement, 2014-2030 (thousand people)

Figure 1 highlights that the total labor demand between 2014 and 2030 is forecasted to be higher for the highly qualified workforce (1,636 million people), compared to the lower qualified workforce (1,474 million people) and those with medium qualifications (763 thousand people). However, by 2030, the employed population with medium qualifications is estimated to remain higher (4,150 million people) than those with higher education (3,085 million people) and lower education (2,234 million people). This suggests a labor market where, although the majority of the employed population will have medium qualifications, the need for highly skilled employees is increasing, reflecting the impact of advanced technologies and digitalization on skill requirements.

The forecasted net decline in jobs for those with medium qualifications (-908 thousand jobs) underscores the vulnerability of these occupations to automation and digitalization, which reduce demand for routine tasks. This phenomenon can be explained by the fact that many jobs for those with medium qualifications involve routine tasks, which modern technologies can perform more efficiently. At the same time, the high replacement demand for this category of the workforce is explained, on the one hand, by the significant share of this category in the total employed population and, on the other hand, by the need for specialization in the context of new transformations.

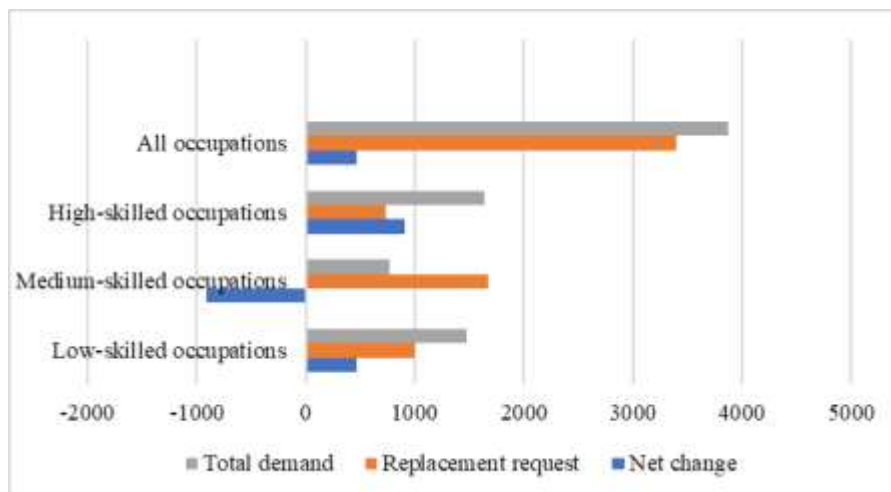


Figure 1. Estimation of the change in the structure of the employed population by qualification levels 2014-2030
Source: authors' processing, CEDEFOP, 2020b



This dynamic emphasizes the need for public policies to support the retraining and development of green and digital skills for those with medium and lower levels of education. Retraining will facilitate the transition of these workers to emerging sectors such as sustainable resource management, the circular economy, and green infrastructure. Preparing the workforce for these new demands is crucial to ensure that the transition to a green economy does not exacerbate social and economic disparities but instead creates equal opportunities in the labor market.

Comparative analysis on the share of the workforce by qualification levels

The comparative analysis took into account the analysis of the variation of the labour force share by qualification levels in the period 2018-2030. 12 EU countries were included for which CEDEFOP data were available for the selected indicators during the analyzed period (Figure no. 2).

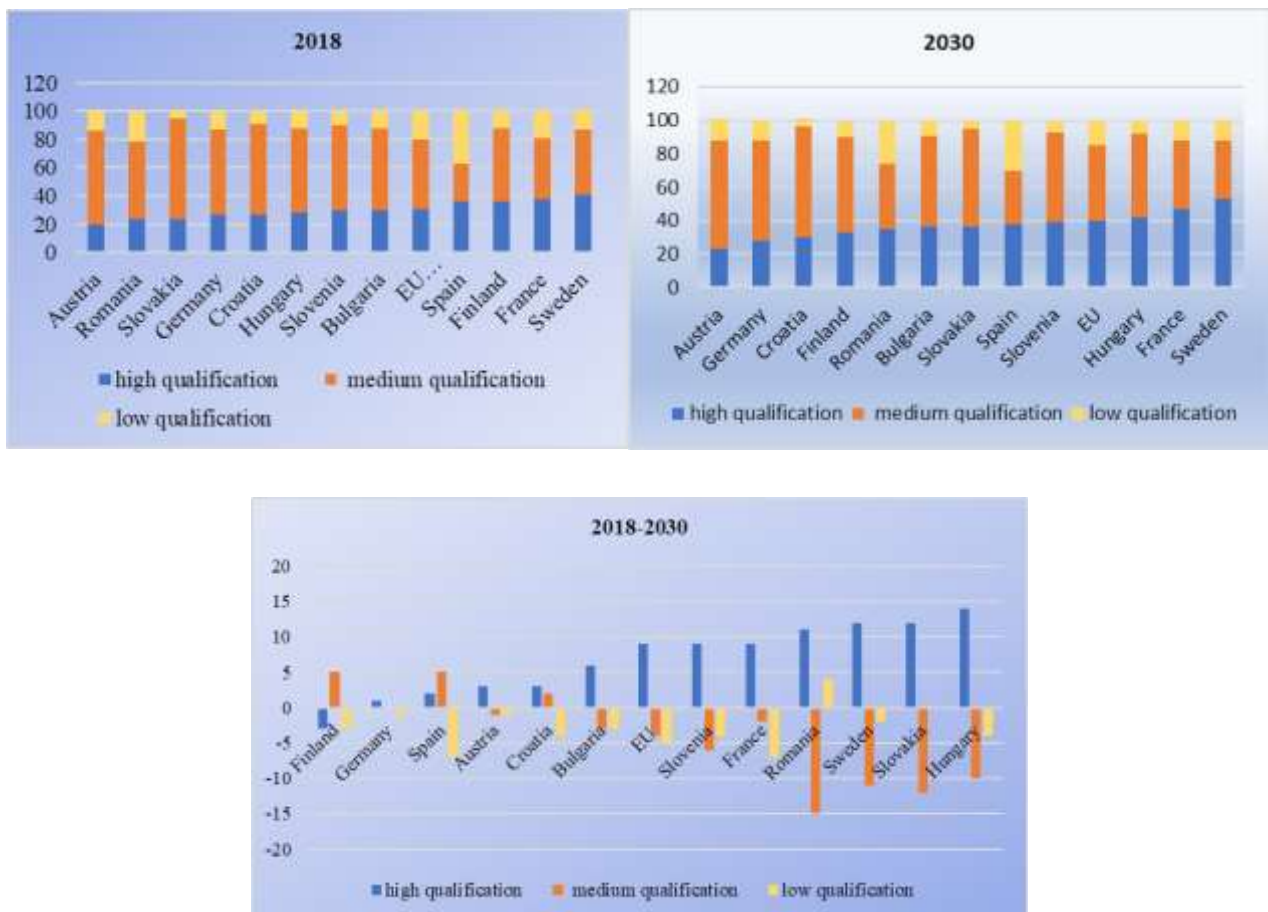


Figure 2. Variation of the share of labour force by qualification levels, 2018-2030
Source: authors' processing, CEDEFOP , 2023

Regarding the highly skilled workforce, the largest shares are found in Sweden and France, both in 2018 and in 2030. These countries maintain their dominant position concerning the highly skilled workforce due to their investments in innovation and sustainability, which are crucial for implementing the technological



solutions necessary to achieve climate neutrality goals. The most significant increase, of over 10%, is anticipated in Hungary, Sweden, Slovakia, and Romania, reflecting a trend of rapid adaptation to new technologies. Increases are forecasted for all analyzed countries, except for Finland, which, despite being advanced in technology, may experience a decline in the share of highly skilled workers due to the maturation of the labor market and the rapid integration of technologies, reducing the need for new specializations.

The average qualification is projected to have the highest share in Croatia, Austria, and Germany, which have a balanced workforce with a significant number of workers possessing medium technical skills. Digitalization emphasizes the need for workers who can manage advanced technological equipment but do not necessarily require extremely high specialization. In this category, a decline is estimated in almost all analyzed countries, except for Spain, Finland, Croatia, and Germany. This decline may result from automation and the integration of technologies that simplify many tasks. Medium-skilled workers are often replaced by advanced technologies that require less direct human intervention. Romania is projected to have the most significant decrease, reflecting changes in the economic structure and the emerging demands of the labor market in the context of rapid digitalization, suggesting an urgent need for retraining.

Regarding low-skilled qualifications, the largest estimated share for 2030 will be recorded in Spain and Romania. This is partly due to the economic structure, as some of the low-skilled workforce may still be employed in traditional sectors that have not been fully transformed in the context of the green transition. Although the low-skilled workforce is estimated to decline in most countries, a notable exception is Romania, where an increase is expected. This could reflect a delay in the automation process and ecological transformation. The largest declines are anticipated in Spain and France, reflecting the impact of advanced technologies and automation that reduce the need for low-skilled workers.

In the context of the green and digital transitions, these trends highlight how digitalization and advanced technologies are transforming the workforce structure, increasing demand for high skills, and reducing the need for low-skilled workers. Investments in education and training for developing green and digital skills will be essential to prevent rising inequalities and ensure a fair transition to a low-carbon economy.

New occupations and competences in the time horizon 2030-2040

The process of anticipating the new occupations in the time horizon 2030-2040 utilizing Delphi methodology reveals important trends that shape the occupations of the future: (1) technologization, digitalization and robotics, (2) the evolution of green and ecologically sustainable economy, (3) the continuously improving of knowledge regarding consumer's behaviour, (4) national and European regulations regarding the reduction of pollution, (5) aging population. At the level of the entire economy, in the time horizon 2030-2040 is expected to increase demand for specialists in technology, IoT, robotics, artificial intelligence and ITC, management and processing of large volumes of data, specialists in the design and operation of renewable energy systems, specialists in management sustainable use of resources and strategic business planning, specialists in the



development of products and services adapted to the needs of customers / beneficiaries, ethics specialists and lawyers.

I. Primary sector

A. Agriculture, forestry, fishing

The new occupations validated through Delphi methodology were: (1) the occupation of digital entrepreneur; (2) occupations related to the expansion of the green economy; (3) urban agricultural occupations; (4) occupations related to the handling of available equipment.

B. Extractive industry

The new occupations validated through Delphi methodology were: (1) occupations in research and development related to the design of greener extraction systems; (2) occupations related to the automation of mining operations.

For domain D. Production and supply of electricity, heat, water, gas and air conditioning, the new occupations validated through the Delphi methodology were: (1) occupations related to the management of large data sets; (2) technical occupations related to the expansion of renewable energy sources.

E. Water distribution, sanitation, waste management

The new occupations validated through the Delphi methodology were: (1) occupations related to waste recovery and re-use and expansion of the circular economy; (2) occupations related to the efficient management of drinking water sources and soil conservation; (3) occupations related to the development of specific regulations regarding the efficient use of resources; (4) occupations concerning the analysis of large data sets.

II. Manufacturing industry

The new occupations validated through the Delphi methodology were: (1) occupations that require knowledge of operating automated, robotic equipment; (2) occupations related to the efficient management of resources and waste resulting from the production process; (3) occupations related to the development of packaging products / systems based on the use of new technologies; (4) occupations related to the preparation of automatic work lines; (5) occupations related to the management of large data sets.

III. Services Sector (G. Wholesale and retail trade, repair of motor vehicles and motorcycles, I. Hotels and restaurants, H. Transport and storage)

The new occupations validated through the Delphi methodology were: (1) occupations generated by the expansion of the green economy; (2) occupations generated by technology development, including data analysis; (3) occupations generated by the tendency towards personalization of products and services; (4) occupations generated by the trend of integrated transport planning, at regional, national or even global level; (5) occupations related to strategic planning; (6) occupations that require knowledge and understanding of consumer behaviour; (7) occupations involving assistance to beneficiaries in the use of automatic devices; (8) occupations related to ethics and risk management (philosophers and specialists in ethics and transport law, ethics officers).



IV. Constructions Sector (F. Constructions)

The new occupations validated through the Delphi methodology were: (1) occupations that appear due to the digitalization of the sector; (2) occupations related to the transition to a sustainable and environmentally friendly sector; (3) occupations related to the efficient use of resources and waste resulting from the construction process, including the identification of new construction materials; (4) occupations related to the efficient use of resources and waste resulting from the construction process, including the identification of new construction materials.

V. Health and Social Assistance Services Sector: Q. Health and Social Assistance

The new occupations validated through the Delphi methodology were: (1) occupations related to the maintenance, scheduling and repair of medical equipment; (2) doctors specialized in telemedicine, able to provide medical care using new technologies; (3) social workers able to provide social assistance using new technologies.

VI. Education sector

The new occupations resulting from the Delphi methodology are: (1) occupations generated by technology development, (2) occupations related to ethics and social risk management, including poverty, school and labour market exclusion (ethics counselor, career counselor for new trades, labour market guidance counselors), (3) occupations regarding the development of transversal competencies, (4) the occupation of lifelong learning coach.

VII. Public Administration and Defense Sector

New occupations resulting from the Delphi methodology are: (1) specialists in data processing and analysis, (2) occupations generated by social risks (anti-poverty specialists, social insurance and social benefits coordinator, personal social insurance advisor, civil servant) (3) occupations generated by the development of technologies, including data processing and analysis (remote control apparatus or drone flight coordinator, drone artillery and missile coordinator, artillery and missile coordinator airborne, driver for armored and automated in terms of weapons systems vehicles).

VIII. Business Services Sector: J. Information and Telecommunications and I. Financial Intermediation and Insurance

New occupations validated through the Delphi methodology were: (1) occupations generated by technology development and (2) occupations involving communication in different languages of communication (eg specialties in communication language).

R. Other services, including visual arts, performing arts and cultural heritage

The new occupations validated through the Delphi methodology were: (1) occupations generated by technology development, including data analysts, digital imaging technicians and digital management operators, (2) occupations involving communication in different types of communication languages (e.g. specialists in communication languages), (3) occupations in the field of unconventional arts, (4) occupations generated by the tendency towards personalization of products and services.



CONCLUSION

The purpose of the article is to contribute to a better understanding of how new digitalisation-focused business models will influence the labour market balance in terms of qualifications and how cross-sectoral reallocations can be made.

The methods used to achieve this goal were: a secondary data analysis to estimate the structure of the employed population by occupational groups, skill level and broad occupational groups by 2030 and a Delphi methodology to obtain information on new occupations and new skills needed in perspective 2030-2040.

In the period 2018-2030, most jobs will appear as a result of the demand for replacement, which illustrates that the potential for creating new jobs remains low. The occupational group in which the largest creation of new jobs is forecast compared to the abolished ones, as well as the highest total demand is that of "specialists". There is also a significant increase in total demand for the "public workers" occupational group, which illustrates the increased need to digitize public services, in order to increase their accessibility and transparency. Most of the abolished places, compared to the newly created ones, are estimated to be in the occupational group "Skilled workers in agriculture and fishing". By large occupational groups, the total demand for the period 2018-2030 is higher for the groups, Manual skilled occupations and Highly qualified non-manual occupations and the lowest for the occupational group Elementary occupations. The demand for replacement is forecast to be the highest in the case of manual skilled occupations, given the higher share of the population employed in this group compared to other groups in total occupations forecast for 2030. Total demand for the highly skilled employed population in 2014 -2030, is estimated to be higher, compared to the population employed with secondary and lower education, this illustrating the transition to the service economy. The analysis of the 12 countries shows that in Romania it is estimated the largest decrease in the share of the medium-skilled population and the largest increase in the share of the low-skilled workforce.

The process of anticipating new occupations in the perspective of 2030-2040 reveals that robotization, technology and robotics, together with the expansion of the ecological economy, will shape the occupations and skills required on the labour market.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions:

Page:

155

Conceptualization, C.G., D.P., M.G., A.M, methodology, M.G., A.M., D.P., validation, C.G., D.P., formal analysis, M.G., A.M., S.C.; writing—original draft preparation, M.G., A.M., D.P., S.C.; writing—review and editing, S.C.; supervision, C.G.; project administration, C.G.; funding acquisition, C.G.

All authors have read and agreed to the published version of the manuscript.



Funding /Acknowledgement

This paper was elaborated and published within the project "Creșterea capacității administrative a ANC și MMJS prin sistematizare și simplificare legislativă în domeniul calificărilor Cod MySMIS:129872 - Analiza privind evoluția pieței muncii din perspectiva competențelor și calificărilor la nivelul tuturor sectoarelor economice, pentru orizontul 2025–2030" (Increasing the administrative capacity for ANCs and MMJSs to plan and simplify the legislative process in the field of qualifications Cod MySMIS:129872 - Analysis on the evolution of the labour market from the perspective of skills and qualifications in all economic sectors, for the horizon 2025-2030), a project funded by the National Authority for Qualifications, contract no. 89 /129872/2020 and within the project PN22100101 funded by the Romanian Ministry of Research, Innovation and Digitization, National Plan for Research, Development and Innovation 2022-2027.

Institutional Review Board Statement: not applicable

Informed Consent Statement: Informed consent was obtained from all the participants involved in the study.

Data Availability Statement:

The data presented in this study are available on request from the corresponding author.

References

- Acemoglu, D., Restrepo, P. (2018). Artificial intelligence, automation and work, *NBER Working Paper Series*, Nr. 24196, NBER, Cambridge, MA
- Acemoglu, D., Autor, D. (2011). *Skills, Tasks and Technologies: Implications for Employment and Earnings, Handbook of Labor Economics*, Volume 4b, ed. D. Card and O. Ashenfelter, Vol. 4, Part B: 1043–1171. Amsterdam: Elsevier. DOI:10.1016/S0169-7218(11)02410-5
- Autor, D., Dorn, D. (2013). The growth of low-skill service jobs and the polarization of the US labor market, *American Economic Review*, 103/5, pp. 1553-1597. DOI: 10.1257/aer.103.5.1553
- CEDEFOP. 2023. Skills forecasts: Country reports. Retrieved from <https://www.cedefop.europa.eu/en/country-reports/skills-forecasts> (accessed 20 septembrie 2024)
- CEDEFOP. 2020a. *Skills forecast 2020: Romania. Cedefop skills forecast*. Retrieved from: https://www.cedefop.europa.eu/files/skills_forecast_2020_romania.pdf (accessed 20 September 2021)
- CEDEFOP. 2020b. Cedefop's Skills forecast data visualisations. Retrieved from: <https://www.cedefop.europa.eu/en/publications-and-resources/data-visualisations/skills-forecast> (accessed 20 September 2021)
- CEDEFOP. 2018a. Skills Forecast 2018. Thessaloniki: Greece. Retrieved from: <https://www.cedefop.europa.eu/en/events-and-projects/projects/skills-forecast> (accessed 20 September 2021)
- CEDEFOP. 2018b. Skills for European synthesis report 2018 update green job. Retrieved from: http://www.cedefop.europa.eu/files/3078_en.pdf (accessed 10 October 2020)
- Construction Blueprint. 2019. D.4. Roadmap and Action Plan. Retrieved from: <https://constructionblueprint.eu/wp-content/uploads/2020/02/D4.-Roadmap-and-Action-Plan.pdf> (accessed 10 October 2020)
- Cortes, G. (2016). Where have the middle-wage workers gone? A study of polarization using panel data, *Jurnal of Labor Economics*, 34/1, pp. 63-105
- Dachs, B. (2018). The impact of new technologies on the labour market and the social economy. Retrieved from: [https://www.europarl.europa.eu/RegData/etudes/STUD/2018/614539/EPRS_STU\(2018\)614539_EN.pdf](https://www.europarl.europa.eu/RegData/etudes/STUD/2018/614539/EPRS_STU(2018)614539_EN.pdf) (accessed 10 October 2020)



- Deloitte. (2017). Future of Work in mining: Attracting, developing and retaining talent. Retrieved from: <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Energy-and-Resources/deloitte-norcat-future-work-in-mining.pdf/> (accessed 20 January 2021)
- de Loë, R. C., Melnychuk, N., Murray, D., & Plummer, R. (2015). Advancing the State of Policy Delphi Practice: A Systematic Review Evaluating Methodological Evolution, Innovation, and Opportunities, *Technological Forecasting & Social Change*, 104 (2016) pp. 78–88. <https://doi.org/10.1016/j.techfore.2015.12.009>
- European Anti-Poverty Network. (2018). The Future of Work Labour market trends and their implications for risks of poverty and social exclusion. Retrieved from: <https://www.eapn.eu/the-future-of-work-labour-market-trends-and-their-implications-for-risks-of-poverty-and-social-exclusion/> (accessed 20 January 2021)
- European Commission. (2023). *Digital Economy and Society Index (DESI) 2023*. Publications Office of the European Union. Retrieved from <https://ec.europa.eu>
- European Commission. (2018). EU coal regions: opportunities and challenges ahead. Retrieved from: <https://publications.jrc.ec.europa.eu/repository/handle/JRC112593?mode=full> (accessed 20 January 2021)
- European Commission. (2020a). Employment in the Energy Sector Status Report 2020. Retrieved from: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC120302/employment_energy_status_report_2020.pdf (accessed 20 January 2021)
- European Commission. (2020b). European Skills Agenda for sustainable competitiveness, social fairness and resilience. Available at: <https://migrant-integration.ec.europa.eu/sites/default/files/2020-07/SkillsAgenda.pdf> (accessed 20 January 2021)
- European Commission. (2016). The European construction sector A global partner. Retrieved from: https://eurocodes.jrc.ec.europa.eu/sites/default/files/2021-12/2016-09-06_The-European-construction-sector-brochure_WEB.pdf (accessed 20 January 2021)
- Food and Agriculture Organization of the United Nations. (2019). Digital technologies in agriculture and rural areas briefing paper. Retrieved from: <http://www.fao.org/3/ca4887en/ca4887en.pdf> (accessed 20 January 2021)
- Goos, M., Manning, A., Salomons, A. (2009). Job Polarization in Europe, *American Economic Review*, 99/2, pp. 58-63
- International Labour Organisation. (2019). Skills for a greener future: a global view. Retrieved from: https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40ed_emp/documents/publication/wcms_732214.pdf (accessed 20 January 2021)
- Manley, A. (2013). The policy Delphi: a method for identifying intended and unintended consequences of educational policy, *Policy Futures in Education*, Vol. 11, pp. 755–768. <https://doi.org/10.2304/pfie.2013.11.6.755>
- OECD. (2020). OECD Employment Outlook: Worker security and the COVID-19 crisis. Retrieved from: <https://doi.org/10.1787/1686c758-en> (accessed 20 January 2021)
- ReSkill Project. (2021). RES-SKILL 02-T1: Skills matching analysis and development of transition profiles. retrieved from: https://res-skill.eu/wp-content/uploads/2023/01/RESSKILL_IO2_AnalysisReport_20210709.pdf (accessed 20 January 2021)

About the authors



Cătălin GHINĂRARU

Senior Researcher, PhD in Economy at the Bucharest University of Economic Studies. Scientific Secretary of the INCSMPS, leads the Labour Market Policies department of INCSMPS.

Research interests: labour market, policy analysis, social protection, ex-ante and ex-post assessment of social policies.

ORCID ID: 0009-0001-9547-6436



Daniela PAȘNICU,

Professor of economics and Senior Researcher in the Labor Market Policy Department, PhD in management from the Bucharest Academy of Economic Studies.

Research interests: labor economics, regional studies, and transition economies.

ORCID ID: 0000-0003-1177-9817



Mihaela GHENȚA,

Senior Researcher within the Social Policies Department, economist (graduate of the Bucharest University of Economic Studies).

Research interests: social policies targeted to vulnerable groups, social and economic effects of ageing; development of quantitative and qualitative research methodologies

ORCID ID: 0000-0002-6629-4676



Aniela MATEI,

PhD, Senior Researcher, sociologist leads the Social Policies Department of the National Scientific Research Institute for Labour and Social Protection.

Research interests: labour market, working conditions and workforce, inequalities.

ORCID ID: 0000-0002-6645-6209



Silvana CRIVOI,

PhD in Sociology at University of Bucharest, Recognized researcher in the Wages, Income and Taxation Department of INCSMPS is an economist and sociologist.

Research interests: quality of working life, human and social sustainable working regimes, decent work, labour market inclusion of vulnerable groups.

ORCID ID: 0000-0002-6945-2801

This work is licensed under the Creative Commons Attribution International License (CC BY)