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INDUSTRY 4.0 AND 5.0 – ORGANIZATIONAL AND COMPETENCY CHALLENGES OF ENTERPRISES

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Abstract: Digitalization, the spread of artificial intelligence solutions and robotization pave the way for new industry trends that shape the framework of a new industrial era. This era brings both benefits and drawbacks for some enterprises. Definitely, a swift reaction is a must when enterprises need to adjust their strategies, products and services according to the latest customer requirements. These trends have a sound impact on human resources management and jobs performed by humans and, at the same time, pose serious security threats to organizations. The research aims to explore what is meant by the term Industry 5.0 and how it differs from Industry 4.0. The research reveals the changing role of human resources management in the context of the necessary digital and computer competencies of society, highlights some security aspects, and looks at how enterprises, including SMEs, fit into the Industry 4.0 and 5.0 era.

Key words: Industry 4.0, Industry 5.0, Collaborative robots, security, risk management, human resources

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Introduction

Manufacturing processes are transformed by the digital revolution, which promotes a resilient working environment. The usage of technology and artificial intelligence promotes operational excellence, safety and risk management, helps manage exposure related to rising labour costs and improves efficiency (Accenture, 2016). According to Accenture research in 2015, which interviewed 512 respondents across all major industrial countries in North America, Western Europe and Asia, 85% of the manufacturing executives expected human-machine-centric environments to be commonplace in their plants by 2020. Robotic automation promotes product quality through standard product quality and producing high-quality products at lower costs. Industrial revolutions occur faster than ever before. Industry 4.0 was launched late in the last decade, yet Industry 5.0 is in adoption and practice. These two terms seem

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to coexist nowadays when it comes to industrial revolutions. Both concepts have clear consequences on human resources and security, which are key concern areas.
Therefore, there is a need to shape and develop employees' competence in handling all kinds of technologies and the ability to harmoniously and synergistically combine the work of people and devices. Digital and computer skills are indispensable for realising full cooperation between humans and new technologies. Indeed, it is pointed out that future workers must be equipped with the right digital skills to work with robots and machines (Kolade and Owoseni, 2022). The study shows how production activities and worker capabilities can be supported by Industry 4.0 technologies (de Assis Dornelles et al., 2022). In addition, today's workforce is increasingly looking for employees with highly skilled digital knowledge that stimulates the creation and dissemination of ideas and information (Laar et al., 2019), which in turn is in line with the concept of Industry 5.0.
Paying attention to the need for organizational and competency changes in the operation of enterprises in the context of Industry 4.0 and Industry 5.0 allowed to formulate the aim of the article, which is to define Industry 5.0, to identify the differences between Industry 4.0 and Industry 5.0, and to define the changing role of human resource management in the context of its competencies. To achieve the aim of the research, the following methods were used:

- a literature review to identify the differences between Industry 4.0 and Industry 5.0, to identify the risks to manufacturing process safety associated with the implementation of Industry 4.0 and Industry 5.0, and to recognize how small and medium-sized enterprises are implementing the objectives of Industry 4.0 and 5.0 era,
- cluster analysis, specifically the agglomeration method and the k-means method, to find countries that are similar in terms of skills that support the implementation of Industry 4.0 and 5.0,
- analysis of variance, which made it possible to determine the component indicators that constitute the main criteria for determining the countries' membership in each cluster,
- dynamics analysis to identify changes in the percentage of enterprises that employ ICT specialists and enterprises recruited or tried to recruit personnel for jobs requiring ICT specialist skills in 2020 compared to 2012.

Literature Review

Industry 4.0 and Industry 5.0: Interpretation

The concept of Industry 4.0 was created in Germany in 2011 (European Commission, 2021) and highlighted two major concepts: Internet of Things (IoT) and Cyber-Physical Systems (CPS) (Jafari et al., 2022). Industry 4.0 put smart technology at the forefront of manufacturing (Atwell, 2017) and mainly emphasized the paradigm shift led by new technologies but paid less attention to human aspects (Jafari et al., 2022). Industry 4.0 enables mass production (Maddikunta et al., 2022) and mass customization (Ostergaard, 2017a). Industry 5.0 brings increased collaboration between humans and machines that will merge the high-speed accuracy of industrial automation with the cognitive, critical thinking skills of humans (Atwell, 2017).

Industry 5.0 enables mass personalization (Ostergaard, 2017a; Maddikunta et al., 2022). Ostergaard, founder and CTO of Universal Robots – ranked as the leading collaborative robot, a.k.a. Cobot manufacturer, particularly in the implementation (Doyle-Kent, 2021), pointed out that the driver behind Industry 5.0 is the desire for mass personalization (2017b). Industry 5.0. enables people to express themselves as individuals through personalized products for the first time since the beginning of the Industrial Age. Industry 4.0 with the traditional industrial robots is perfect for products such as engine blocks, nobody wants personalized, and they can be made in lights-out factories at a minimal cost. At the same time, Industry 5.0 products bring back the human touch and help consumers express their identity through a particular product, such as a fine watch or designer items, even if there is a premium to be paid for. Collaborative robots are the tools to produce these personalized products that support human craftsmanship with the speed, accuracy and precision required to produce modern products with a human touch (Ostergaard, 2017b).

Industry 4.0 had the ultimate goal, in theory, that a factory is fully automated without human presence onsite by replacing them with autonomous machines and devices supported by artificial intelligence solutions (Ostergaard, 2017a; Sanuk et al., 2022). The use of robots spread in the car industry for the first time. Now, in many sectors, industrial robots replace human resources with automated processes. 'Machines', Robots can do what humans tell them to do but not more. However, human workers can do what robots can't (Ostergaard, 2017a). This inherent nature of robots shows their limitations that can be balanced through human interaction. Romero et al. (2016) mentioned the role of operators in Industry 4.0 for the first time and have developed a typology for Operator 4.0, which aims at expanding the industry worker with innovative technological means, rather than replacing the worker with robots (European Commission, 2021; Romero et al., 2016; Saniuk et al., 2022).

Industry 5.0's objective is to leverage human experts' creativity to collaborate with efficient, intelligent and accurate machines and get resource-efficient and user-preferred manufacturing solutions compared to Industry 4.0 (Maddikunta et al., 2022). Technologies and applications assist Industry 5.0 in increasing productivity and delivering customized products (Maddikunta et al., 2022). European Commission defines the core elements of Industry 5.0: human-centric, sustainable and resilient (2021). In Ostergaard's interpretation, Industry 5.0 is not an incremental development of Industry 4.0; it is, in fact, "a return to pre-industrial production, but one that is enabled by the most advanced technologies out there" (Ostergaard, 2017b). This makes the essence of Industry 5.0 concept.

The authors believe that Industry 5.0 sets out new ways of working direction that reshape the manufacturing processes and job set-up regardless of how researchers define this, whether

- Industry 5.0. serves to augment Industry 4.0 and adds the human edge to Industry 4.0 (SAP Insights, n.d.; George & George, 2020) and the main driver behind the development of industrialization from Industry 4.0 to Industry 5.0 is to demonstrate the role of humans in cyber-physical systems (Saniuk et al. 2022); or
- Industry 5.0 is not an incremental development of Industry 4.0; it is a new direction, i.e., a return to the pre-industrial era with the use of the most advanced technologies (Ostergaard, 2017b).

The Industry 5.0 concept has a number of effects, including HR effects of Cobots in Industry 5.0 based on Doyle-Kent (2021):

- enable social distancing measures in response to pandemic like COVID-19
- keep employees safe since Cobots interact with humans in a shared workplace in a safe manner
- increased productivity since humans and machines co-work/work simultaneously
- possibility to apply Cobots with limited scope based on assessment, e.g., replacing the human workforce with machines in case of dull, monotonous or dangerous tasks and reducing health and safety risks
- opportunity for partial automatization with the benefit of safety, quality and throughput provided by the Cobots
- employees fulfil transformed roles at all levels as a result of the transformation, skills required have been changed, e.g., digital skills, problem-solving and decision-making skills
- flexibility in deployment and redeployment
- lower entry barriers for automatization, available for manufacturers of all sizes
- cost-effective and competitive solution, increase productivity
- increased vulnerability to security threats since devices and machines are networked externally.

With the increase in demand for quality, hands-on custom-made products, manufacturers will benefit from what Industry 5.0 offers (Atwell, 2017). Businesses need a clear vision and mindset for transformation and realize that success will come to those who are more innovative and responsive to market changes to deliver quality products and services on customer requests (Paschek et al., 2019).

Security aspects of Industry 4.0 and 5.0

Security aspects of Industry 4.0 and 5.0 concepts are essential from risk management point of view. Industry 4.0 and 5.0, with their supporting technology and applications, face serious security threats. The risks from the IT world affect the industrial manufacturing processes; new potential manufacturing risks arise through the integration of IT and the key infrastructure for the digitalization of manufacturing (Tupa et al., 2017). The Accenture survey (2016) found that safety concerns are marked as key concern areas. Data vulnerability (e.g., privacy threats, corporate data security) and System vulnerability (e.g., system breakdowns due to complexity) were ranked as medium-risk areas.

6G has a core role in enabling advancements in the automated industrial environment of Industry 5.0 (Porambage et al., 2021). Artificial intelligence (AI) and Machine Learning (ML) require defined security measures to provide adequate protection levels. The integrity of data set is used for ML model training, and AI algorithm requires protection for proper operation. Furthermore, the dependency on ICT systems prescribes security requirements, such as mitigation of Zero-day attacks (Maddikunta et al., 2022).

Key security requirements of Industry 5.0 need to address the security needs related to integrity, availability (access control mechanisms, access restricted only to authorized stakeholders), authentication (authentication mechanisms; authentication of massive number of stakeholders, such as IoT nodes, machines, communication nodes) and audit aspects (audit logs, log management) (Maddikunta et al., 2022; Porambage et al., 2021). When developing security measures for Industry 5.0, factors such as reduced operating cost, interoperability, real-time operation, diversity of devices, high scalability and IoT data security need to be considered (Porambage et al., 2021). High scalable and automated access control mechanisms and audit systems must restrict access to sensitive resources (Porambage et al., 2021).

The role of risk management is crucial given the challenges in the current risk and control environment, where it has become of utmost importance to address the new emerging risks (Kemendi et al., 2022). The development of automated manufacturing practice 5.0 requires a new definition of risk management in the context of requirements specification, case formulation, formalization, implementation and validation approaches (Guebitz et al., 2012).

Security aspects need to be handled thoroughly and with due care to prevent process failures, including serious incidents already as part of design phases of processes related to Industry 4.0 and 5.0, and later on during and after the implementation, including regular reviews and any relevant triggers.

Human resources aspects of Industry 4.0 and 5.0

Human resources aspects inherently belong to Industry 4.0 and 5.0. Processes are implemented through human and ‘machine’ interaction. The ratio of human and machine contribution varies. The proliferation of digitalization reshapes the work scene (Kemendi, 2021). The transformation, changing roles and increased reliance on complex technologies pose new requirements for the workforce, e.g., new skills, including digital skills. Industry workers may see their role changed or even threatened (European Commission, 2021). This calls for attracting and developing new talent, re-skilling current employees through training programs, and redesigning work processes to reduce the skill mismatch between jobs and employees. Engineering education is changing in this transformation (e.g., new cross-functional roles that combine IT and production knowledge and skills) (Ustundag and Cevikcan, 2018). The collaborative Industry 5.0 workplace will perhaps reduce the inherent fear of most production workers that they are being replaced by automation

(Atwell, 2017). This type of collaboration requires, however, cognitive, critical thinking skills of humans (Atwell, 2017). Industry 5.0 can enhance production quality through task setup, namely repetitive and monotonous tasks are assigned to machines and humans perform tasks that need critical thinking (Maddikunta et al. 2022).

The Accenture survey (2016) found that the shortage of skilled workers is a key area of concern and was marked as a high-risk area. Missing digital competence is an issue for most companies (Paschek et al., 2019), which has to be dealt with on the management level.

Competencies become strategic focus areas. In the Industry 5.0 interpretation, jobs are more meaningful jobs than traditional factory jobs (Ostergaard, 2017b). Industry 5.0 promotes skilled jobs compared to Industry 4.0, and intellectual professionals work with machines (Maddikunta et al., 2022). Collaboration-oriented robotics has a significant role in supporting harmonious cooperation between workers and robots (Doyle-Kent and Kopacek, 2021). Due to the role of cobots aimed at synergistic cooperation with human workers, their acceptance in the workplace is important (Prassida and Asfari, 2022). Cobots can be utilized for labour-intensive tasks, allowing more interesting responsibilities for human workers (Maddikunta et al., 2022). It can be expected that the 5.0 wave of the industrial revolution will bring net job growth, not loss (Ostergaard, 2017b).

Industry 5.0 will create new jobs in human-machine interaction and human computational factors. Most critical areas include intelligent systems, artificial intelligence (AI) and robotics, machine programming, machine learning, maintenance and training (Saniuk et al., 2022). Education and training, including retraining employees and lifelong learning, are essential to a transformation process. Industry 4.0 may have been considered a technology-driven transformation but may not be considered a human-centric initiative (Xu et al., 2021). The Industry 5.0 concept is meant to be a human-centric approach that puts core human needs and interests at the heart of the production process and uses technology to adapt the production process to the needs of the worker, e.g., to guide or train him/her. This concept respects human rights, such as privacy, dignity or autonomy (European Commission, 2021). With regard to production processes, the diversity of employees in terms of experience, productivity and physical capabilities pose a challenge for companies, especially those with high staff turnover and manual, labor-intensive processes with poor ergonomics (Battini et al., 2022). Even more so, there is still no common understanding of the essence of human-centered manufacturing (Lu et al., 2022).

Industry 5.0 is the era of collaborative robots, also known as cobots which physically interact with humans in a shared workplace in a safe manner (Doyle-Kent, 2021; Ostergaard, 2017a; Shaji and Hovan, 2020; SAP Insights, n.d.). Cobots are designed to work safely and efficiently alongside humans, and robots assist humans in working better and fast by using advanced technologies. Collaborative robots are safe to use around human workers to prevent injuries in the workplace (Atwell, 2017). These features are distinctive compared to industrial robots, which operate independently without human interaction (Shaji and Hovan, 2020; SAP Insights, n.d.; Ostergaard, 2017a), and they may also cause serious injuries to people (Shaji and Hovan, 2020). This also shows the role of humans in processes.

Historically, industrial robots' role was to help reduce or eliminate dull, dangerous and dirty jobs ('Three D's) (Ostergaard, 2017a). By now, robots fulfil a much more integrated and connected role. Industry 5.0 envisions the co-working of machines and robots positively and beneficially that get the most out of the collaboration. However, the possible obstacles have to be considered and evaluated as well. The co-work of humans and machines may bring various issues, e.g., the changing role of human resources, IT departments, psychological concerns when adopting the new way of working, and ethical problems associated with cobots (Maddikunta et al., 2022). Demir et al. (2019) name the following issues in human-robot co-working:

- Legal and regulatory issues
- Personal preferences toward working with robots
- Psychological issues resulting from the co-working
- Social implications
- Changing role of human resources and information technology departments, the emerging role of the robotics department
- Ethical issues related to co-working and the ethical status of robots,
- Preference toward types of robots to work with (Learning or Rule-based robots)
- Learning to work with robots
- Negative attitude toward robots due to the shrinking human workforce
- Humans compete with robots, or robots complement humans (Demir et al., 2019).

Human and robot collaborative work means a significant transformation and will definitely reshape the usual way of working. Employees and Employers need to adapt to a number of changes and challenges. Corporate culture and human resources management must be properly managed to address these challenges.

Research Methodology

Research questions

Digital skills indicate labour productivity in the digital decade, which defines the European Union's vision of digital transformation and is the starting point for the development of Industry 4.0 and 5.0. The following research questions were formulated:

Research question 1: Are there similarities in the formation of digital competencies of the societies of the European Union countries?

Research question 2: Which component indicators of digital competence are the main criteria for determining the similarity of the societies of the European Union countries?

Robots are IT applications used to automate business processes in a service environment. In the context of Industry 4.0 and 5.0, companies should therefore need ICT specialists or employees in positions requiring specialized ICT skills, especially since Industry 5.0 promotes more skilled jobs compared to Industry 4.0 due to the need for humans to work with machines. Thus, ICT specialists' employment level in European Union and its dynamics were investigated. Another research question was posed:

Research question 3: How has the level of employment of ICT specialists in enterprises in the various countries of the European Union changed?

Data description

In order to examine whether certain similarities can be observed in the formation of digital competencies (Research question 1) and which component indicators of digital skills are the main criteria for determining the similarity of the population of the European Union countries (Research question 2) the following variables were analyzed:

- Individuals' digital skills;
- Individuals' computer skills.

Data on individuals' digital skills and individuals' computer skills for European Union countries were subjected to cluster analysis to see if similar countries could be distinguished in terms of skills that support the implementation of Industry 4.0 and 5.0. The following skills were distinguished among individuals' digital skills:

DS_1 - Individuals with basic or above basic information and data literacy skills;
DS_2 - Individuals with basic or above basic communication and collaboration skills;
DS_3 - Individuals with basic or above basic digital content creation skills;
DS_4 - Individuals with basic or above basic safety skills;
DS_5 - Individuals with basic or above basic problem-solving skills.

Individuals' computer skills include:

CS_1 - Individuals who have written code in a programming language (3 months);
CS_2 - Individuals who have copied or moved files between folders, devices or on the cloud (3 months);
CS_3 - Individuals who downloaded or installed software or apps (3 months);
CS_4 - Individuals who changed the settings of software, app or device (3 months);
CS_5 - Individuals who used word processing software (3 months);
CS_6 - Individuals who have created files integrating elements such as text, pictures, tables, charts, animations or sound (3 months);
CS_7 - Individuals who used spreadsheet software (3 months);
CS_8 - Individuals who used advanced features of spreadsheet software to organize, analyze, structure or modify data (3 months);
CS_9 - Individuals who edited photos, video or audio files (3 months).

All variables were expressed in percentage of individuals.

The following data were analyzed to see how the level of employment of ICT specialists in companies in each European Union country has changed (Research question 3):

- All enterprises without financial sector (10 or more employees and self-employed persons) that employ ICT specialists,
- Small enterprises (10-49 employees and self-employed persons) without financial sector that employ ICT specialists,
- Medium enterprises (50-249 employees and self-employed persons) without financial sector that employ ICT specialists,
- Large enterprises (250 employees and self-employed persons or more) without financial sector that employ ICT specialists,
- All enterprises without financial sector (10 or more employees and self-employed persons) recruited or tried to recruit personnel for jobs requiring ICT specialist skills.

Data from 2012 and 2021 are presented as a percentage of enterprises.

All data used in the analyses are from the Eurostat database.

Methods

Cluster analysis, specifically the agglomeration and k-means methods, was used to identify similarities in digital and computer skills (that support the implementation of Industry 4.0 and 5.0) of societies belonging to different European Union countries. Cluster analysis makes it possible to find a group of objects that are more similar to objects belonging to the same cluster than to objects of other clusters. Thus, the basic idea of cluster analysis is to separate objects into a number of groups of objects that are similar to each other, which at the same time are not similar to objects in other groups, which allows learning about the structure of the community. Indeed, thanks to cluster analysis, it is possible to:

- detect whether the resulting clustering indicates some regularity related, for example, to the geographic location of the analyzed countries,
- make a reduction of a large set of data to the averages of individual groups,
- perform further multivariate analyses, such as analysis of variance.

Analysis of variance and analysis of averages were used to determine the component indicators that constitute the main criteria for determining the countries' membership in each cluster. Analysis of variance and analysis of averages make it possible to estimate the accuracy of classifications and identify the nature of clusters.

The analysis of changes in the percentage of enterprises that employ ICT specialists and enterprises that recruited or tried to recruit personnel for jobs requiring ICT specialists was carried out on the basis of dynamic indices for 2021 in relation to 2012. The indices used made it possible to identify the direction and intensity of changes in the values of the analyzed variables and determine their consequences for the development of industry 4.0 and industry 5.0.

Research Results

Cluster analysis in the field of digital skills and competencies supporting the development of Industry 4.0 and 5.0

The results of the cluster analysis by agglomeration for individuals' digital skills and individuals' computer skills are shown in the tree diagram (Figure 1 and Figure 2).

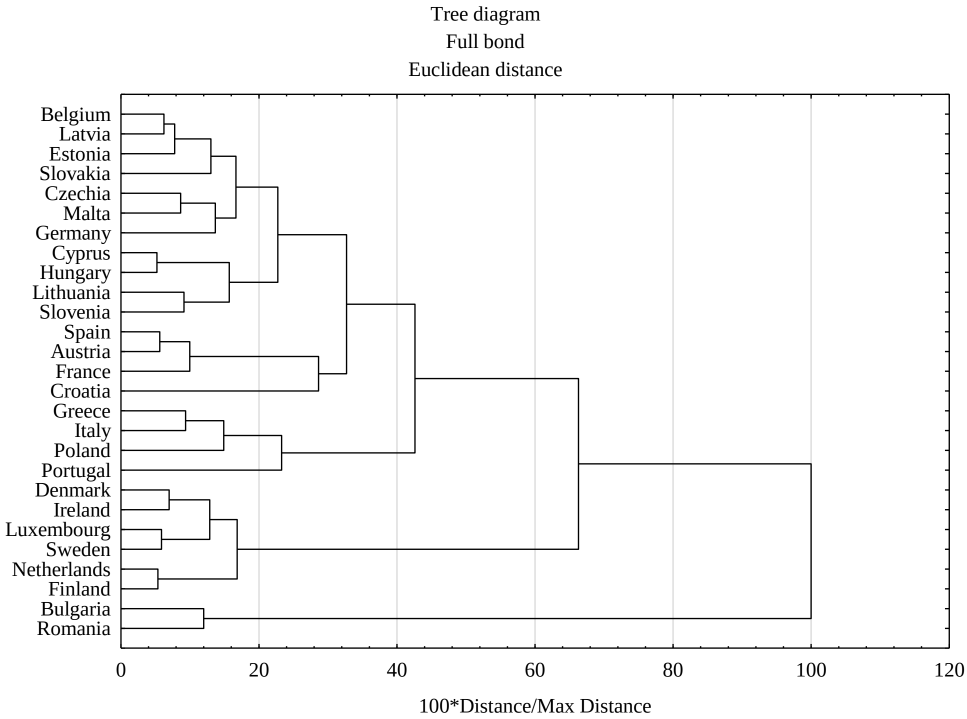

Figure 1: Tree diagram for individuals' digital skills for European Union countries (year 2021)

Analysis of the tree diagram for individuals' digital skills makes it possible to distinguish four clusters. The first is made up of countries, such as Belgium, Latvia, Estonia, Slovakia, Czechia, Malta, Germany, Cyprus, Hungary, Lithuania, Slovenia, Spain, Austria, France and Croatia, i.e., mostly Central and Western European countries. The second cluster is made up of Greece, Italy, Poland, and Portugal, which, with the exception of Poland, belong to Southern Europe. The third cluster consists mainly of Northern European countries: Denmark, Ireland, Luxembourg, Sweden, Netherlands and Finland. A separate cluster is formed by two Eastern European countries, namely Bulgaria and Romania.

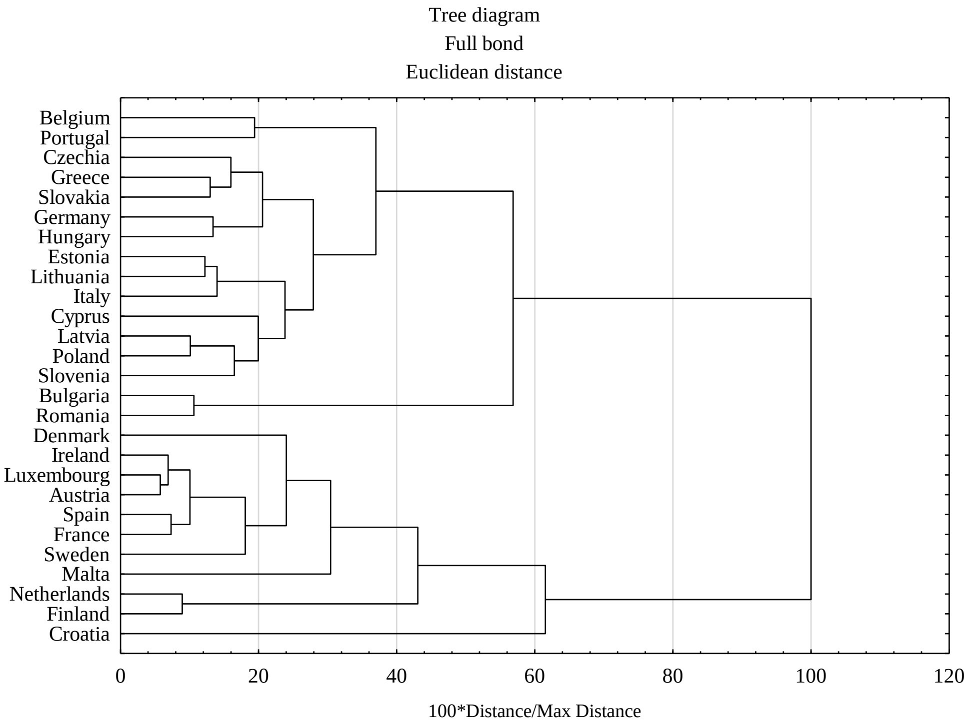

Figure 2: Tree diagram for individuals' computer skills for European Union countries (year 2021)

Analysing the tree diagram for computer skills, it can be seen that a large concentration is formed by countries like Belgium, Portugal, Czechia, Greece, Slovakia, Germany, Hungary, Estonia, Lithuania, Italy, Cyprus, Latvia, Poland and Slovenia. These countries are mostly in central Europe, so they are similar in terms of economic and technological development. A separate cluster is formed by Bulgaria and Romania, thus countries classified as Eastern Europe, characterized by much later industrialization than Central European countries. A large cluster is also formed by such countries as Denmark, Ireland, Luxembourg, Austria, Spain, France, Sweden, Malta, Netherlands and Finland, mostly belonging to Northern and Western Europe. Its concentration is formed by Croatia, which, however, is closer in terms of individuals' computer skills to the countries of Northern and Western Europe than to Central Europe.

To confirm the conclusions drawn from the tree diagram, the k-means clustering method was also applied to individuals' digital and computer skills. The number of clusters (k) was assumed to be equal to four for both variables. The results of the k-means method are shown in Tables 1 and 2.

Table 1. Results of k-means clustering for individuals' digital skills

Cluster elements number1		Cluster elements number 2		Cluster elements number 3		Cluster elements number 4	
Countries	Distance	Countries	Distance	Countries	Distance	Countries	Distance
Greece	4.833477	Bulgaria	2.236068	Belgium	3.703695	Denmark	2.451757
Italy	5.250000	Romania	2.236068	Czechia	2.998347	Ireland	2,208569
Cyprus	5.036119			Germany	4,104221	Luxembourg	2.853847
Lithuania	3,059820			Estonia	3.428370	Netherlands	2,545148
Hungary	3.829165			Spain	4.555625	Finland	3.698348
Poland	4,308422			France	3.553371	Sweden	2.672909
Portugal	5.173248			Croatia	8,319151		
Slovenia	5.006246			Latvia	4,708705		
				Malta	1.965403		
				Austria	4,296837		
				Slovakia	3.304142		

Using the k-means method for individuals' digital skills with the assumption of four clusters, differences from the agglomeration method occurred in only two clusters of countries. Cyprus, Hungary, Lithuania and Slovenia were included in the cluster that included Southern European countries and Poland.

Table 2. Results of k-means clustering for individuals' computer skills

Cluster elements number1		Cluster elements number 2		Cluster elements number 3		Cluster elements number 4	
Countries	Distance	Countries	Distance	Countries	Distance	Countries	Distance
Belgium	6.261188	Croatia	0.00	Bulgaria	1.922094	Denmark	6.669958
Czechia	5.238980			Romania	1.922094	Ireland	2.038383
Germany	4.715093					Spain	3.382153
Estonia	4.789907					France	3.098298
Greece	4.661373					Luxembourg	3.659177
Italy	5.338424					Netherlands	6.866051
Cyprus	5.780128					Austria	3.268925
Latvia	4.415740					Finland	7.355652
Lithuania	4.979464					Sweden	4.914774
Hungary	4.933884						
Malta	8.056437						
Poland	5.592544						
Portugal	8.531134						
Slovenia	3.675075						
Slovakia	4.983925						

The k-means method for individuals' computer skills, assuming the existence of four clusters, confirmed the clustering results of the agglomeration method. The only difference is the inclusion of Malta in the cluster that includes Central European countries rather than the group of Northern and Western European countries.

An analysis of variance was applied to see which component indicators of the two variables are the main criteria for determining membership in each cluster, the results of which are shown in Tables 3 and 4.

Table 3. Results of analysis of variance for individuals' digital skills

Variables	Intra-group SS	df	Internal SS	df	F	p value
DS_1	1316.833	3	393.8333	23	25.63451	0.000000
DS _2	780.121	3	326.5454	23	18.31576	0.000003
DS _3	2590.362	3	408.3787	23	48.62997	0.000000
DS _4	2442.621	3	642.0456	23	29.16734	0.000000
DS _5	3562.720	3	410.9092	23	66.47257	0.000000

For the variable individuals' digital skills, membership in each cluster was determined primarily by two-component indicators: individuals with basic or above basic digital content creation skills and individuals with basic or above basic problem-solving skills.

Table 4. Results of analysis of variance for individuals' computer skills

Variables	Intra-group SS	df	Internal SS	df	F	p value
CS_1	144.778	2	47.889	24	36.27841	0.000000
CS _2	1682.526	2	1321.326	24	15.28033	0.000052
CS _3	3102.414	2	819.660	24	45.42003	0.000000
CS _4	2699.525	2	1451.438	24	22.31877	0.000003
CS _5	2263.380	2	884.472	24	30.70821	0.000000
CS _6	2235.136	2	657.827	24	40.77312	0.000000
CS _7	1538.581	2	1250.826	24	14.76062	0.000066
CS _8	725.340	2	1242.660	24	7.00440	0.004017
CS _9	1722.340	2	975.660	24	21.18370	0.000005

The results of the analysis of variance for individuals' computer skills prove that the component indicators: individuals who have written code in a programming language (3 months), individuals who downloaded or installed software or apps (3 months) and individuals who have created files integrating elements such as text, pictures, tables, charts, animations or sound (3 months) are the main criteria for determining cluster membership.
Identification of the nature of the cluster was also made by analyzing the averages for each cluster of both variables (Figure 3 and Figure 4).

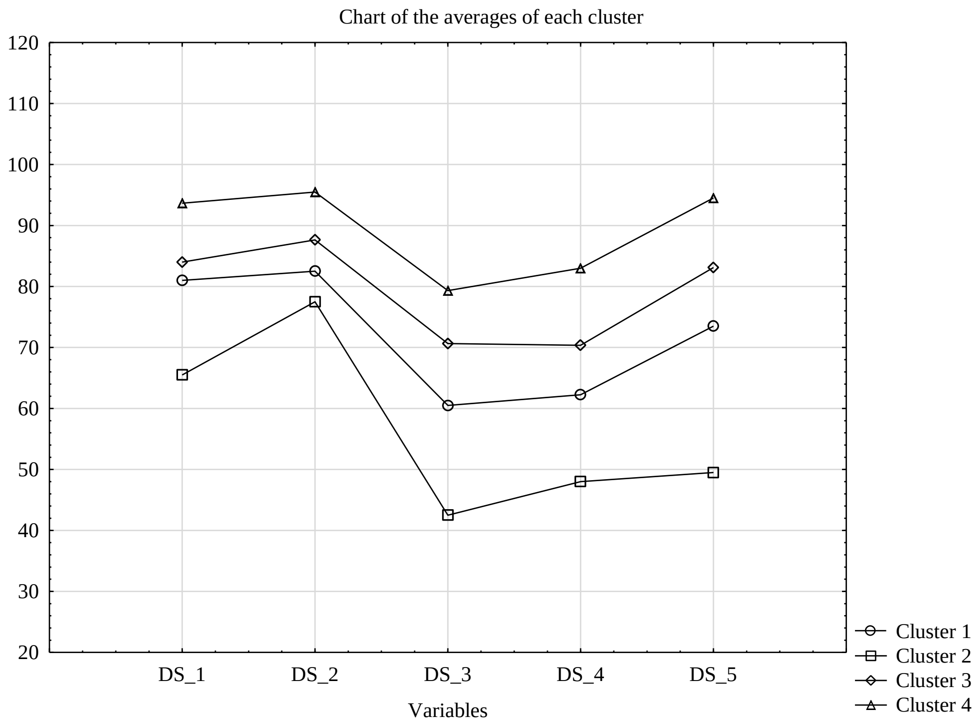

Figure 3: Chart of the averages of each cluster for individuals' digital skills

Analyzing the average values of the individual component indicators of the variable individuals' digital skills, it can be noted that:

1. The highest values of individual component indicators are characterized by countries belonging to cluster number 4, the lowest - to cluster number 2.
2. Countries belonging to cluster number 4 are characterized by the greatest variation in the average values of individual component indicators.

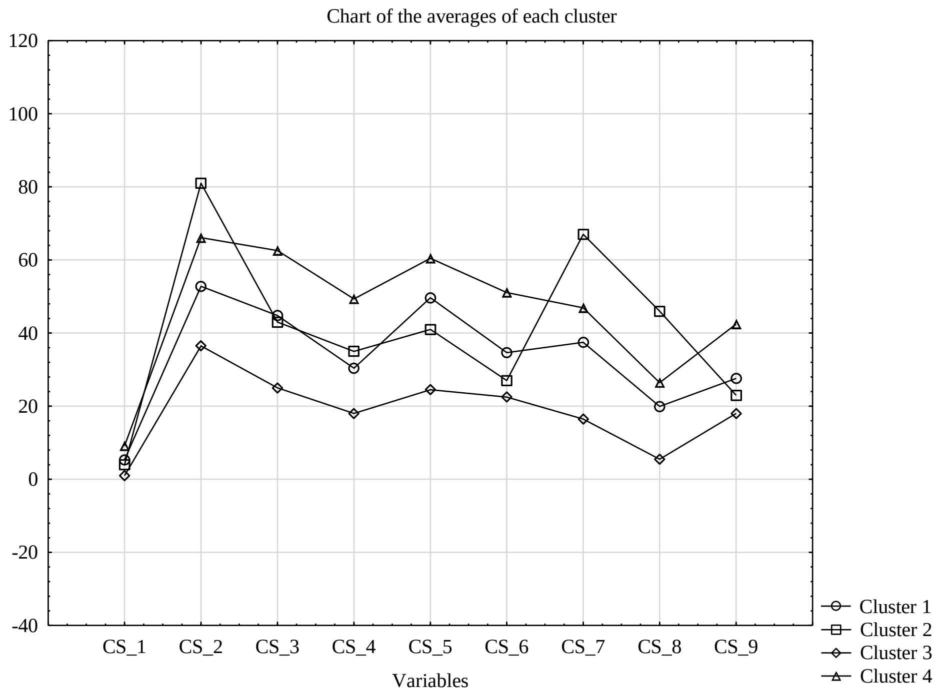

Figure 4: Chart of the averages of each cluster for individuals' computer skills

Comparing the clusters for individuals' computer skills, it can be noted that:

1. Countries belonging to cluster 4 are characterized by a higher percentage of individuals' computer skills in all component indicators compared to countries belonging to clusters 1 and 3.
2. Countries belonging to cluster 3 are characterized by the lowest percentage of individuals' computer skills in all component indicators compared to countries belonging to clusters 1 and 4.
3. Croatia is distinguished by the highest percentage of individuals who copied or moved files between folders, devices or on the cloud (3 months) and those who used spreadsheet software (3 months).

Dynamics of change in employment of ICT specialists in enterprises

In the context of Industry 4.0 and 5.0, companies need ICT specialists or employees in positions requiring specialized ICT skills. Figure 5 shows the percentage of companies that employ ICT specialists between 2012 and 2020 in 27 countries of the European Union.

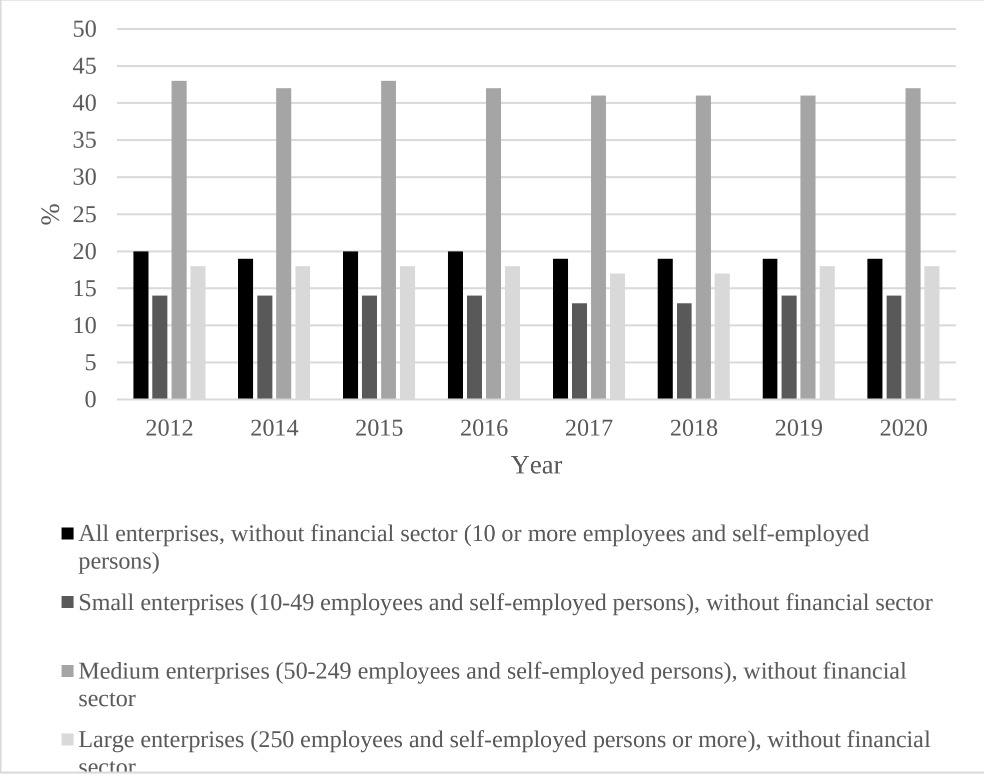

Figure 5: Percentage of enterprises that employ ICT specialists in the European Union – 27 countries

Medium-sized enterprises are the most likely to employ specialists. However, the percentage of medium-sized enterprises that employ ICT specialists in any studied years did not exceed 45%. Small enterprises employ ICT specialists at an insignificant rate - only about 14% of these enterprises can boast of employing ICT specialists. In the European Union, there is also a low percentage of enterprises recruited or tried to recruit personnel for jobs requiring ICT specialist skills between 2012 and 2020 – the highest occurred in 2019 and amounted to 9%; in 2012 and 2013, it amounted to 7%, and in the remaining years it reached 8%.

Table 5 shows the dynamics of the percentage of enterprises that employ ICT specialists and enterprises that recruited or tried to recruit personnel for jobs requiring ICT specialist skills in 2020 compared to 2012.

Table 5. Change in the percentage of enterprises that employ ICT specialists and enterprises recruited or tried to recruit personnel for jobs requiring ICT specialist skills in 2020 compared to 2012

EU countries	Enterprises that employ ICT specialists				Enterprises recruited or tried to recruit personnel for jobs requiring ICT specialist skills
	All enterprises without financial sector (10 or more employees and self-employed persons)	Small enterprises (10-49 employees and self-employed persons) without financial sector	Medium enterprises (50-249 employees and self-employed persons) without financial sector	Large enterprises (250 employees and self-employed persons or more) without financial sector	All enterprises without financial sector (10 or more employees and self-employed persons)
European Union - 27 countries	95%	100%	98%	100%	114%
Belgium	107%	110%	104%	105%	164%
Bulgaria	123%	100%	140%	254%	90%
Czechia	62%	57%	64%	96%	133%
Denmark	107%	116%	91%	98%	127%
Germany	90%	92%	90%	94%	125%
Estonia	94%	100%	100%	93%	100%
Ireland	94%	96%	92%	101%	125%
Greece	54%	50%	82%	80%	67%
Spain	77%	67%	81%	92%	217%
France	120%	130%	108%	108%	129%
Croatia	90%	80%	108%	103%	133%
Italy	93%	90%	95%	101%	100%
Cyprus	104%	100%	124%	104%	122%
Latvia	87%	88%	80%	94%	71%
Lithuania	73%	63%	83%	95%	90%
Luxembourg	69%	62%	78%	95%	86%
Hungary	97%	92%	104%	126%	100%

Malta	112%	121%	109%	109%	130%
Netherlands	92%	94%	93%	92%	150%
Austria	65%	56%	79%	97%	100%
Poland	179%	238%	145%	114%	50%
Portugal	69%	56%	90%	110%	140%
Romania	400%	325%	420%	470%	75%
Slovenia	81%	71%	90%	97%	117%
Slovakia	68%	53%	86%	100%	71%
Finland	85%	85%	91%	93%	108%
Sweden	95%	88%	107%	97%	82%

Across the European Union, only the percentage of enterprises recruited or tried to recruit personnel for jobs requiring ICT specialist skills for all enterprises, without financial sector with 10 or more employees and self-employed persons shows an upward trend between 2012 and 2020. Regardless of size, the percentage of enterprises that employ ICT specialists across the European Union remains stable or shows a slight downward trend. A significant increase in the percentage of enterprises that employ ICT specialists is observed in Romania, Bulgaria and Poland, slightly less in Malta, Cyprus, France and Belgium. In the case of Romania, Bulgaria and Poland, with a significant increase in the percentage of enterprises that employ ICT specialists, a significant decrease in the percentage of enterprises with 10 or more employees and self-employed persons is observed recruited or tried to recruit personnel for jobs requiring ICT specialist skills.

Discussion

The article pointed out the significant role of computer and digital skills in enterprises, especially in the era of Industry 4.0 and Industry 5.0. Thus, the research conducted is part of the research on employee competencies in the digital transformation era. Peng (2017) highlighted the impact of computer skills on employment. In his research, he proved that computer literacy not only reduces employee displacement but also facilitates employee reemployment. In addition, computer skills are desirable, especially for managerial and knowledge-intensive positions (Peng, 2017). Falck et al. (2021) pointed out the relevance of ICT proficiency in today's labor markets in terms of economic labor outcomes (Falck et al., 2021). On the other hand, Pedersen et al. (2022) focused their research on pointing out the benefits to the company of investing in information technology and a skilled workforce.

The research presented also relates to the topic of collaborative robots, which also require digital and computer skills to operate. Ostergaard (2017a) finds that cobots fulfil versatile roles and are easy to program, small, lightweight and affordable, and for this reason, they have played a major role in enabling companies, e.g., SMEs that

could not afford industrial robots, to start automating processes. Cobots are suitable for deployment in processes that were not part of automation before (Doyle-Kent, 2021). Robots are IT applications used to automate business processes in a service environment. Digital and computer skills, therefore, undoubtedly increase the efficiency of work in a cobot environment.
The survey showed a negative situation regarding hiring ICT specialists or employees for positions requiring specialized ICT skills. However, the implementation of Industry 4.0 and 5.0 solutions requires companies to hire personnel with ICT competencies. The need to develop digital competencies in business and society is pointed out by many studies (Babis, 2018; Śledziewska and Włoch, 2020, Awom et al., 2021, Wu and Yang, 2022). Indeed, digital transformation is putting pressure on the skilled workforce (Skare et al., 2023), especially since Industry 5.0 promotes more skilled jobs compared to Industry 4.0 due to the need for humans to work with machines (Coronado et al., 2022).

Conclusion

Industry 4.0 has mostly concentrated on automatization, while Industry 5.0 aims to get the most out of machine and human interaction. The authors believe that the set-up of collaborative work in Industry 5.0 requires high-quality work from the human workforce that can promote motivation and job satisfaction compared to dull, monotonous and closely supervised jobs. This type of work structure requires specific skills to be available onsite and proper management strategy to escort these changes for a successful operation. Changes are inevitable. Adopting new ways of working requires strategic considerations and implementation decisions along with sound change management processes at all levels of the organization, such as top management commitment, project implementations (budget holding etc.), human resources-, information technology-, and enterprise security aspects.
Analyzing the digital and computer skills of the population of the various countries of the European Union, it can be concluded that there are similarities in the level of these skills depending on the economic and technological development of these countries. Countries belonging to Western Europe are characterized by a similar level in terms of individuals' digital and computer skills as Northern European countries. Separate clusters form the countries of Central and Eastern Europe. These results should not come as a surprise in the context of Industry 4.0 and 5.0. The computerization, robotization and automation of processes carried out in both manufacturing and service companies depend on quantitative changes concerning the growth of production, employment, investment, the size of functioning capital, income, consumption and other economic quantities that characterize the economy from the quantitative side (economic growth), as well as accompanying changes of a qualitative nature (changes in the organization of society) and changes of a structural nature, as well as technical progress.
European Union countries are not well prepared to implement Industry 4.0 and 5.0. This is expressed in the low percentage of enterprises that employ ICT specialists

and enterprises that recruited or tried to recruit personnel for jobs requiring ICT specialist skills and its changes in 2020 compared to 2012. A clear increase in the percentage of enterprises that employ ICT specialists is observed in a few European Union countries, mainly Eastern European countries.

The nature of the subject matter with the constantly present changes in the operating-, and risk- and control environment and the concern areas in the context of Industry 4.0 and 5.0 underpin the need for future research in this field. The available data sources can be reviewed over time. Future research could identify and compare the changes and their impact in years.

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PRZEMYSŁ 4.0 I 5.0 - ORGANIZACYJNE I KOMPETENCYJNE WYZWANIA PRZEDSIĘBIORSTW

Streszczenie: Digitalizacja, upowszechnienie rozwiązań z zakresu sztucznej inteligencji oraz robotyzacja torują drogę nowym trendom w przemyśle, które kształtują ramy nowej ery przemysłowej. Era ta niesie ze sobą zarówno korzyści, jak i wady dla niektórych przedsiębiorstw. Zdecydowanie szybka reakcja jest koniecznością, gdy przedsiębiorstwa muszą dostosować swoje strategie, produkty i usługi do najnowszych wymagań klientów. Trendy te mają solidny wpływ na zarządzanie zasobami ludzkimi i pracę wykonywaną przez człowieka, a jednocześnie stanowią poważne zagrożenie dla bezpieczeństwa organizacji. Badania mają na celu zbadanie, co oznacza termin Przemysł 5.0 i czym różni się on od Przemysłu 4.0. Badania ukazują zmieniającą się rolę zarządzania zasobami ludzkimi w kontekście niezbędnych kompetencji cyfrowych i komputerowych społeczeństwa, podkreślają niektóre aspekty bezpieczeństwa oraz analizują, w jaki sposób przedsiębiorstwa, w tym MŚP, wpisują się w erę Przemysłu 4.0 i 5.0.

Słowa kluczowe: Przemysł 4.0, Przemysł 5.0, roboty współpracujące, bezpieczeństwo, zarządzanie ryzykiem, zasoby ludzkie

工业4.0和5.0--企业的组织和能力挑战

摘要：数字化、人工智能解决方案的普及和机器人化为新的工业趋势铺平了道路，形成了新的工业时代框架。这个时代为一些企业带来了好处和坏处。肯定的是，当企业需要根据最新的客户要求调整他们的战略、产品和服务时，迅速的反应是必须的。这些趋势对人力资源管理和人类从事的工作产生了良好的影响，同时也对组织构成了严重的安全威胁。该研究旨在探索工业5.0**一**词的含义，以及它与工业4.0**的区**别。研究揭示了在社会必要的数字和计算机能力的背景下，人力资源管理的变化作用，强调了一些安全方面的问题，并研究了企业，包括中小企业，如何融入工业4.0**和**5.0时代

关键字。工业4.0, **工**业5.0, 协作机器人，安全，风险管理，人力资源