Strategic Innovations in Industry 5.0: Overcoming the Challenges of Industry 4.0

Innovaciones estratégicas en la Industria 5.0: Cómo superar los retos de la Industria 4.0

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ABSTRACT

Introduction: The transition from Industry 4.0 to Industry 5.0 marks a significant evolution in the field of manufacturing and automation. Industry 4.0 introduced the integration of digital technologies, data analytics, and connectivity to optimize industrial processes and enable smart factories. However, Industry 5.0 takes this transformation to a new level by emphasizing the collaboration and interaction between humans and machines.
Objective: While this industrial revolution holds immense potential for industrial growth, it also presents numerous challenges such as technical integration, human resource management, supply chain complexities, and data security concerns. However, the advent of Industry 5.0 promises to address these challenges head-on. Industry 5.0 introduces innovative technologies like predictive maintenance, hyper customization, cyber-physical cognitive systems, and collaborative robots. By prioritizing a human-centric approach, Industry 5.0 successfully overcomes the hurdles encountered in Industry 4.0, paving the way for a more efficient and collaborative future in the industry.
Method: This paper investigates the evolution from Industry 4.0 to Industry 5.0, focusing on the distinctive features and advancements that characterize these industrial transformations. It examines the underlying principles, cutting-edge technologies, and their broader implications, emphasizing both the opportunities and challenges they present to industries and society.
Result: It addresses the socio-economic ramifications of these advancements, including their potential to reshape manufacturing processes, improve efficiency, and foster sustainability.
Conclusion: The paper provides valuable insights into the trajectory of industrial innovation. It highlights how these developments promise a transformative impact on the future of manufacturing, aligning technological progress with ethical considerations, social responsibility, and sustainable practices.

RESUMEN

Introducción: La transición de la Industria 4.0 a la Industria 5.0 marca una evolución significativa en el campo de la fabricación y la automatización. La Industria 4.0 introdujo la integración de tecnologías digitales, análisis de datos y conectividad para optimizar los procesos industriales y habilitar fábricas inteligentes. Sin embargo, la Industria 5.0 lleva esta transformación a un nuevo nivel haciendo hincapié en la colaboración y la interacción entre humanos y máquinas.
Objetivo: Aunque esta revolución industrial encierra un inmenso potencial para el crecimiento industrial, también presenta numerosos retos como la integración técnica, la gestión de los recursos humanos, las complejidades de la cadena de suministro y los problemas de seguridad de los datos. Sin embargo, la llegada de la Industria 5.0 promete abordar estos retos de frente. La Industria 5.0 introduce tecnologías innovadoras como el mantenimiento predictivo, la hiperpersonalización, los sistemas cognitivos ciberfísicos y los robots colaborativos. Al dar prioridad a un enfoque centrado en el ser humano, la Industria 5.0 supera con éxito los obstáculos encontrados en la Industria 4.0, allanando el camino para un futuro más eficiente y colaborativo en la industria.
Método: Este artículo investiga la evolución de la Industria 4.0 a la Industria 5.0, centrándose en los rasgos distintivos y los avances que caracterizan estas transformaciones industriales. Examina los principios subyacentes, las tecnologías de vanguardia y sus implicaciones más amplias, haciendo hincapié tanto en las oportunidades como en los retos que presentan para las industrias y la sociedad.
Resultado: Aborda las ramificaciones socioeconómicas de estos avances, incluido su potencial para remodelar los procesos de fabricación, mejorar la eficiencia y fomentar la sostenibilidad.
Conclusión: El documento ofrece valiosas perspectivas sobre la trayectoria de la innovación industrial. Destaca cómo estos avances prometen un impacto transformador en el futuro de la fabricación, alineando el progreso tecnológico con consideraciones éticas, responsabilidad social y prácticas sostenibles.

Palabras clave: Industria 5.0, Industria 4.0, Inteligencia Artificial, Internet de las Cosas.

INTRODUCTION

The progression of industrial paradigms has undergone remarkable transformations, with Industry 4.0 ushering in a new era of digitalization and automation across manufacturing processes. As we advance toward Industry 5.0, the fusion of cyber-physical systems, artificial intelligence, and human-centric collaboration presents unprecedented opportunities for innovation. This shift from Industry 4.0 to Industry 5.0 is not merely a sequential advancement but represents a fundamental reimagining of industrial processes and technological integration.

Industry 5.0 builds upon the digital foundations of its predecessor, incorporating cutting-edge technologies to create a more symbiotic relationship between humans and machines. This evolution emphasizes collaborative systems where human creativity and decision-making are augmented by intelligent automation. It also signals a paradigm shift aimed at achieving greater efficiency, sustainability, and adaptability within manufacturing frameworks [1]. This transformative phase challenges traditional industrial norms, paving the way for groundbreaking advancements that promise to reshape the landscape of modern manufacturing and redefine what is possible in industrial innovation [2].

Industry 4.0 revolutionized strategic decision-making by introducing real-time data analysis as a core capability. This paradigm shift enabled organizations to process vast amounts of information

instantaneously, allowing for faster and more informed decisions that directly influence operations. With its data-centric approach, Industry 4.0 not only optimized decision-making processes but also provided deeper insights into ever-changing market dynamics and operational intricacies. The ability to generate actionable insights in real time marked a significant departure from traditional decision-making frameworks, where delays in data analysis often hindered responsiveness. This transition ushered in an era of enhanced operational efficiency and agility, enabling businesses to adapt swiftly to emerging challenges and opportunities[3]. This transformative era has introduced a host of groundbreaking advancements, such as 3D Printing, Artificial Intelligence (AI), Augmented Reality (AR), Blockchain, and enhanced Cybersecurity measures. These technologies collectively form the backbone of Industry 4.0, revolutionizing industrial processes, fostering innovation, and fortifying operational security. Similarly, AR has transformed how industries visualize and interact with data, enhancing training, design processes, and real-time problem-solving. Blockchain ensures secure, transparent transactions and data integrity, while advanced Cybersecurity safeguards sensitive information against emerging threats, reinforcing the digital foundation of Industry 4.0[4][5].

The Industrial Revolution emerged from the need to evolve traditional machinery into adaptive, self-improving systems capable of interacting with their environment. This shift paved the way for groundbreaking advancements, with the Internet of Things (IoT) enabling interconnected systems to communicate seamlessly within cyber-physical frameworks. IoT remains central to driving innovation and efficiency in modern industries[6]. The Internet of Things (IoT) extends beyond data sharing, integrating the digital and physical worlds into a unified ecosystem. Devices, sensors, and machines work collaboratively, enabling real-time insights and smarter decision-making. This convergence fuels limitless innovation, combining adaptability, intelligence, and connectivity. The synergy between autonomous systems and IoT defines a new industrial paradigm, revolutionizing how industries operate and optimize processes. This transformation reshapes machinery and prepares industries to navigate the challenges of a fast-changing global environment[7,8].

Industry 5.0 marks a transformative era where human creativity and machine precision seamlessly converge, integrating Artificial Intelligence (AI) into industrial processes. It emphasizes collaboration between humans and machines, fostering innovation and enhancing technological capabilities. Emerging as a response to the challenges of Industry 4.0, Industry 5.0 places human-centricity at its core, aligning technological progress with societal and environmental needs.[9]. This shift redefines technology's role, using AI to augment rather than replace human abilities, creating solutions that are efficient and aligned with human aspirations. By harmonizing industrial growth with societal well-being, Industry 5.0 offers a balanced and holistic advancement[10].

The main objectives of this research

This research centers on examining how Industry 5.0 advancements address the challenges left unresolved by Industry 4.0. The shift to Industry 5.0 introduces groundbreaking technologies while proactively mitigating limitations of its predecessor. This study focuses on identifying the obstacles faced during Industry 4.0 and explores how Industry 5.0's innovations provide effective solutions. Central to this investigation is the integration of advanced technologies with human creativity and expertise. By emphasizing collaboration between humans and machines, Industry 5.0 offers industries an opportunity to overcome prior constraints and achieve transformative progress[10][11].

DATA ENGINEERING

This study adopts a review-based approach, offering a thorough synthesis of existing knowledge in the field. It leverages an array of relevant literature as a primary source for gathering critical data and methodologies. By exploring established research, the study aims to extract key insights that deepen understanding and foster meaningful analysis. This approach ensures a comprehensive perspective, forming a solid foundation for advancing knowledge in the area of focus.

Understanding industry 4.0

The foundations of Industry 4.0 represent the fundamental building blocks that underpin this transformative industrial paradigm. Industry 4.0, often referred to as the Fourth Industrial Revolution, is characterized by the integration of advanced digital technologies into various aspects of manufacturing and production processes[12]. At its core, Industry 4.0 aims to create a dynamic, interconnected ecosystem where smart machines, systems, and humans collaborate seamlessly to enhance efficiency, productivity, and innovation.

The foundations of Industry 4.0 can be described through several key aspects:

Cyber-Physical Systems (CPS): At the heart of Industry 4.0 are cyber-physical systems, which combine digital intelligence with physical processes. CPS involves the integration of sensors, actuators, and communication technologies to enable real-time data collection, analysis, and decision-making[13]. This integration facilitates the creation of responsive and adaptive manufacturing environments.

Internet of Things (IoT): The IoT plays a pivotal role in Industry 4.0 by connecting devices, machines, and systems through a network infrastructure[14,15]. This interconnectedness allows for seamless data exchange and communication, enabling remote monitoring, control, and optimization of various processes.

Data Analytics and Big Data: The fourth industrial revolution harnesses cutting-edge data analytics and big data tools to extract meaningful insights from the massive data streams produced by machines and sensors. This technology-driven strategy enables smarter decisions, anticipates maintenance needs, and uncovers ways to improve efficiency[16,17].

Cloud Computing and Edge Computing: Cloud computing offers the resources needed to store massive datasets, perform intensive computations, and ensure accessibility. In contrast, edge computing processes data near its origin, delivering quicker responses and minimizing delays for essential tasks[18].

Artificial Intelligence (AI) and Machine Learning: Artificial intelligence and machine learning empower systems to analyze data and independently adjust their actions. These advancements drive improvements in automation, forecasting, and process optimization using real-time insights[14,15].

Human-Machine Interaction: The essence of Industry 4.0 lies in fostering seamless cooperation between humans and machines. Technologies like augmented reality, virtual reality, and advanced human-machine interfaces enable intuitive interactions, enhancing efficiency in activities such as training and maintenance.

Grasping the core of Industry 4.0 involves understanding the integration of various advanced technologies. This integration creates a dynamic environment that drives innovation, enhances operational efficiency, and enables the development of new business strategies, revolutionizing manufacturing and industrial practices. Despite these advancements, challenges like data security risks, compatibility hurdles, and the demand for workforce reskilling have become prominent[21].

Challenges of industry 4.0

Industry 4.0 holds immense potential to revolutionize industries, but its implementation comes with notable challenges that must be addressed to unlock its full benefits. These challenges span technological, operational, and socio-economic dimensions. The extensive data exchange and interconnected systems integral to Industry 4.0 amplify concerns about data security and privacy. With vast volumes of information flowing across devices, networks, and platforms, protecting sensitive data from cyber threats, unauthorized access, and breaches becomes paramount.

A critical technological hurdle lies in achieving interoperability among diverse systems, devices, and technologies supplied by different vendors. Integrating these components seamlessly requires the adoption of standardized communication protocols and frameworks, a task that is both complex and resource-intensive. Moreover, embedding advanced technologies such as IoT, AI, and big data into existing processes adds another layer of intricacy. Ensuring that these technologies work cohesively without disrupting current operations necessitates meticulous planning and robust implementation strategies. On

the human resource front, Industry 4.0 demands a workforce skilled in data analytics, digital tools, and emerging technologies. Bridging this skills gap is crucial for industries to effectively leverage the capabilities of advanced systems. Comprehensive training and upskilling programs are essential to prepare employees for new roles and responsibilities in this technologically driven landscape. Successfully navigating these challenges will require a multi-faceted approach, combining technological innovation with robust cybersecurity measures, standardization efforts, and workforce development initiatives. By addressing these issues, industries can fully capitalize on the transformative opportunities offered by Industry 4.0, driving innovation, efficiency, and growth in the years to come[22].

Industry 5.0: a glimpse of the future

The advent of Industry 5.0 marks a transformative chapter in the industrial revolution, where technological prowess and human creativity converge to redefine manufacturing and beyond. Unlike its predecessor, Industry 4.0, which focused primarily on automation and digital integration, Industry 5.0 introduces a human-centric approach. It emphasizes the harmonious collaboration between advanced technologies—such as artificial intelligence (AI), the Internet of Things (IoT), and robotics—and the unique ingenuity of skilled human labor. This innovative paradigm aspires to elevate human potential, fostering the creation of groundbreaking business models, exceptional products, and enriched customer experiences. At its core, Industry 5.0 envisions a future where technology becomes a tool to enhance human capabilities rather than replace them. It champions the idea that the fusion of human creativity and technological innovation can achieve outcomes that neither could accomplish alone. This approach redefines the industrial landscape, turning it into a canvas where industries can craft their futures with a blend of artistry and precision. By leveraging the synergy between man and machine, Industry 5.0 aims to push the boundaries of possibility, opening doors to new opportunities and brightening the horizon for businesses and consumers alike. A defining feature of Industry 5.0 is its commitment to sustainability through innovative practices like Industry Upcycling. This approach seeks to repurpose and optimize existing resources, minimizing waste generation and promoting environmental stewardship. By integrating sustainability into the industrial framework, Industry 5.0 not only addresses pressing environmental challenges but also lays the groundwork for a circular economy where resources are utilized responsibly and efficiently. This shift towards sustainable practices underscores the transformative potential of Industry 5.0, where economic growth and environmental responsibility coexist harmoniously. In addition to technological advancements, Industry 5.0 places a strong emphasis on the human element. It prioritizes the well-being of workers by creating environments where human skills and creativity are valued alongside technological efficiency. This human-centric approach fosters job satisfaction and enables workers to engage in more meaningful tasks, shifting away from monotonous or hazardous roles. By empowering the workforce and prioritizing their contributions, Industry 5.0 creates a more inclusive and equitable industrial ecosystem[23][24].

Industry 5.0 as a way to overcome the challenges of industry 4.0

Industry 5.0 emerges as a visionary response to the limitations and challenges presented by Industry 4.0, marking a significant shift in industrial development. This evolution is not merely a sequential advancement but a reimagining of industrial processes to address inefficiencies and unlock new possibilities. Industry 4.0, characterized by the integration of digital technologies into manufacturing, revolutionized operations through automation and data-driven decision-making. However, its implementation often revealed gaps, such as fragmented technology integration and limited human-machine collaboration, which hindered the realization of a fully intelligent and interconnected ecosystem. Recognizing these challenges, Industry 5.0 introduces a transformative approach that combines the strengths of human ingenuity with the precision of advanced technologies. Unlike its predecessor, which prioritized automation, Industry 5.0 places equal emphasis on human creativity, intuition, and adaptability. This paradigm shift acknowledges the irreplaceable value of human insight, aiming to enhance, not replace, human contributions through synergistic collaboration with machines. By

fostering this balance, Industry 5.0 aspires to create a more cohesive and dynamic industrial environment. A core aspect of Industry 5.0 is its commitment to sustainability and responsible innovation. While Industry 4.0 made significant strides in efficiency, it often fell short in addressing pressing global issues such as resource depletion and environmental degradation. In response, Industry 5.0 champions concepts like circular economies and upcycling, which focus on minimizing waste, reusing resources, and aligning industrial practices with ecological stewardship. This sustainable focus ensures that progress is not achieved at the expense of the planet or society.

Ultimately, Industry 5.0 reflects the adaptive and forward-thinking nature of modern industries. By building on the foundations of Industry 4.0, it offers a holistic framework that integrates technology, human expertise, and sustainability. This evolution sets the stage for a future where industries operate more efficiently, responsibly, and harmoniously, benefiting both humanity and the environment [25].

Navigating Industry 5.0: Addressing the Residues of Industry 4.0

The Internet of Things (IoT) within Industry 4.0 unlocked a wealth of opportunities, revolutionizing industrial processes through device interconnectivity and data exchange. However, this transformative technology also introduced significant challenges, such as cybersecurity vulnerabilities and integration complexities. Industry 5.0 emerges as a thoughtful response to these issues, addressing the shortcomings of IoT implementation in Industry 4.0 with a more strategic and resilient approach. The transition from Industry 4.0 to Industry 5.0 represents a strategic evolution that prioritizes the safe and seamless integration of IoT technologies. Industry 5.0 not only acknowledges the transformative power of IoT but also underscores the importance of balancing innovation with security and privacy. By fostering trust and resilience, it ensures that technology can flourish without compromising safety or efficiency. This progression reflects a commitment to leveraging IoT's full potential while safeguarding the infrastructure that supports it. Industry 5.0 envisions a future where interconnected systems operate harmoniously within a secure framework, embodying a balanced approach that champions innovation, resilience, and ethical practices. As industries move forward, this paradigm shift signifies a dedication to navigating the complexities of modern technology while upholding core values of security and sustainability [26].

FINDINGS AND RESULTS

The roots of the industrial revolution were planted with the advent of steam power, which revolutionized electricity generation and set the stage for industrial transformation. Over the centuries, this initial breakthrough evolved from mechanization and partial automation to the advanced era of complete automation, epitomized by Industry 4.0. This phase marked a monumental shift in industrial development, introducing groundbreaking technologies that redefined manufacturing and production processes. Beyond technological advancements, Industry 4.0 addressed critical challenges, notably within supply chain management. By enabling precise product tracking and enhancing supply chain visibility, it empowered businesses to predict market fluctuations accurately, paving the way for informed and strategic decision-making during times of uncertainty. Building on these achievements, Industry 5.0 represents a paradigm shift with its focus on a human-centric approach. It introduces advanced technologies designed to overcome the limitations faced by its predecessor. Among the most notable advancements is Predictive Maintenance, which revolutionizes equipment management by anticipating and preventing potential failures. This proactive approach reduces downtime and ensures seamless operations, fostering greater efficiency. At the heart of Industry 5.0 are Cyber-Physical Cognitive Systems, which seamlessly integrate the physical and digital realms. These systems go beyond traditional automation, incorporating cognitive abilities to enhance decision-making, streamline problem-solving, and optimize overall industrial performance. However, the standout innovation of Industry 5.0 lies in Collaborative Robots, or Cobots. These advanced machines work alongside human operators, embodying a harmonious partnership between man and technology. Cobots amplify productivity and creativity while maintaining high standards of safety and precision, redefining what is achievable in modern industries.

Industry 5.0 is more than an evolution—it is a revolution that bridges the gaps left by Industry 4.0. By blending advanced technologies with human ingenuity, it propels industries toward a future where innovation and human potential coexist in harmony, fostering growth and progress like never before.

CONCLUSION

This comprehensive review delves deeply into the challenges faced by Industry 4.0 and the innovative solutions introduced by Industry 5.0. By examining the obstacles that Industry 4.0 encountered, the analysis highlights how its successor has devised groundbreaking strategies to overcome these limitations. This exploration reveals Industry 5.0 as a transformative force, offering novel approaches that redefine industrial progress. As we embark on this exploration, we delve into the realm of Industry 5.0's technological arsenal, each component seamlessly intertwined with a grand vision of ushering industries into a future of uncharted possibilities. Industry 5.0 represents a paradigm shift that transcends the limitations of Industry 4.0 while aligning with the overarching goals of innovation, sustainability, and human empowerment. By understanding the challenges of its predecessor and strategically leveraging advancements, human-machine symbiosis, and collaborative efforts, Industry 5.0 holds the promise of reshaping industries, improving societal well-being, and propelling us towards a more resilient and adaptive manufacturing future.

REFERENCES

1. Xu X, Lu Y, Vogel-Heuser B, Wang L. Industry 4.0 and Industry 5.0—Inception, conception and perception. J Manuf Syst. 2021;61:530–5.
2. Leng J, Sha W, Wang B, Zheng P, Zhuang C, Liu Q, et al. Industry 5.0: Prospect and retrospect. J Manuf Syst. 2022;65:279–95.
3. Huang S, Wang B, Li X, Zheng P, Mourtzis D, Wang L. Industry 5.0 and Society 5.0—Comparison, complementation and co-evolution. J Manuf Syst. 2022;64:424–8.
4. Akundi A, Euresti D, Luna S, Ankobiah W, Lopes A, Edinbarough I. State of Industry 5.0—Analysis and identification of current research trends. Appl Syst Innov. 2022;5(1):27.
5. Al Faruqi U. Future service in industry 5.0. J Sist Cerdas. 2019;2(1):67–79.
6. Haque S, Haque MA, Kumar D, Mishra K, Islam F, Ahmad S, et al. Assessing the Impact of IoT Enabled E-Learning System for Higher Education. SN Comput Sci [Internet]. 2023;4(5):459. Available from: https://doi.org/10.1007/s42979-023-01860-8
7. Prakash A, Haque A, Islam F, Sonal D. Exploring the Potential of Metaverse for Higher Education: Opportunities, Challenges, and Implications. Metaverse Basic Appl Res [Internet]. 2023 Apr 26;2(SE-Reviews):40. Available from: https://mr.saludcyt.ar/index.php/mr/article/view/40
8. Kumar D, Haque A, Mishra K, Islam F, Mishra BK, Ahmad S. Exploring the Transformative Role of Artificial Intelligence and Metaverse in Education: A Comprehensive Review. Metaverse Basic Appl Res. 2023;2:55.
9. Quispe JFP, Diaz DZ, Choque-Flores L, León ALC, Carbajal LVR, Serquen EEP, et al. Quantitative Evaluation of the Impact of Artificial Intelligence on the Automation of Processes. Data Metadata. 2023;2:101.
10. Rane N. Transformers in Industry 4.0, Industry 5.0, and Society 5.0: Roles and Challenges. 2023;
11. Rane N. ChatGPT and Similar Generative Artificial Intelligence (AI) for Building and Construction Industry: Contribution, Opportunities and Challenges of Large Language Models for Industry 4.0, Industry 5.0, and Society 5.0. Oppor Challenges Large Lang Model Ind. 2023;4.
12. Donmezer S, Demircioglu P, Bogrekci I, Bas G, Durakbasa MN. Revolutionizing the Garment Industry 5.0: Embracing Closed-Loop Design, E-Libraries, and Digital Twins. Sustainability. 2023;15(22):15839.

13.   Javaid M, Haleem A, Singh RP, Suman R, Gonzalez ES. Understanding the adoption of Industry 4.0 technologies in improving environmental sustainability. Sustain Oper Comput. 2022;3:203–17.

14.   Haque A, Haque S, Rahman M, Kumar K, Zeba S. Potential Applications of the Internet of Things in Sustainable Rural Development in India. In: Proceedings of Third International Conference on Sustainable Computing. Springer; 2022. p. 455–67.

15.   Haque MA, Ahmad S, Abboud AJ, Hossain MA, Kumar K, Haque S, et al. 6G wireless Communication Networks: Challenges and Potential Solution. Int J Bus Data Commun Netw. 2024;19(1):1–27.

16.   Haque MA, Ahmad S, Haque S, Kumar K, Mishra K, Mishra BK. Analyzing University Students' Awareness of Cybersecurity. In: 2023 International Conference on Emerging Trends in Networks and Computer Communications (ETNCC). IEEE; 2023. p. 250–7.

17.   Almrezeq N, Haque MA, Haque S, El-Aziz AAA. Device Access Control and Key Exchange (DACK) Protocol for Internet of Things. Int J Cloud Appl Comput [Internet]. 2022 Jan;12(1):1–14. Available from: https://services.igi-global.com/resolvedoi/resolve.aspx?doi=10.4018/IJCAC.297103

18.   Zeba S, Haque MA, Alhazmi S, Haque S. Advanced Topics in Machine Learning. Mach Learn Methods Eng Appl Dev. 2022;197.

19.   Haque MA, Haque S, Zeba S, Kumar K, Ahmad S, Rahman M, et al. Sustainable and efficient E-learning internet of things system through blockchain technology. E-Learning Digit Media [Internet]. 2023;0(0):1–20. Available from: https://journals.sagepub.com/doi/abs/10.1177/20427530231156711

20.   Md. Alimul Haque, Shameemul Haque, Samah Alhazmi DNP. Artificial Intelligence and Covid-19: A Practical Approach [Internet]. Bentham Science Publisher; 2022. 92-109 (18) p. Available from: https://www.eurekaselect.com/chapter/18168

21.   Rojko A. Industry 4.0 concept: Background and overview. Int J Interact Mob Technol. 2017;11(5).

22.   Haque MA, Ahmad S, John A, Mishra K, Mishra BK, Kumar K, et al. Cybersecurity in Universities: An Evaluation Model. SN Comput Sci [Internet]. 2023;4(5):569. Available from: https://doi.org/10.1007/s42979-023-01984-x

23.   Hossain KA. ANALYSIS OF PRESENT AND FUTURE USE OFARTIFICIAL INTELLIGENCE (AI) IN LINE OF FOUTH INDUSTRIAL REVOLUTION (4IR). 2023;

24.   Calvo J. Journey of the Future Enterprise: How to Compete in the Age of Moonshot Leadership and Exponential Organizations. Libros de Cabecera; 2020.

25.   Jain P, Chou MC feng. Supply Chain 5.0: The Next Generation of Business Success Through Customer Centricity, Sustainability & Human Rights and Digitalization. World Scientific; 2023.

26.   Xu L Da, Xu EL, Li L. Industry 4.0: state of the art and future trends. Int J Prod Res. 2018;56(8):2941–62.

27.   Ghobakhloo M, Fathi M, Iranmanesh M, Maroufkhani P, Morales ME. Industry 4.0 ten years on: A bibliometric and systematic review of concepts, sustainability value drivers, and success determinants. J Clean Prod. 2021;302:127052.

28.   Zambon I, Cecchini M, Egidi G, Saporito MG, Colantoni A. Revolution 4.0: Industry vs. agriculture in a future development for SMEs. Processes. 2019;7(1):36.

29.   Cannavacciuolo L, Ferraro G, Ponsiglione C, Primario S, Quinto I. Technological innovation-enabling industry 4.0 paradigm: A systematic literature review. Technovation. 2023;124:102733.

30.   Mourtzis D, Angelopoulos J, Panopoulos N. A Literature Review of the Challenges and Opportunities of the Transition from Industry 4.0 to Society 5.0. Energies. 2022;15(17):6276.

COMPETING INTERESTS SECTION

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CONFLICT OF INTEREST

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