



## Economics & 5IR model: Towards a competitive and sustainable economic path

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### Abstract:

The objectives of this study are to identify the 5I- revolution in terms of the concepts and the main pillars on which it is based, in addition to pointing out the fundamental differences between the previous industrial revolutions. To achieve these objectives, a descriptive method is employed with its analytical tools. The findings revealed that, there is a direct impact on the economy as a key through the development of productivity (smart production) based on technology and data in design. Besides, accessing the sustainability model, human resources and machine and achieving sustainable economic growth are important features in building a smart economy. To sum up, The 5.0 is key to the global economy, it is suggested to develop human resources (smart HR), use of automation in the economy (operations & process) and achieve integration between Sustainability & HR.

**Keywords:** 5.0 IR, sustainable, economic growth, smart economy, hr and Resilience.

**JEL Classification Codes:** Q56, F43, O32, O15.

## I. Introduction:

Over the past two decades, the global economy is in a state of constant change, moving from classical to automated, as a result of the technological and technical factors used by the world's economies (organizations working in this field). This is the result of revolutions associated with analyzing data and information, including the 5IR which has become a key focus for organizations to stay in a dynamic environment. Due to its interest in the technological and human dimension within the framework of human-machine integration to achieve well-being, smartly, and realise the dimensions of SD. Economically, it focused on economic sustainability through economic growth and the development of the productive base, by using advanced technologies such as AI, biotechnology that contribute to finding solutions for communities, especially with the evolution of working methods, This opens up new horizons at the level of the industrial structure.

As a result, 5I is emerging as one of the most important trends that could contribute to changing and reshaping the global economy by enhancing the human element in the production process, unlike 4I which focused primarily on automation and digitization.

Those who follow the developments in current economic policy trends can identify one of the most important models designed for the industrial age 5, known as the smart economy, which is based on digitization, big data, artificial intelligence, and technological innovation, thereby promoting the ninth Sustainable Development Goal, which includes aspects such as building resilient infrastructure, promoting sustainable manufacturing, and encouraging innovation. Thus, the link between the Fifth Industrial Revolution, the smart economy, and sustainability is not merely an option, but a strategic necessity for reshaping the global economy on more inclusive and equitable foundations, where technology is not an end in itself but a means to achieve smart, knowledge-based, green, and sustainable economic development.

In this context, studies such as the European Commission report (2023) have shown that "Industry is of vital importance to the economic fabric of the European Union, contributing around 20% of GDP and providing jobs and prosperity. However, it faces challenges from globalization, geopolitical volatility, supply chain fragility, and the requirements for the transition to a green digital economy. Although the 4IR has boosted efficiency through automation and digital technologies, it has remained a technical and economic vision. In contrast, the 5IR offers a perspective that integrates technological innovation with social and environmental values, ensuring the well-being of human resources within the objective framework that is being implemented, with the use of smart material applications, DT, AI, and promoting renewable energy while aligning the interests and incentives of all stakeholders with the value of their shareholders, so that workers and society as a whole benefit from industrial transformations, within a framework that promotes well-being and keeps pace with environmental, social, and economic transformations" (Singh et al., 2023, pp 5-7).

Also, "many organizations face difficulties in identifying the necessary steps and delivering and implementing effective sustainable development programs, given their lack of methodological guidance and appropriate tools to address the complexities of sustainability, and integrate them into their strategic and operational plans. Without a structured approach, resources may be wasted and opportunities for real change lost. In this context, Industry 5.0 provides a unified framework, methodological tools, and specialized knowledge to support organizations in strengthening their efforts toward sustainability, with a focus on flexible, human-centered processes and the integration of sustainable development principles into their business models, products, and services" (Czvetkó et al., 2025, p 1).

It has been pointed out that "despite the progress made by Industry 4.0, it has not achieved the desired goals and has neglected the environmental aspect, with machines being prioritized at the expense of humans. For this reason, the 5.0 is emerging as a revolution aimed at implementing sustainability concepts and integrating human values with technology, representing a step forward towards achieving sustainable development goals" (Sindhvani et al., 2022).

This view is supported by research that found that "the 5.0 represents the future of industrial transformation and offers potential solutions to social, economic, and environmental problems that have not been adequately addressed or have been exacerbated by 4.0" (Ghobakhloo et al., 2023, p 432).

On the other hand, a study conducted by Rejeb et al. shows that "5.0 applications represent a fundamental framework for restructuring supply chains and business strategies to align with circular economy goals and achieve long-term sustainability. In addition, the focus on human-centric design in 5.0 illustrates that organizations must adopt modern technologies while considering social impacts, improving worker well-being, and promoting work environments that are more flexible and human-friendly" (Rejeb et al., 2025, p 25).

From the above, our research problem is defined by answering the following main question:

**To what extent can the 5IR contribute to promoting the shift towards a sustainable competitive economy?**

➤ **Study questions:**

This study discusses the following issues:

- What is meant by the 5 Industrial Revolution?
- What are the components of the model on which the 5.0 is based?
- What are the technological tools that help build the 5.0?
- What economic opportunities have been achieved from implementing?

➤ **Objectives of the Study:**

- Introducing the 5.0;
- Defining the differences between revolutions;

- Clarifying the importance of implementing the 5.0 on the economy;
- Recognizing the key factors on which it is based.
- **Importance of the study:**
- **Scientific:** interest in the topic in terms of scientific presentation and discussion of literature.
- **Practical:** Explaining the return on the application for organizations.
- **for the society:** the topic focuses on sustainability linked to the human resource.
- **Previous Studies:**

**Table (1): Summary of previous studies**

| Author(s) & Year          | Objective   | Study sample   | Methodology data collection tools   | key results   |
|---------------------------|---|--|---|---|
| (Benghoual a & al., 2025) | <ul style="list-style-type: none"> <li>● Statement on how Industry 5.0 is used and the challenges it faces in Algeria;</li> <li>● Identification of mechanisms that help implement Industry 5.0 in Algerian factories.</li> </ul> | An estimated 230 companies from the manufacturing sector in Algeria were selected using simple random sampling.  | Quantitative approach based on a questionnaire  | The implementation of Industry 5.0 is still in its infancy. In addition, social sustainability factors play a role in the implementation of the 5.0 within factories in Algeria. However, environmental sustainability and innovation factors do not play any role.   |
| (Anwar & al., 2025)       | Revealing Egypt's experience in transitioning to 4IR and moving towards the development of resilient cities, and the extent of its potential to transition to 5IR.  | Estimated at 174 items for various stakeholders (such as urban planners, policymakers, and citizens).  | Qualitative approach using a structured online questionnaire distributed via Google Forms | Innovation and excellence in education, driven by integrated efforts in governance, curriculum design, professional development, inclusivity, emerging technologies, and entrepreneurship, play a role in promoting the shift towards 5IR.  |
| (Hermawati & al., 2025)   | Assessing the focus on the human element in Industry 5.0 through the readiness of occupational science/human factors communities in the UK.   | Three professional bodies (CIEHF, International Ergonomics Association (IEA), and Ergonomics/Human Factors Society (E/HFS)) and eight researchers from human experience engineering professionals on LinkedIn were included. | Descriptive analytical approach using an interview tool.                                  | Caring for people in industry 5.0 It goes beyond the traditional concept of the extent to which work is compatible with human tasks, to include additional aspects such as mental health, diversity of opportunities, and social and ethical considerations, in addition to helping workers adapt to constant changes in the skills required in the work environment. |

➤ **Research gap:**

Our study intersects with most studies in the theoretical aspect (review of literature and studies), The studies also addressed the uses of the technologies and keys of the 5IR, Our study differs in that it approached the topic from an economic perspective.

● **Research Map (Paper Organization):**

This article is organized as follows, we review the definitions of Industry 5.0 from the available literature, the second section Reference to other industrial revolutions, In addition to the benefits and roles. Finally, we conclude this paper by presenting the economic importance.

## II. Literature Review

### 1- Definitions and Conceptual Perspectives:

Below is a set of definitions related to the term Fifth Industrial Revolution, reflecting diverse scholarly perspectives in this field:

**Definition 1:** “the 5.0 is an economic model based on investing human capital in the industrial environment where the automated system and humans working together to enhance operational efficiency, by leveraging cognitive abilities and intellectual creativity”(Lykov & Razumowsky, 2023, pp. 1-2).

**Definition 2:** “the 5.0 is a dynamic change that combines the adaptive capabilities of physical-digital systems with interactive human intelligence, to create production ecosystems through technical and cognitive integration”(Lou et al., 2025, pp. 494-495).

**Definition 3:** “introduces the paradigm of the socially intelligent factory, where human operators and collaborative robotic systems (cobots) engage in integrated workflows within physical-digital production environments enhanced by enterprise-level social networks. This configuration fosters real-time interaction and bidirectional information exchange between human agents and automated system components”(Isaza Domínguez, 2024, p.1).

**Definition 4:** “An integrated system of humans and machines for the purpose of improving the efficiency of industrial processes” (Timilehin, Clainos, & Susela, 2024, p. 136).

**Definition 5:** “Industrial 5.0 is an advanced industrial model that blends human intelligence with collaborative robotics and intelligent production, resulting in smart production environments. Its aim is to enhance human capabilities and deliver personalized products and services by leveraging AI and institutional social structure to improve interactions between AI and physical-digital systems, leveraging on-the-go behavioral and cognitive technologies to enhance human capabilities and deliver value-driven outcomes”(Maddikunta & al., 2022).

**Definition 6:** “Revolution 5.0 represents a turning point in industrial history, as it is based on human expertise in smart technologies and AI-led robotics, and its objective is to promote production efficiency while maintaining the importance of human-centered principles, operational resilience, and sustainable development” (Ashish & Singh, 2025, p. 204).

**Definition 7:** “As a blend of humans and robots” (Taj & Zaman, 2022, p. 285).

**Definition 8:** “the 5.0 an emerging industry that keeps pace with changing workforce needs and ensures their well-being within the production process” (Breque, De Nul, Petridis, & others, 2021, pp. 13-14).

**Definition 9:** "5IR is a more progressed phase of industrial growth defined by the combination of intelligent technologies like the Internet of Things, cloud technology, cooperative robots (Cobots), virtual and augmented reality (VR/AR), along with extensive data analysis (Big Data Analytics). The goal is to successfully merge automated systems with human actions" (Adigun, Ajani, & Enakrire, 2024, p. 212).

**Definition 10:** “5IR, Consider the value of human-machine collaboration” (Kumar, 2024, p. 20).

From the above definitions, we conclude that:

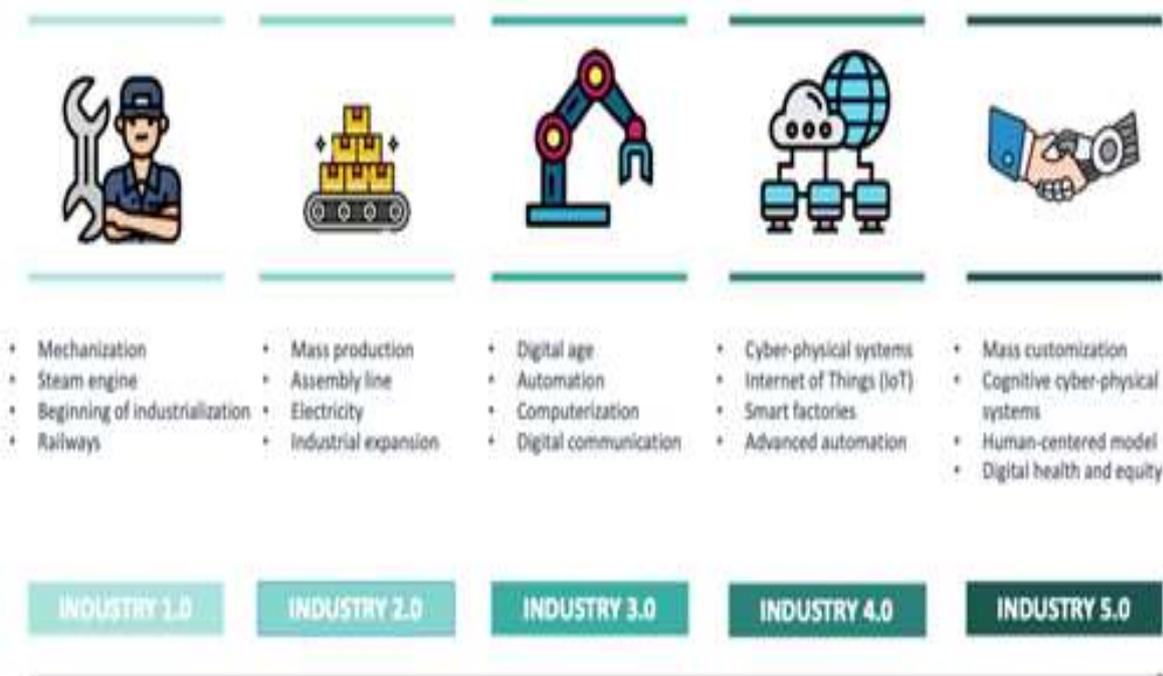
- The 5.0 is a modern approach;
- Driven by technology;
- Focus on the industrial sector;
- Creates added value for other sectors.

Consequently, Industry 5.0 is a leading technological phase that showcases:

- The combination of human cognition and artificial intelligence;
- Intelligent and adaptive infrastructure is one of the driving forces behind this;
- A strong emphasis on sustainability and social responsibility through a sustainable approach and a steadfast commitment to incorporating them into the community.

about the progression of IR (1.0 .....5.0) , We present them in the following:

**Figure (1): 1.0 to 5.0**



Source: (Basulo-Ribeiro & Teixeira, 2024, p. 4)

**2- Industry 5.0 vs. other industrial revolutions:**

Which we explain in the following points (Ghobakhloo et al., 2022, p. 718):

- 5IR balances production improvement with achieving environmental and social sustainability goals.
- It focuses on empowering the human element through technologies that take into account the human dimension.
- It encourages innovation in the fields of clean energy and sustainable technology.
- It gives importance to stakeholder participation in directing technology and monitoring its impact.
- It relies on a functional combination of smart technologies to achieve flexible integration between automated system and human behavior.

In this context, we attempt to present a set of features and developments related to the Third, Fourth, and Fifth Industrial Revolutions:

**Table (2): Major advancements 3.0 & 4.0 and Key features of 5.0**

| Industry3.0               | Industry4.0            | Industry5.0                                   |
|---------------------------|------------------------|---|
| Arrival of internet       | Data driven Industry   | Collaborative functioning of Man and Machines |
| Automated factories       | Introduction of AI     | Emphasis towards sustainability               |
| Microprocessors and Chips | Autonomous functioning | IoMT & IoET                                   |
| PLCs                      | Efficient productivity | 6G networks                                   |
| IT services               | Wireless communication | Blockchain & Digital twin                     |
| Communication devices     | Computer Vision        | Machine based autonomous services             |
| Industrial robots         | IoT based machines     |   |

Source: (Pandey, 2024, p. 3, 4, 5)

### 3- Stages of development towards industry 5.0:

Over the past two decades, the world has witnessed major industrial developments and transformations, starting with the use of steam energy, followed by large-scale electrical production, then automation based on control systems, to emerge 4IR based on the integration of the physical and digital worlds, followed by 5IR, which represents an advanced generation that integrates artificial intelligence and human capabilities, within the framework of an intelligent production environment characterized by flexibility and cooperation (Yang et al., 2021).

**Table (3): Milestones in the Transformation of Industrial Systems (1.0 to 5.0)**

| Industry | Chronology      | Intrinsic properties  | Supporting technologies  | The resulting economic impact                                |
|----------|-----------------|---|--|--|
| 1.0      | 1784~           | Steam electric power  | Primary energy sources, mechanical production techniques and water propulsion  | Shift from manual labor to mechanized manufacturing          |
| 2.0      | 1870~           | Large-scale use of electrical energy and manufacturing                            | Sequential electrical production and organization of work according to tasks   | Increased productivity and cost reduction                    |
| 3.0      | 1969~           | The introduction of electronic control systems and the beginnings of digitization | Digital technology, computer processors, automated control systems   | Enhanced production efficiency and product quality           |
| 4.0      | 2011~           | Interconnected intelligent systems that combine the physical and digital world    | IoT – Artificial Intelligence<br>Cloud Computing   | Digital economy,<br>Smart supply chains<br>Connected systems |
| 5.0      | 2015~ – present | Employing (AI) and individual-oriented production                                 | Intelligent machines interacting with humans, biological technologies, creative artificial intelligence, robots inspired by biological systems | Sustainable economy,<br>Industrial resilience<br>Human focus |

Source: (Mezgebe, Gebreslassie, Sibhato, & Bahta, 2023, p. 4)

#### 4- Benefits and Role of Industry 5.0:

##### 4-1: Benefits 5IR

- Increasing productivity;
- Agility and profitability;
- Change-readiness.

##### 4-2: Role 5IR

Industry 5.0 represents a strategic direction towards promoting sustainable industrial development, focusing on combining advanced digital technologies (artificial intelligence) and (machine learning) with human-centered innovation, each of which leads to a unique field of knowledge and machine learning in the manufacturing sector. Hence, the main roles and impacts of Industry 5.0 include **(Awotunde, Muduli, & Brahma, 2025, pp 9-10)** :

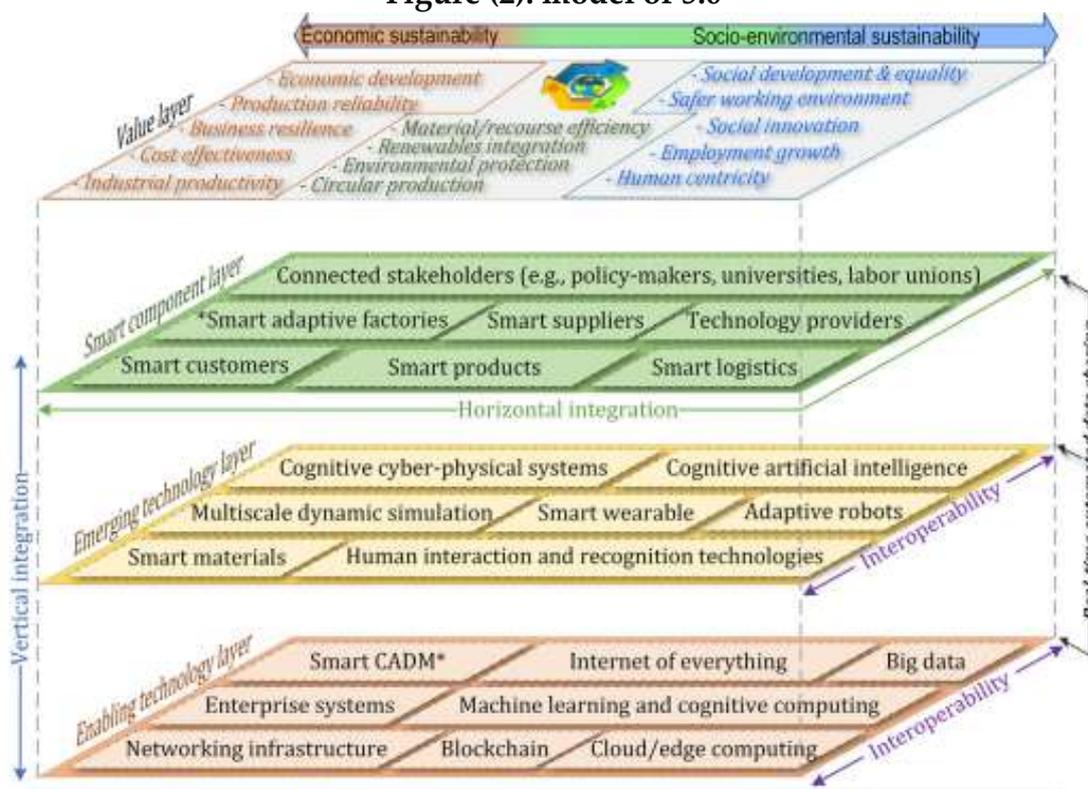
- The interaction between the automated system and human behavior: the 5.0 focuses on human intelligence and machine accuracy, as well as the role of artificial intelligence in increasing and enhancing human capabilities rather than replacing them. For example, HCAI systems aim to empower workers and promote greater independence in decision-making.
- Operational intelligence and production efficiency: Contemporary organizations rely on AI and ML technologies to enhance operational efficiency and achieve high productivity in a timely manner. On the other hand, these technologies contribute to reducing unexpected errors and improving product quality through automatic adjustments and automation of production processes. This transformation is also supported by the use of digital systems, cloud computing, and predictive analytics, which enable accurate and data-driven decision-making instantly and effectively.
- Design and Modification: the 5.0 seeks to ensure advanced data analysis of manufacturing processes, and attempts to design products and services according to customer preferences, while reducing the cost per unit or per production line in order to ensure efficiency on a large scale.
- Sustainable Industrial Development: Industry 5.0 introduces intelligent resource management by utilizing AI and IoT to reduce energy consumption, lower emissions, and support circular economy models focused on durability, reuse, and recyclability of materials.
- Resilience and Adaptability: Through federated learning and explainable AI (XAI), Industry 5.0 addresses data privacy, system transparency, and compliance requirements, equipping enterprises to respond swiftly to disruptions such as global pandemics or supply chain instability.
- Talent Development and Societal Value: The paradigm encourages a workforce transition toward high-skill roles by requiring new competencies in robotics, digital systems, and AI interaction- positioning human workers at the center of creative and strategic industrial functions.

– Cross-Sectoral Innovation: Industry 5.0’s AI-driven applications extend beyond manufacturing into healthcare, finance, and logistics—enhancing fraud detection, predictive diagnostics, algorithmic trading, and conversational AI, thus broadening its impact across socio-economic domains.

**5- The reference model of Industry 5.0:**

5.0 is based on a model that includes technological tools that help realise the keys to sustainable development and human resources through AI (CAI), robotics, and smart systems. This can be clarified as follows:

**Figure (2): model of 5.0**



Source: (Ghobakhloo & al., 2022, p. 718)

**6- Methods and Technologies of Industry 5.0:**

the 5IR represents a fundamental transformation in the technological framework of industrial systems. Scholarly views vary regarding its nature: one perspective considers it an evolutionary phase building on 4IR through the gradual enhancement of digital technologies such as AI-IoT, big data within adaptive, and human-centric production models. Another view treats it as a disruptive shift driven by emerging technologies like brain-machine interfaces, smart materials, and synthetic biology, aiming to redefine industrial structures and functions. A third, more integrative approach envisions Industry 5.0 as a convergence of cognitive and digital technologies, fostering intelligent ecosystems capable of dynamic collaboration with human operators (Ghobakhloo et al., 2024, pp. 7-9).

The following table provides a structured synthesis of the three dominant theoretical perspectives regarding the technological progression underpinning Industry 5.0:

**Table (4): Top Industry 5.0 Technologies and Classifications Patterns**

| Perspective                                       | General Description  | Core Technological Sources   | Key Characteristics  | Representative References   |
|---|--|--|--|---|
| Expansive (Incremental Extension of Industry 4.0) | Views 5IR as a natural evolution of 4IR with incremental refinements and human integration.  | AI, IoT, Big Data, Cloud Computing, Blockchain, Additive Manufacturing, Industrial Robots, Enterprise & Execution Systems, Industrial Control Systems, Networking Infrastructure   | Human-machine synergy without disrupting existing infrastructure; continuity of digitalization and automation efficiency.                            | Ghobakhloo & al. (2023) Santhi & Muthuswamy (2023)                  |
| Radical (Disruptive Shift)                        | Sees Industry 5.0 as a paradigm shift introducing revolutionary and bio-integrated technologies beyond traditional digital models. | AGI, Brain-Machine Interfaces, Bio-inspired Technologies, Biosensors, Causal AI, Fiber Computing, Genomics, Humanoid Robots, IoMT, Smart Materials, Self-Healing Systems, Swarm Intelligence   | Breaks away from Industry 4.0 legacy; emphasizes disruptive, bio-digital, and intelligent convergence for addressing socio-environmental challenges. | Sachsenmeier (2016); European Commission (2020)                     |
| Hybrid (Integrated Perspective)                   | Suggests 5IR is a hybrid of matured 4IR infrastructure and human-centered cognitive innovations.                                   | Cognitive Robotics, Cyber-Physical Systems, Generative AI, Internet of Everything (IoE), XR, Smart Wearables, Adaptive Robots, Human Recognition Tech, Autonomous Mobile Robots, Dynamic Simulation, Smart Energy & Product Lifecycle Management | Focuses on resilience, sustainability, and personalization through intelligent human-machine collaboration.  | Maddikunta & al. (2022); Ghobakhloo & al.(2022); Leng et al. (2022) |

Source: (Ghobakhloo & al., 2024, p. 10).

**7- challenge areas for Industry 5.0:**

are (Saniuk & Grabowska, 2023, p. 1189):

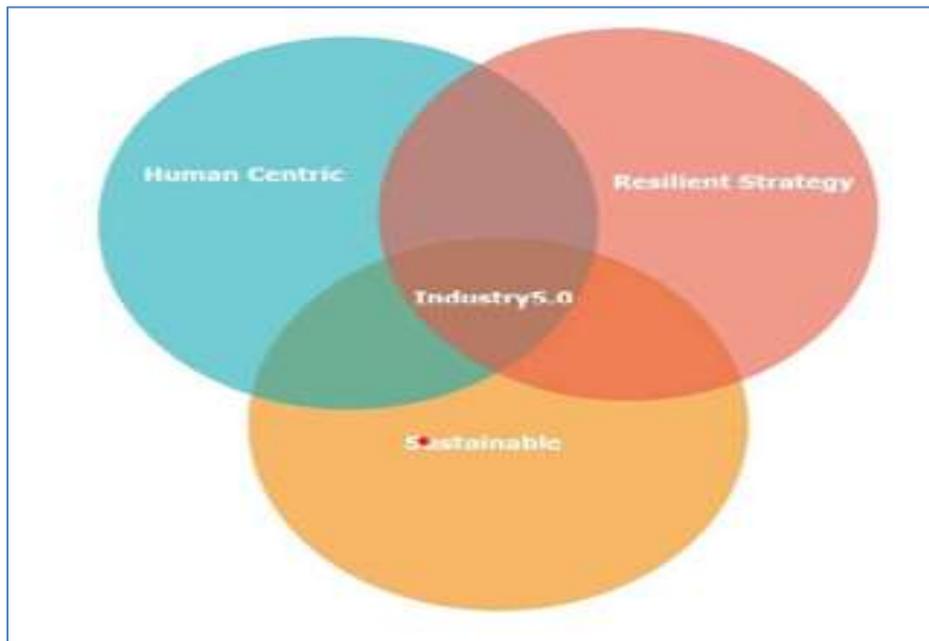
- Interaction between the human workforce and intelligent systems;
- Smart materials and technologies and their applications in business and industry;
- Digital twins and simulation software in the manufacturing sector;
- Data transfer, storage, and analysis and processing technologies from the staging area to production;
- Artificial Intelligence;
- New technologies for efficiency in the use of new and renewable energy.

**8- Industry 5.0 within the economic orientation:**

**8-1: Keys and importance of the economy**

The three key elements of 5IR as presented by the European Commission, are:

**Figure (3): elements of 5.0**



Source: (Pandey, 2024, p. 5)

Such that:

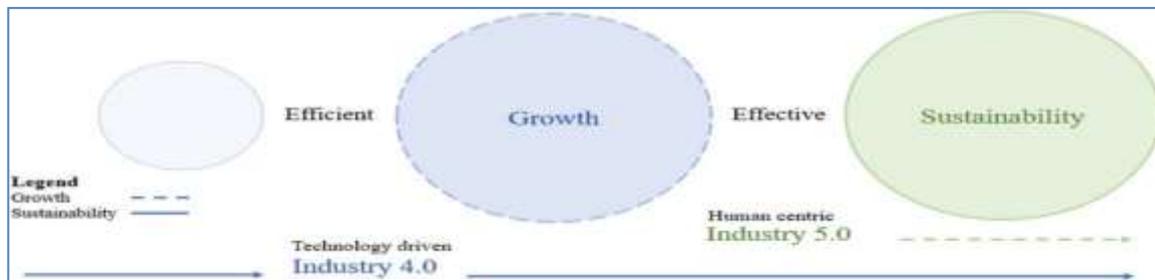
| Sustainability Strategy  | Human-Centricity Strategy   | Resilience Strategy  |
|--|---|--|
| <ul style="list-style-type: none"> <li>- Optimising resource management.</li> <li>- Minimising polluting emissions.</li> <li>- Transitioning to renewable energy sources.</li> <li>- Use digital in production.</li> </ul> | <ul style="list-style-type: none"> <li>- Use the designers</li> <li>- App the green tech</li> </ul> | Realise by: <ul style="list-style-type: none"> <li>- Application of the strategic management (vision)</li> <li>- dynamic process</li> <li>- governance )shareholders – stakeholders(</li> <li>- open innovation</li> </ul> |

**8-2: Economic Importance of 5.0**

5IR has witnessed significant development compared to previous industrial stages, due to the difference in its vision and goal, which focuses on the importance of human-machine interaction within a "processed, customized and sustainable" production model, which is the opposite of what 4IR came with, which focused primarily on digitization, technology and cyber physical systems (Atif, 2023, p. 2158).

This is based on a "new human-centered economic philosophy"– a philosophy that believes humans are now strategic partners, not implementers, in driving intelligent systems through advanced human-machine interaction. The integration of collaborative robots that perform repetitive and tedious tasks enables humans to focus on "personalization, creative design, and critical decision-making" (Aheleroff et al., 2022, pp. 6-7).

**Figure (4): Towards Strategic Human–Machine Partnership in Industry 5.0**



**Source: (Aheleroff & al., 2022, p. 7)**

The form shows the transition from industry 4.0, which focuses on efficiency and growth through technological automation and its principle "doing things right", in contrast, to Industry 5.0, which seeks to ensure sustainability through an integrated human–machine collaboration model by "doing the right things". In this paradigm, the human becomes a central partner in the production system, and the objective shifts toward achieving effective growth that balances economic performance with environmental and social sustainability.

It also creates opportunities for the economy:

| Fields          | Opp   |
|-----------------|---|
| productivity    | Improve operational efficiency<br>Developing processes<br>smart production        |
| economic growth | Promoting<br>Increasing economic<br>achieving efficiencies<br>developing products |
| Quality         | Use of advanced technology in design(product)<br>control.                         |
| Cost            | Reduce in process (ops) / Rationalization   |

*Source: Prepared by the researcher*

### III. Conclusion

5.0 is one of the most important pillars of the global economy, because it focuses on industry, which is key to the sustainability of the economic structure. In addition, other sectors have been integrated, using advanced technology in processes, production, and design. It has also contributed to sustainable development and the realisation of human-machine interaction.

Through this research paper, it was concluded that many sectors will witness a profound transformation, especially the industrial sector, as part of the shift towards smart factories characterized by productivity and cost reduction, In addition to enhancing innovation and creativity capabilities based on focusing on humans and digital at the same time (integration), It also focuses on flexibility through adaptation in order to maintain continuity and position in a dynamic environment through the sustainability index while maintaining profitability, It also enhances the content of hybrid economy, especially in light of technological developments, as one of the factors for the continuity of the 0.5.

#### Result:

- 5.0 has led to the use of advanced technology.
- Achieving an integrated industry model.
- Achieving flexibility and design in industry (production).
- Opening new opportunities for human resources.
- Developing the basics of institutions, which are: people (consumers), process, product, place.
- Enabling sectors to survive and continue.
- Shifting towards the features of a smart society.

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