

**TRANSFORMING HUMAN CAPITAL FOR THE DIGITAL
AGE: INDUSTRY 4.0 AND 5.0**

Transformando el capital humano para la era digital:
Industria 4.0 y 5.0

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ABSTRACT

The advent of Industry 4.0 and 5.0, characterized by integrating modern technologies and automation, significantly reshapes the workplace and the need for specific skills. The article aims to analyze the impact of Industry 4.0 and 5.0 on human resources, focusing on the challenges and benefits these technological breakthroughs provide for workforce expansion. This study investigates the impact of Industry 4.0 and 5.0 on human capital via a comprehensive analysis of current trends and future projections. The article suggests that Industry 4.0 and 5.0 provide significant challenges to the labor market, including job displacement and the need for skill adaption. Nevertheless, they also provide significant potential for enhancing productivity and competitiveness. The report emphasizes the immediate need for focused investment in enhancing human resources, facilitated by advantageous governmental policies and educational overhauls.

Keywords: Human capital, transformation, digital age, Industry 4.0, Industry 5.0.

RESUMEN

La llegada de la Industria 4.0 y 5.0, caracterizada por la integración de tecnologías modernas y la automatización, ha transformado significativamente el lugar de trabajo y la necesidad de habilidades específicas. El artículo tiene como objetivo analizar el impacto de la Industria 4.0 y 5.0 en los recursos humanos, centrándose en los desafíos y beneficios que estos avances tecnológicos brindan para la expansión de la fuerza laboral. Este estudio investiga el impacto de la Industria 4.0 y 5.0 en el capital humano a través de un análisis integral de las tendencias actuales y las proyecciones futuras. El artículo sugiere que la Industria 4.0 y 5.0 plantean desafíos importantes para el mercado laboral, incluido el desplazamiento de puestos de trabajo y la necesidad de adaptación de habilidades. Sin embargo, también ofrecen un potencial significativo para mejorar la productividad y la competitividad. El informe enfatiza la necesidad inmediata de una inversión enfocada en la mejora de los recursos humanos, facilitada por políticas gubernamentales ventajosas y reformas educativas.

Palabras claves: Capital humano, transformación, era digital, Industria 4.0, Industria 5.0.

INTRODUCCIÓN

The emergence of Industry 4.0 and 5.0, known as the Fourth and Fifth Industrial Revolutions, has ushered in the digital era, providing a transformative setting for the advancement of human resources. The current era is characterized by the rise of intelligent technologies, automation, and enhanced connectivity, which are fundamentally transforming the composition of the labor force and the necessary skills to navigate the future of work effectively. It is vital to understand the intricate impact of these technical advancements on human resources, which are fundamental for the development and long-term viability of any economy.

The shift from Industry 4.0 to 5.0 represents a significant evolution towards systems that are characterized by enhanced intelligence, efficiency, and connectivity. The research conducted by Sima et al. examines the influence of Industry 4.0 on the advancement of human capital and customer behavior. They emphasize the need to perform a comprehensive study to have a complete understanding of these alterations [1]. In their study, Alimam et al. investigate the idea of intelligent retrofitting, highlighting the transition to a digital triplet hierarchy as a key component of Industry 5.0 [2]. This shift emphasizes the urgent need to rethink human capital in order to harness the opportunities presented by these economic shifts.

Orlova offers significant insights into the construction of personal paths for professional advancement in the information society during the age of Industry 5.0. She proposes using adaptive and flexible learning frameworks to efficiently meet the demands of a rapidly evolving digital economy [3]. The study conducted by Alcácer and Cruz-Machado highlights the need for flexibility and continu-

ous learning in the context of Industry 4.0's technological underpinnings and production systems. The article emphasizes the necessity of adopting a complete strategy for workforce development [4].

Furthermore, the transition to a digital society and Industry 5.0 necessitates a deep understanding of the role of information technology, as examined by Martynov et al. [5]. The construction of this technological infrastructure is essential for enabling humans to adapt and thrive in new digital environments. Setianingsih et al. examine the relationship between the readiness of human resources in Era 4.0 and the digital culture in terms of employee performance, illustrating the intricate link between digital transformation and workforce competence [6].

The research undertaken by Savastano et al. [7] provides insights into the broader impacts of digital transformation on industrial processes, specifically regarding the enhancement of human resources. Mourtzis et al. investigate the challenges and benefits associated with transitioning from Industry 4.0 to Society 5.0, providing a comprehensive understanding of the conditions necessary for the transformation of human resources [8].

The article aims to provide a thorough comprehension of the challenges and benefits associated with human resources in the age of digitalization. By integrating information from many scholarly sources, our objective is to uncover the processes via which human skills may be developed and adjusted to meet the demands of Industry 4.0 and 5.0. The goal is to provide individuals and organizations with the necessary knowledge and skills to navigate the complexities of the digital era proficiently. This will guarantee their ability to endure and adjust to the continuous technological progress, fostering resilience, adaptability, and sustainability.

The Aim of the Article

The article aims to examine the effects of the Fourth and Fifth Industrial Revolutions (Industry 4.0 and 5.0) on human capital and the difficulties and possibilities they bring. This paper discusses how education, training, and development programs may help people, businesses, and governments adjust to the dynamic nature of the labor market. Ultimately, the study highlights the significance of human capital transformation in the digital era and guides how to prepare for Industry 4.0 and 5.0.

Problem Statement

The Fourth and Fifth Industrial Revolutions (Industry 4.0 and 5.0), in particular, are changing the nature of employment and the skills necessary to compete in the digital era. The demand for human capital transformation is growing, and this transition is presenting difficulties and possibilities for people, businesses, and governments. Unfortunately, there needs to be more knowledgeable about the advantages and disadvantages of Industry 4.0 and 5.0 and how people, businesses, and governments may be ready for the digital future. This article thus highlights how human capital might be changed to prepare for the digital era and the difficulties and possibilities given by Industry 4.0 and 5.0.

The increasing use of new technologies like artificial intelligence, the Internet of Things, and sophisticated robotics is a significant challenge brought on by Industry 4.0 and 5.0 since it is automating numerous processes and transforming the nature of employment. It is leading to a gap between the skills now held by the workforce and those necessary for future employment. Lack of investment in training and development programs, especially by smaller and medium-sized businesses, may also hinder human capital transformation. In addition, underprivileged populations face disproportionately high barriers to

participation in educational and vocational opportunities. These obstacles must be overcome to guarantee that everyone is equipped with the abilities necessary to thrive in the digital era.

LITERATURE REVIEW

The Fourth Industrial Revolution, characterized by the incorporation of advanced digital technologies, artificial intelligence (AI), and the Internet of Things (IoT), has resulted in significant changes across several sectors, including manufacturing, healthcare, and public welfare. This academic research synthesizes concepts from prior scholarly works to thoroughly examine the many impacts of Industry 4.0 on innovation, public health, ethical concerns, and the requisite competencies for proficiently navigating these transformations.

In their study, Sapta et al. investigate the relationship between the conversion of digital resources and the welfare of public health. They emphasize the significance of social capital and the sharing of information in enhancing public health initiatives in rural creative businesses [9]. This study emphasizes the potential of digital tools to enhance public health outcomes via community involvement and information exchange. It facilitates the use of digital technologies to enhance knowledge about health and execute actions.

Mahmood and Mubarik examine the relationship between creativity, intellectual capital, and the capacity to embrace and use technology within the framework of the fourth industrial revolution [10]. They argue that finding an equilibrium between innovation and the use of existing technology is crucial for businesses aiming to thrive in Industry 4.0. They stress the significance of intellectual capital as a crucial element in effectively adjusting to and profiting from new technologies.

Prim et al. examine the conduct of intangible assets, such as organi-

zational knowledge and skills, throughout the adoption of Industry 4.0 technologies [11]. Their study highlights the vital importance of creating a conducive atmosphere that fosters continuous learning and skill development, enabling organizations to navigate the challenges and opportunities presented by Industry 4.0 efficiently.

The advent of novel technology gives rise to significant apprehensions about ethical dilemmas and privacy problems. Dhirani et al. investigate the challenges associated with the use of AI and IoT technologies, as outlined in reference [12]. The review underscores the need for robust ethical frameworks and privacy-preserving protections to secure individuals' rights and instill trust in the utilization of technology.

The research done by Yu et al. investigates the progressive development of the manufacturing sector, focusing on the economic benefits that can be obtained by improving supply chain relationships and using environmentally conscious management practices [13]. Their analysis emphasizes the potential of Industry 4.0 technologies to enhance operational efficiency and sustainability, hence making significant contributions to both economic and environmental objectives.

Ghobakhloo examines the capacity of digitization and Industry 4.0 to promote sustainability and advocates for the integration of sustainable practices within the digital transformation agenda [14]. Adopting this perspective is essential to guarantee that the technological advancements of Industry 4.0 align with the goals of sustainable development.

Herceg et al. examine the difficulties and incentives associated with the implementation of Industry 4.0. The authors highlight crucial determinants that impact the effective implementation of Industry 4.0 technologies, including the readiness of the

organization, the dedication of leadership, and the acquisition of essential skill [15].

Erceg and Zoranović highlight the need to have a skilled workforce capable of proficiently using digital tools and technologies to accomplish a successful digital transformation. They explicitly emphasize the importance of having the requisite skills for this objective [16]. Their research emphasizes the ever-changing nature of work and the increasing need for digital literacy, critical thinking, and adaptability in the job market.

Rajnai and Kocsis assess the degree of readiness of companies to embrace digital transformation within the framework of Industry 4.0, providing useful insights about organizational preparedness [17]. Their study underscores the disparities in readiness levels across different sectors and underscores the need for targeted endeavors to facilitate the transition to Industry 4.0.

The transition towards Industry 4.0 and subsequent advancements need a comprehensive approach that encompasses innovation management, ethical considerations, sustainability, and workforce enhancement. These studies highlight the need to integrate digital transformation strategies with sustainability goals, ethical standards, and continuous learning frameworks in order to fully use the potential of Industry 4.0 for the betterment of society.

REINVENTING EDUCATION FOR THE DIGITAL ERA: KEY DIRECTIONS OF TRANSFORMATION

The digital transformation in education is leading to significant changes in the way education is delivered, accessed, and experienced. The main directions of this transformation include:

Online Learning: The growth of online learning platforms and the availability of massive open online cour-

ses (MOOCs) is enabling students to access educational content from anywhere and at any time. This has greatly expanded access to education and is changing the traditional model of education delivery. Coursera, edX, and Udemy are examples of online learning platforms that offer massive open online courses (MOOCs) on a wide range of subjects. These platforms allow students to access educational content from anywhere and at any time, and have greatly expanded access to education [18], [19].

Technology-Enhanced Classrooms: The integration of technology in classrooms is allowing for a more interactive and engaging learning experience. This includes the use of digital whiteboards, interactive displays, and learning management systems. Smartboards, interactive displays, and learning management systems such as Blackboard and Canvas are examples of technology that is being used to enhance the classroom experience. These technologies allow for a more interactive and engaging learning experience and have the potential to improve student outcomes [20].

Personalized Learning: Digital technologies are enabling personalized learning experiences tailored to the individual needs and interests of students. This includes the use of artificial intelligence and machine learning algorithms to provide personalized recommendations and feedback. Adaptive learning platforms such as Knewton and DreamBox are examples of technology that is being used to personalize the learning experience. These platforms use artificial intelligence and machine learning algorithms to provide personalized recommendations and feedback to students, and have the potential to greatly improve student engagement and achievement [21], [22].

Data-Driven Decision Making: The availability of educational data and analytics tools is allowing educational institutions to make data-driven

decisions about teaching and learning. This includes the use of data to track student progress, identify areas for improvement, and develop targeted interventions. Data analytics tools such as PowerSchool and Illuminate Education are examples of technology that is being used to support data-driven decision making in education. These tools allow educational institutions to track student progress, identify areas for improvement, and develop targeted interventions to support student success [23], [24].

Blended Learning: The integration of online and traditional classroom-based learning is creating blended learning environments that offer the best of both worlds. This allows for the flexibility of online learning and the benefits of face-to-face interaction with teachers and peers. Blended learning environments such as those offered by online charter schools and hybrid schools are examples of the integration of online and traditional classroom-based learning. These environments offer the flexibility of online learning and the benefits of face-to-face interaction with teachers and peers, and have the potential to improve student outcomes and engagement [25], [26].

The digital transformation in education is leading to more accessible, personalized, and engaging learning experiences for students and has the potential to greatly improve the effectiveness and efficiency of education delivery.

METHODS AND MODELS

There are several methods and models that can be used to support human capital transformation for the digital age. Some of the key methods and models include:

Competency-based education and training (CBET) is an approach to education and training that focuses on developing the skills and competencies that are in demand for Indus-

try 4.0 and 5.0. Rather than focusing on completing a certain number of courses or accumulating a set number of credit hours, CBET programs are designed to provide students and workers with the knowledge and experience they need to succeed in the digital age [27].

CBET programs are often designed with input from employers to ensure that the skills and competencies taught in the program are aligned with the needs of the industry. CBET programs also often incorporate digital technologies and hands-on learning experiences, such as simulations, case studies, and project-based learning [28].

Table 1. Competency-Based Education/Learning Model

Model	Description	Example
Mastery-based learning	Students work at their own pace and must demonstrate mastery of each learning objective before moving on to the next one.	A student taking an online course that requires them to pass a quiz on a specific topic before moving on to the next lesson. A high school student demonstrating proficiency in a math concept before moving on to the next level.
Personalized learning	Instruction and resources are tailored to each student's individual needs and interests.	A student in a language class being given additional resources and guidance to help them with a specific grammar concept they are struggling with. A student with dyslexia receiving assistive technology and support to help them with reading and writing.
Self-directed learning	Students take responsibility for their own learning and are empowered to explore topics on their own.	A student pursuing an independent research project in a subject that interests them. A professional learning on their own using online resources to improve their skills.
Apprenticeships	Students learn a skill or trade through a combination of classroom instruction and on-the-job training.	A student learning carpentry skill through a carpentry apprenticeship program. An aspiring chef learning cooking skills by working in a restaurant kitchen.
Competency-based training	Training programs are designed around specific competencies needed for a job or profession.	A nursing training program that focuses on developing specific skills needed for the job, such as administering medication and monitoring vital signs. A coding bootcamp that teaches specific coding skills and languages required by employers.

An example of a CBET program could be a coding bootcamp. In this program, students would focus on developing the specific coding skills and competencies that are in demand for Industry 4.0 and 5.0, such as programming languages like Python or Java, software development, and web development.

Modeling and a digital twin refer to the creation of virtual representations of physical systems, processes, and environments. In the context of education and training, modeling and digital twin technology can be used to provide students and workers with

hands-on experience and develop the necessary skills for Industry 4.0 and 5.0. Modeling involves creating a simulation of a system, process, or environment that can be used to test different scenarios and make decisions. For example, in engineering, students can use modeling to simulate real-world systems, such as power plants or manufacturing processes, to gain a deeper understanding of the concepts they are studying [29].

A digital twin refers to a virtual representation of a physical system, process, or environment that can be used to monitor and control the

system in real-time. digital twin technology can be used to create virtual representations of physical systems, processes, and environments. In education and training, digital twin technology can be used to provide students and workers with hands-on experience and develop the necessary skills for Industry 4.0 and 5.0. In education and training, digital twin technology can be used to create immersive and interactive learning experiences that simulate real-world scenarios and situations, helping individuals to develop the necessary skills for Industry 4.0 [30], [31].

Each of these digital twin technology models allows for real-time monitoring, analysis, and optimization of physical objects and systems. By si-

mulating the behavior and performance of physical objects and systems in a digital environment, organizations can identify and address issues before they become problems. Additionally, digital twin technology can help improve the efficiency and productivity of physical objects and systems by providing real-time data and insights. In training programs, digital twins can also be used to provide workers with immersive and interactive learning experiences that simulate real-world scenarios and situations. This can help them to develop the necessary skills for Industry 4.0, such as critical thinking, problem-solving, and collaboration.

Table 2. Digital Twin Technology Model

Model	Description	Example
Virtual twin	A digital model that simulates the physical characteristics and behavior of a physical object or system.	A virtual model of an airplane that simulates the performance of the airplane in different weather conditions.
Hybrid twin	A combination of a virtual twin and real-time data from sensors embedded in the physical object or system.	A hybrid twin of a wind turbine that uses real-time data to monitor performance and predict maintenance needs.
Process twin	A digital model that simulates the behavior and performance of a manufacturing process.	A process twin of a car manufacturing assembly line that simulates the flow of materials and the performance of each machine in the line.
System twin	A digital model that simulates the behavior and performance of a complex system made up of multiple interconnected objects or processes.	A system twin of a city's transportation system that simulates the flow of traffic, the performance of each vehicle, and the impact on the environment.

Blended learning is an approach to education that combines both online and in-person learning experiences. This approach allows students

to learn in a variety of settings and at their own pace, while also providing opportunities for interaction and collaboration with teachers and peers [32].

Table 3. Blended Learning Model

Model	Description	Example
Flipped Classroom	Students learn new content online outside of class and use class time for collaborative activities and discussions.	Students watch a video lecture before class and then participate in group discussions or projects during class time.
Rotation Model	Students rotate between online and offline learning activities, working on specific tasks or projects.	Students spend one-hour learning math online, then switch to group activities for one hour, then work with the teacher for one hour.

Flex Model	Students work independently online and offline, with support and guidance from the teacher as needed.	Students complete online activities and assignments at their own pace, with the teacher providing feedback and support as needed.
Station Rotation	Students rotate between different learning stations, such as online learning, small-group instruction, and individual work.	Students spend one hour working independently online, then switch to small-group instruction for one hour, and then work on individual assignments for one hour.
Online Lab	Students complete online coursework and receive hands-on support and instruction in a physical lab.	Students complete online science coursework and then receive hands-on instruction and practice in a science lab.

Gamification — This approach incorporates elements of game design into education and training programs to make learning more engaging and enjoyable. Gamification can be used

to motivate students and workers to learn and develop the necessary skills for Industry 4.0 and 5.0 [33], [34].

Table 4. Gamification method with them models

Model	Description	Example
Points, Badges, and Leaderboards	Students earn points and badges for completing specific tasks or reaching certain milestones, and their progress is tracked on a leaderboard.	A language learning app that awards points and badges for completing lessons and quizzes, and shows the user's ranking on a leaderboard.
Quests and Challenges	Students complete quests or challenges to earn rewards and progress through a game-like environment.	A math game that requires students to complete a series of challenges to progress through different levels and earn rewards.
Simulations and Role-Playing	Students participate in simulations or role-playing activities to learn and practice skills in a game-like environment.	A healthcare training program that uses a simulation to allow students to practice diagnosing and treating patients in a virtual hospital.
Narrative-Based Games	Students engage in a game-like environment that involves a storyline or narrative, allowing them to immerse themselves in a fictional world.	A language learning game that uses a fictional story to engage students and help them learn vocabulary and grammar in context.

Collaborative learning - This approach focuses on promoting collaboration and teamwork among students and workers. Collaborative learning can be used to develop critical

thinking, problem-solving, and communication skills, which are essential for success in the digital age [35].

Table 5. Collaborative learning with models

Model	Description	Example
Project-based learning	Students work together in groups to research and solve a real-world problem or challenge.	Designing an app to solve a community problem.
Peer teaching	Students take turns teaching each other a specific concept or skill.	Students in a language class teach each other grammar rules.

Jigsaw method	Students are divided into small groups, each responsible for learning one aspect of a larger topic. After each group has mastered their portion of the material, they share their knowledge with the other groups.	Each group in a history class researched a different aspect of a historical event and then shared their findings with the class.
Problem-based learning	Students work together in groups to solve a specific problem or challenge.	Designing and conducting a science experiment to test a hypothesis.
Case study method	Students work in groups to analyze and solve a complex problem or case study.	Analyzing a real-world business problem and proposing a solution in a business class.

These methods and models can be combined and customized to create effective and innovative education and training programs that support human capital transformation for the digital age.

PROGRAMS FOR TRANSFORMATION OF HUMAN CAPITAL

In the digital age, the development of new technologies and automation is changing the nature of work and the skills that are in demand. As a result, the transformation of human capital has become increasingly important for individuals and organizations to remain competitive.

Investing in education, training, and development programs is one way to transform human capital. These programs help individuals and organizations to acquire new skills and knowledge, adapt to the changing job market, and remain competitive in the digital age. The role of governments and educational institutions is also critical in promoting human capital transformation and providing the necessary support to individuals and organizations.

Programs for Helping Individuals and Organizations Acquire New Skills and Knowledge:

- **Online courses and training programs:** Many websites and platforms offer online courses and training programs that individuals can take at their own pace. These programs cover a wide range of topics and can help individuals to

acquire new skills and knowledge.

- **Professional development programs:** Many organizations offer professional development programs for their employees. These programs can include workshops, training sessions, and conferences that help employees to develop new skills and knowledge.
- **Degree and certification programs:** Degree and certification programs can help individuals to acquire new skills and knowledge in a specific field. These programs are often offered by universities and colleges and can range from short-term courses to full-fledged degree programs.
- **Apprenticeships and internships:** Apprenticeships and internships are programs that provide individuals with hands-on experience in a specific field. They can help individuals to acquire new skills and knowledge while also gaining practical experience.
- **Workshops and conferences:** Workshops and conferences are events that bring together experts in a specific field to share their knowledge and experience. Attending these events can help individuals to acquire new skills and knowledge and network with others in their field.

Programs for Helping Individuals and Organizations Adapt to the Changing Job Market:

- Career counseling and job placement services: Career counseling and job placement services can help individuals to assess their skills and interests and find job opportunities that match their needs.
- Job training programs: Job training programs are designed to help individuals acquire the skills and knowledge needed for specific jobs. These programs can be offered by governments, non-profit organizations, or employers.
- Career fairs and job expos: Career fairs and job expos are events that bring together employers and job seekers. These events can help individuals to learn about job opportunities and network with potential employers.

Programs for Helping Individuals and Organizations Remain Competitive in the Digital Age:

- Digital skills training programs: Digital skills training programs are designed to help individuals acquire the digital skills needed for success in the digital age. These programs can include courses on coding, data analysis, and digital marketing.
- Professional networking events: Professional networking events are events that bring together individuals in a specific field to network and exchange ideas. Attending these events can help individuals to stay up-to-date with industry trends and connect with potential employers.
- Mentorship programs: Mentorship programs pair individuals with experienced professionals who can provide guidance and support. These programs can help individuals to acquire new skills and knowledge and stay competitive in the digital age.

However, there are also challenges to transforming human capital in the digital age. The cost of education, training, and development programs can be high, and access to technology and resources may be limited in some regions. Additionally, the development of new technologies and automation may lead to job displacement, which can have a negative impact on the job market and the overall economy.

It is difficult to determine the best program for transforming human capital in the digital age as it depends on the specific needs and goals of individuals and organizations. Some popular programs include:

- Online courses and certifications - platforms such as Coursera, Udemy, and LinkedIn Learning offer a wide range of courses and certifications in a variety of subjects, including technology and digital skills.
- On-the-job training programs - many organizations offer on-the-job training programs to help employees acquire new skills and knowledge.
- Professional development programs - organizations such as the Institute of Management or the Project Management Institute offer professional development programs and certifications.
- Apprenticeships - apprenticeships provide hands-on training and experience in a specific field or industry.
- Bootcamps - boot camps are intensive, short-term training programs focused on a specific skill or technology.

It is important for individuals and organizations to carefully evaluate their needs and goals and choose a program that best meets their specific requirements.

Transforming human capital for the digital age requires a multi-faceted approach involving individuals, organizations, governments, and educational institutions. Here are some key programs that each of these groups can undertake:

Individuals: In order to transform their own human capital for the digital age, individuals can take the following steps:

- Continuously upgrade their skills and knowledge through self-learning and online courses.
- Seek opportunities to work on projects and assignments that involve the use of digital technologies.
- Network and engage with experts in their field to stay up-to-date with the latest trends and technologies.
- Join communities of practice and professional associations to learn from peers and share knowledge.
- Consider getting certifications or professional development programs to demonstrate their skills and competencies to employers.

Organizations:

- To transform their human capital for the digital age, organizations can implement the following programs:
- Offer training and development programs that focus on the skills and competencies needed for Industry 4.0 and 5.0.
- Provide opportunities for employees to work on digital projects and learn new skills on the job.
- Use digital technologies to enhance the employee learning experience, such as e-learning platforms and virtual reality training.
- Encourage and support employee innovation and experimental

tion with new technologies.

- Foster a culture of continuous learning and growth.

Governments:

- To transform human capital at the national level, governments can undertake the following initiatives:
- Develop policies and funding programs to support education and training programs that focus on Industry 4.0 and 5.0 skills and competencies.
- Encourage public-private partnerships to support the development of digital skills.
- Foster entrepreneurship and innovation in the digital sector through funding programs and regulatory frameworks.
- Develop and promote national digital literacy programs to enhance the digital skills of the population.
- Promote and incentivize companies to invest in the development of their human capital.

Educational institutions:

- To transform their programs to prepare students for Industry 4.0 and 5.0, educational institutions can implement the following:
- Develop and offer programs that focus on the skills and competencies needed for the digital age, such as data analysis, cybersecurity, and artificial intelligence.
- Incorporate digital technologies and online learning platforms into their curriculum to enhance the learning experience.
- Provide opportunities for students to work on digital projects and gain practical experience.
- Foster innovation and entrepre-

neurship through incubator programs and partnerships with industry.

- Develop programs that promote continuous learning and professional development for graduates.

By investing in their human capital through education, training, and development programs, individuals and organizations can acquire new skills and knowledge, stay current with technological advancements, and remain competitive in the job market. These programs can also help individuals and organizations to adapt to the changing demands of the digital age, including Industry 4.0 and 5.0. This investment in human capital can have a positive impact on the individual's or organization's competitiveness and overall success in the digital age.

The transformation of human capital is essential for success in the digital age, but it requires a commitment of time, resources, and effort from individuals, organizations, governments, and educational institutions.



Figure 1. Advantages of Transforming Human Capital for the Digital Age: Industry 4.0 and 5.0

RESULT

The results of transforming human capital for the digital age can be observed in various countries and industries, and can be quantified through data analysis. Some examples of these results include:

Increased competitiveness - In countries such as Germany and South Korea, investment in human capital

has led to increased competitiveness and a strong presence in industries such as manufacturing and technology. Data analysis shows that these countries have higher levels of productivity and economic growth compared to countries with less investment in human capital.

Improved job opportunities - In countries such as the United States and Canada, investment in human capital has led to the creation of new and better job opportunities in industries such as information technology and renewable energy. Data analysis shows that these countries have lower unemployment rates and higher levels of job satisfaction compared to countries with less investment in human capital.

Improved education and training outcomes - In countries such as Finland and Singapore, investment in education and training programs has led to improved outcomes in terms of literacy, numeracy, and digital skills. Data analysis shows that these countries have higher levels of educational attainment and higher scores on international assessments such as PISA and TIMSS.

Increased innovation and creativity - In countries such as Israel and Sweden, investment in human capital has led to increased innovation and creativity in industries such as technology and biotech. Data analysis shows that these countries have higher levels of patent activity and a higher concentration of high-tech firms compared to countries with less investment in human capital.

These examples demonstrate the positive impact that transforming human capital for the digital age can have on individuals, organizations, and society as a whole. By analyzing data and comparing the outcomes of different countries and industries, we can further understand the impact of this transformation and identify best practices for promoting human capital development.

A successful human capital transformation is the approach taken by the government of Germany. The German government has implemented a range of policies and initiatives aimed at promoting human capital transformation and developing a skilled and competitive workforce. This includes investing in education and training programs, providing support for businesses to adopt Industry 4.0 technologies, and promoting the development of new skills and competencies. As a result, Germany has become a leader in Industry 4.0 and has a highly skilled and competitive workforce.

The approach taken by companies such as Google and Amazon, who have invested heavily in their employees' education, training, and development programs. These companies have recognized the importance of human capital transformation in the digital age and have taken proactive steps to prepare their workforce for the future. This has not only helped these companies to remain competitive, but has also provided their employees with the skills and knowledge they need to succeed in the rapidly changing job market.

Data analysis has shown that countries and organizations that have invested in human capital transformation have achieved significant benefits. For example, countries with highly skilled and competitive workforces have seen higher levels of economic growth and increased competitiveness. Similarly, organizations that have invested in their employees' education, training, and development programs have experienced higher levels of productivity, innovation, and employee engagement. Let's look at the example of Eastern Europe, who provides training when choosing a job, how quickly people adapt to changes in skills.



Figure 2. Eastern Europe training providers



Figure 3. Motives for choosing a certain workplace



Figure 4. The Typical Need for Retraining in North America (share of workforce)

Here the list the most necessary jobs, which similar for most countries:

- Software and Applications Developers
- Analysts Data Analysts
- Scientists Sales
- Marketing Professionals Managing
- Directors Chief Executives
- General Operations Managers
- Sales Representatives, Wholesale and Manufacturing,
- Technical and Scientific Products
- Human Resources Specialists
- Financial Analysts Assembly and Factory Workers
- Financial and Investment Advisers

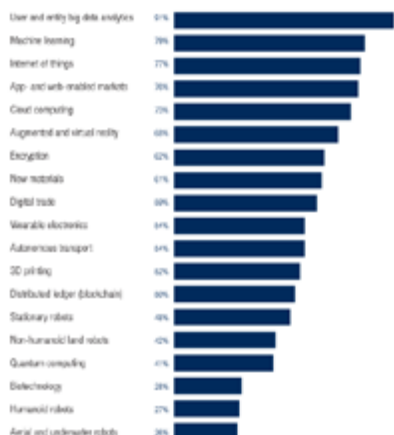


Figure 5. Implementation of New Technologies (share of companies surveyed) on the examples Of Middle East and North Africa

Individuals and businesses may boost their competitiveness, employment opportunities, and readiness for the technological changes of Industry 4.0 and 5.0 by investing in their human resources. Individuals and businesses may use these programs to stay ahead of the curve and compete in the quickly developing digital world by taking advantage of the opportunities for ongoing learning and growth that they provide.

DISCUSSION

The advent of the Fourth and Fifth Industrial Revolutions, also known as Industry 4.0 and 5.0, has profoundly affected human resource growth, resulting in a pivotal transformation in the worldwide job market and the broader socio-economic landscape. This discourse aims to compare the findings of the current research with those of earlier studies, emphasizing new insights and their potential ramifications.

Sima et al. have highlighted the substantial impact of Industry 4.0 on advancing human resources and consumer conduct. They have emphasized the need to undertake systematic reviews in order to have

a comprehensive grasp of these repercussions [1]. Our analysis corroborates these viewpoints, offering more insights into how technological advancements influence the dynamics of the labor market and the requisite skill sets. Unlike Sima et al., our study builds upon the discourse by examining the implications of Industry 5.0, offering a more extensive viewpoint on the continuous advancement of human resources in conjunction with growing technology.

Alimam et al. examine the concept of intelligent retrofitting inside the digital triplet hierarchy, offering insights into the technological underpinnings of Industry 4.0 and 5.0 [2]. We enhance their analysis by examining the human capital dimension of these technological shifts. With the retrofitting of technology, the concurrent development of human capital is crucial for effectively using these advancements.

Orlova investigates the development of personalized career trajectories to promote employee advancement within the context of Industry 5.0 [3]. Our research aligns with this finding since it advocates for using customized and adaptable learning frameworks to prepare the workforce for future challenges. Our study offers new insights into applying these frameworks on a broad scale, emphasizing the importance of government and organizational support in fostering these avenues for development.

Alcácer and Cruz-Machado conducted a comprehensive study of manufacturing system technologies in the context of Industry 4.0 in their literature review [4]. We build from their foundational research by investigating the ramifications of these technologies on human capital, emphasizing inadequacies in skills, and proposing strategies to address these inadequacies. We provide cutting-edge frameworks for continuous skill development, focusing on the dynamic nature of technology adaptation.

Prim et al. examine the patterns of intangible resources in adopting Industry 4.0 [11], a relevant subject to our research. Furthermore, we enrich the dialogue by correlating these intangible assets and specific human capital attributes, such as ingenuity, analytical reasoning, and adaptability. This offers a more thorough analysis of how specific skills may be cultivated.

Dhirani et al. examine the ethical dilemmas and privacy issues that arise throughout technology development [12]. Our research acknowledges the existence of these difficulties and proposes ethical frameworks and educational curricula that include ethical concerns in the development of human resources for Industry 4.0 and 5.0. This groundbreaking and substantial contribution bridges the gap between technological advancement and ethical management.

After analyzing our findings compared to previous research, it is evident that although most studies have focused on the technological and organizational components of Industry 4.0 and 5.0, there still needs to be a critical need to fully understand and address the transformation of human resources. The current article offers new perspectives by emphasizing the need for a holistic approach to cultivating human skills, which encompasses adaptive learning techniques, ethical considerations, and a focus on intangible capabilities. These insights enrich the existing knowledge and provide practical frameworks for stakeholders to anticipate and address the ongoing and future challenges posed by the digital era..

CONCLUSION

The Fourth and Fifth Industrial Revolutions (also known as Industry 4.0 and Industry 5.0) are now redefining the fundamental characteristics of work and the kinds of talents in high demand. Human capital transformation is becoming more critical for individuals and businesses to remain competitive in the digital age.

In this paper, we investigated the implications of Industry 4.0 and 5.0 on human capital, including the opportunities and dangers that may arise due to their implementation. It has been shown that to meet the dynamic demands of the labor market, individuals and organizations must develop their human resources via schooling, preparation, and training programs. It has been brought to light as a result of those mentioned above. The role that governments and educational institutions play in supporting transformations in human capital and providing critical assistance to individuals and organizations is another topic investigated in this paper.

The literature review reveals that many academics and professionals have the same point of view about the necessity of human capital transformation in this era of digital technology. There are a variety of viewpoints on the most effective approach to bringing about this shift, and further research is necessary to determine which methods will be the most effective.

The article discusses the importance of human capital transformation in the digital world and describes how to prepare for Industry 4.0 and 5.0. In order to stay relevant and competitive in the digital era, businesses and people must embrace lifelong learning and consistently invest in their skills and knowledge. It also emphasizes the necessity of cooperation between governments, educational institutions, and businesses to foster human capital transformation and ensure that everyone can take advantage of the opportunities afforded by Industry 4.0 and 5.0. It is done to ensure that everyone can take advantage of the possibilities afforded by Industry 4.0 and 5.0.

The transformation of human capital into a form suitable for the digital age is necessary for the success of individuals, companies, and whole communities in today's dynamic glo-

bal economy. As the rapid pace of technological advancement is not going away soon, it is up to us to adjust and make the most of the opportunities presented by Industry 4.0 and 5.0.

Industry 4.0 and 5.0 are the most recent expressions of how the digital revolution alters our lives and work. Because new technologies are changing quickly, jobs are becoming more diverse and requiring a more comprehensive range of skills. To flourish in today's digital economy, individuals and corporations must invest in developing their human capital. People and organizations must invest in chances for learning and advancement to keep up with the constantly shifting job market requirements.

Human capital transformation depends not just on the efforts of for-profit corporations and charitable organizations but also on the aid of public sector organizations and educational establishments. That involves ensuring that individuals have access to adequate and affordable education and training programs, enacting policies, and promoting learning throughout one's life. Unsurprisingly, individuals and companies must alter their human capital to succeed in the digital age. We must prioritize human capital development to ensure that no one is left behind as we go on with the Fourth and Fifth Industrial Revolutions. The best way to ensure everyone has access to the knowledge and skills they need to thrive in the digital world is to invest in training, education, and career advancement and create an environment supporting innovation and entrepreneurial activity.

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