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INDUSTRY 5.0: AN OVERALL ASSESSMENT OF USING ARTIFICIAL INTELLIGENCE IN INDUSTRIES

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ABSTRACT

In recent years, the increasing complexity of digital technologies and the emergence of Artificial Intelligence (AI)-based solutions have posed challenges to maintaining a competitive edge. Industry 4.0, known as the fourth industrial revolution, entails an increased degree of automation with the goal of improving operational productivity and efficiency in both the digital and physical domains of an organization. The importance of AI computing is seeing significant growth in tandem with the advancements made during the Fourth Industrial Revolution. Notwithstanding the persistent challenges, several enterprises continue to face obstacles in their endeavor to digitalize their operations via the utilization of technologies such as the Internet of Things (IoT), AI, and other analogous improvements. To address this challenge, the introduction of the fifth industrial revolution, sometimes referred to as "Industry 5.0," aimed to address individualized production processes and enhance people across different industries. The advent of Industry 5.0 signifies the emergence of a new era characterized by personalized approaches, which enable digital production systems to achieve improved outcomes. In recent times, there has been a notable surge in the prominence of AI-based wireless applications, owing to the rapid advancements in remote devices and the emergence of AI-driven technologies. Creative AI-based advancements are emerging in industrial applications to address demands that cannot be fulfilled by traditional remote handling and communication technologies. These demands include high throughput, high mobility, low latency, heterogeneity, and flexibility. The primary aim of this research paper is to explore the effect of AI in the Industries. In order to accomplish this, initially, it provide a thorough examination of AI in the Industries, including its technological, economic, and regulatory dimensions. This analysis will include all facets of the technical assessment and impact assessment of AI in industries.

Keywords: *Industry 5.0, Artificial Intelligence, Technological Assessment, Impact Assessment*

1. INTRODUCTION

The rise of digital technology is expediting the digitization of corporate operations, propelling an industrial revolution across diverse sectors, spanning manufacturing to service-oriented industries [1]. This swift advancement in digital technology is applying a considerable impact on production systems and the sphere of operations management. Within the domain of digital technology, Artificial Intelligence (AI) adopts a pivotal role in shaping the trajectory of business evolution, production systems, operations management, and business process management [2]. Recently, the adoption of digital technologies, encompassing AI systems, has emerged as a practical remedy for addressing prevalent industry challenges. The primary objective is to achieve mass customization and implement a sophisticated production system with minimal human intervention [3]. The concept of Industry 5.0, proposed in 2015, has materialized as a driving force behind the establishment of enterprises grounded in automated production processes. Central to this paradigm is the thorough addresses of customers' precise demands. Industry 5.0, distinguished by the incorporation of advanced technologies, is poised to substantially elevate computing capabilities, leaving a profound impact, particularly within the manufacturing sector [4]. The primary aim is to optimize the benefits

ushered in by Industry 4.0 through the strategic utilization of AI. The term "Industry 4.0" refers to the integration of intelligent devices and systems, aimed at catalyzing transformative changes in the current industrial system, ultimately resulting in heightened productivity [5]. In recent times, AI has emerged as a prominent catalyst for the digital transformation of service operations. Particularly, the utilization of mechanical AI robots plays a pivotal role in automating diverse functions within service companies, encompassing business operations and manufacturing processes. The overarching goal is to achieve heightened operational efficiency through AI integration. When compared to manufacturing sectors, service industries manifest notable distinctions, primarily in the collaborative nature of their production processes. This collaboration involves the collective contributions of both service providers and recipients in generating the final service result [6].

Given the transformative impact of AI on operational processes across sectors, it becomes imperative to incorporate consumer perspectives when assessing the augmentation of service operations by AI. Undoubtedly, AI has the potential to redefine the role of customers in the collaborative production of services, thereby significantly influencing service operations facilitated by AI [7]. Delving into a specific domain, Industrial AI represents a well-defined area of research centered on conceiving, validating, and deploying machine learning algorithms tailored for industrial applications. The core objective is to ensure the consistent and reliable performance of these algorithms over time [8]. Industrial AI systems possess the capacity to empower smart manufacturing systems, addressing a prevalent need among companies for a systematic framework to seamlessly integrate AI within industrial environments. The implementation of Industrial AI holds the promise of advancing intelligent and resilient industrial systems, allowing them to demonstrate error tolerance, immediate efficiency, and self-organization. Figure 1 illustrates the block diagram of an Industrial AI system, providing a visual representation of its components and functionalities in the context of enhancing industrial settings with AI capabilities.

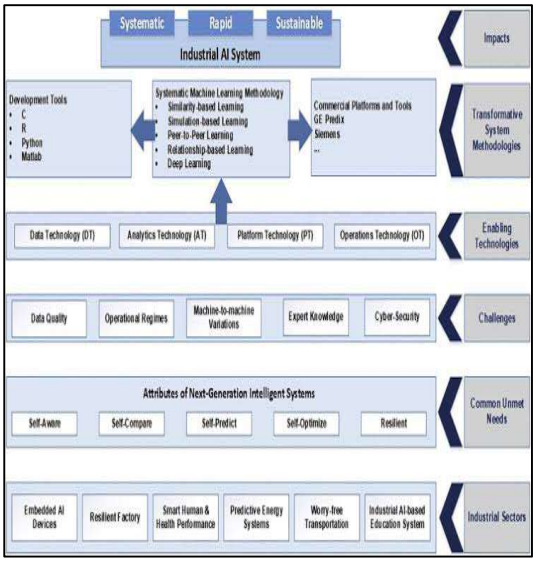

Figure 1. Block Diagram of an Industrial AI System [8]

To achieve the seamless integration of emerging technologies, it is imperative to establish a well-structured system that aligns with fundamental principles [9]. These guiding principles encompass real-time capabilities, virtualization, interoperability, service orientation, and modularity. The essence of AI can be succinctly characterized as the progression of systems demonstrating attributes traditionally associated with human intellect, encompassing learning, reasoning, and self-enhancement [10]. Despite continuing discourse, a universally acknowledged, clear, and precise definition of AI remains intangible. While not limited, machine learning holds a prominent position within the broader domain of AI, with the terms often used interchangeably. Industrial systems exhibit the capability to perceive their surrounding environment, collect pertinent data, and adeptly tackle intricate challenges through the application of artificial intelligence approaches. The acquisition of knowledge by individuals through experiential learning contributes to an enhancement in proficiency for specific tasks. As machine learning algorithms advance in sophistication, their increased complexity poses challenges in terms of understanding and discerning limitations, defects, and performance issues. The rapid advancements in AI have generated contemplation among users, giving rise to considerations spanning economic, social, political, legal, technical, ethical, and philosophical dimensions. Despite notable technological progress achieved in prior industrial revolutions, the industrial sector persists in tackling with significant growth and rapid development.

While AI presents numerous benefits to the industries, demands persist regarding the precise mechanisms through which AI contributes to the realization of Industry 5.0. The emergence of Industry 5.0 has instigated a substantial transformation within the industrial domain, signifying a noteworthy transmutation. In addition, while there are studies examining the intersection of Industry 5.0 and AI in various industrial sectors, the predominant focus has been on analyzing their impact within service-based and manufacturing industries. This research raises the following questions, which should be observed. However, there are still notable challenges that need to be addressed regarding the acceptability and use of this technology.

This research work focuses on to response the following research questions (RQ's):

RQ1: To study the brief overview of Industry 5.0 and AI in industries;
RQ2: To identify the relevant works related to the incorporation of AI in manufacturing sector;
RQ3: To examine the effect of technological assessment of AI-Key elements, existing frameworks and challenges;
RQ4: To examine and validate the impact assessment of AI on economy, environment, and government;

a) What have previous such studies presented? How does our work differ in motivation and findings? Needs a lot of attention.

Previous research in the realm of AI and Industry 5.0 has predominantly concentrated on exploring the transformative influence of digital technology across diverse sectors, from manufacturing to service-oriented industries. These studies have investigated the role of AI in shaping business evolution, production systems, operations management, and business process management, proposing AI systems as practical solutions to address industry challenges and achieve mass customization with minimal human intervention [11]. Recent emphasis has been on AI as a catalyst for the digital transformation of service operations, introducing mechanical AI robots to enhance operational efficiency. Despite distinctions in collaborative production processes between manufacturing and service industries, both sectors share the need for AI to reshape operational processes. The primary objective of industrial AI research has been customized machine learning algorithms to ensure consistent performance. This study stands out because it provides a comprehensive analysis of artificial intelligence (AI) in the industrial sector from a range of perspectives, including politics, economics, legislation, and technology. By highlighting its applications, challenges, and broader implications, it aims to offer insightful perspectives on how artificial intelligence is transforming the industrial environment. The research carefully examines the current state of AI in the industrial and service sectors, assessing innovations, applications, and manufacturing integration into systems while taking operational efficiency into account in order to achieve these goals. The study looks at current practices to find barriers and impediments to the widespread use of intelligent process automation. The research examines how AI influences Industry 5.0, emphasizing automated production methods and satisfying consumer needs. It then summarizes these findings into suggestions for researchers, politicians, and industry players. This involves providing information on the probable future directions of AI in the industrial sector as well as its more general effects on the environment, society, and economy.

Paper Structure: Section 2 presents an extensive examination of previous scholarly studies that are pertinent to the present research study. The research methodology for the forthcoming investigation is detailed in Section 3. It encompasses the assessment of AI impact on both technological aspects and various sectors, including the economy, environment, government, and the manufacturing industry. Section 4 depicts the performance analysis of AI and finally, section 5 critical findings of this research and conclusion of the work.

2. LITERATURE REVIEW

This section presents the literature review that has focused on relevant articles related to AI in successfully implementing Industry 5.0.

2.1. Articles screening criteria

The selection criteria for articles in this study necessitate a direct and substantive engagement with the concept of Industry 5.0, specifically focusing on the incorporation of artificial intelligence in industrial contexts. In this context, we conducted a search for terms such as "industry 4.0," "the fifth industrial revolution," "Impact Assessment," "AI technologies," "AI Challenges," in well-established international journals. Subsequently, from the identified terms, this paper selected and scrutinized pertinent

publications published between the years 2015 and 2023. Publications considered for inclusion comprise scholarly articles, research papers, and conference proceedings that have undergone rigorous peer review, ensuring the reliability and academic integrity of the content. Emphasis is placed on recent publications to capture the latest developments in the ever-evolving realms of Industry 5.0 and artificial intelligence. The study extensively relies on content from academic databases and reputable publishers, ensuring the credibility of the literature incorporated. To provide a comprehensive understanding of the subject, the research adopts diverse perspectives and methodologies, encompassing both theoretical and empirical studies. A language criterion dictates the inclusion of English-language publications to facilitate a coherent analysis. Intentional exclusion criteria involve omitting articles from low-impact factor journals, as their potential contribution to academic discourse may be limited. Articles with low citation counts are also excluded to prioritize works that have received significant attention within the scholarly community. Addressing outliers in citation counts or articles with unusual patterns is crucial, and such instances may be excluded to maintain a representative sample. The inclusion of recent publication dates is essential for an accurate reflection of current trends. Furthermore, articles with inconsistent or irrelevant keywords not aligning with the main themes of the research may be excluded to maintain coherence in the study's focus.

2.2. Role of AI in shaping the industrial landscape from Industry 4.0 to the Emergence of Industry 5.0

Research [12] delves into Industry 4.0's humanization and sustainability domains. Employing bibliometric analytics via tools like Excel, Vosviewer, and Word on the Internet's Journal of Science database, the study analyzes identified papers. Results clarify temporal patterns in industry-related publications and underscore limitations in Industry 4.0, particularly concerning human involvement in smart factories and sustainable growth. This prompts the formulation of a framework, encompassing the concept of Industry 5.0. Additionally, the bibliometric study reveals a significant trajectory in enhancing staff skills and improving personnel competencies. In [13], the focus is on analyzing Industry 5.0 applications, addressing existing advancements and challenges. A thorough examination of prior scholarly works identifies research limits, establishing a systematic analysis technique. The study explores Industry 5.0 categories, associated advanced technologies, and application domains such as cloud-based industrial production, healthcare, and supply chain management. Additionally, it delves into challenges and concerns surrounding interactions between organizations, robotic systems, and humans on production lines, aiming for a deeper understanding of these issues.

In the study [14], the impact of AI-empowered service operations on customer satisfaction was assessed through online review data analysis. Examining over 50,000 TripAdvisor reviews for 35 hotels in Asia and America, the research found that positive interactions with mechanical AI significantly influence overall satisfaction, emphasizing the importance of incorporating AI for resilient service operation. Research [15] addresses limitations by proposing Industry 5.0, advocating the collaborative integration of robots and human workers. The study delineates key aspects, alleviating manufacturing concerns and highlighting empirical breakthroughs applicable to Industry 5.0. Furthermore, it investigates the impact of Industry 5.0 on the manufacturing sector and the broader economy, emphasizing economic and productivity dimensions. The research work [16] identified the primary constituents of Industry 5.0 within the industrial sector. The use of intelligent robots in this paradigm shift efficiently addresses practical challenges in the actual world. Industry 5.0 enables the allocation of processing capacity to the sector, hence facilitating the development of digital production systems that contain the potential to build interconnections. Hence, the implementation of mass personalization leads to enhanced customer pleasure and heightened value generation within the context of Industry 5.0. The study [17] employs a joint cognitive system approach, incorporating methodologies from actor-network theory to underscore human-centricity in initial design stages and the continuous evolution of human-machine teams. The focus is on monitoring and evaluating cooperation within these teams, building a concept of operations with key stakeholders, and integrating ethical considerations into their design and development. The research investigates the potential and challenges in creating seamless and robust human-machine teams within the framework of Industry 5.0 production systems. In [18], the research delves into the impact of Industry 5.0 on the business sector, evaluating the success, shortcomings, and risks of the Industry 4.0 business

transformation through interviews with experts and corporate representatives. The analysis of the current corporate landscape provides insights into prospects, risks, and recommendations for effectively navigating the impending Fourth Industrial Revolution. Additionally, the study engages in an ongoing discussion on strategically reintegrating human employees into the supply chain alongside automated processes. Results suggest that companies faced challenges foreseeing the Industry 4.0 advent due to insufficient entrepreneurial efforts and transformational skills.

2.3. An Overall analysis of existing studies based on AI implementation

Table 1: Overall Analysis of Existing studies

Authors	Technique used	Review
Frank et al. (2019) [19]	Smart supply technology	The examination revealed that while other front-end technologies complement Smart Manufacturing, their implementation remains limited in the studied sample. It is noteworthy, Notably, the machinery and equipment industry, being inherently centered on business-to-business (B2B) activities, diverges significantly from business-to-consumer (B2C) models. however, that the study did not delve into the impact of these technologies on industrial performance, indicating a potential avenue for intriguing future research. Exploring the influence of these technologies on overall industrial performance could provide valuable insights and warrant further investigation.
Raj et al. (2020) [20]	Grey-DEMATEL	This study aims to recognize the obstacles hindering the adoption of Industry 4.0 in the manufacturing sector, considering both developed and developing economies. The research compares the identified barriers, highlighting distinctions based on the characteristics unique to each type of economy.
Guo et al. (2021) [21]	A Smart Manufacturing Platform enabled by the Hyperconnected Physical Internet (HPISMP) and the Graduation Intelligent Manufacturing System (GiMS)	The heuristic algorithm, GiMS, has been devised to attain synchroperation within HAL. However, when dealing with intricate or expansive issues, it is worthwhile to delve deeper into more effective

		optimization algorithms, such as evolutionary algorithms and machine learning algorithms.
Mohd Javaid and Abid Haleem (2020) [22]	Robots and it's varients	This revolution profoundly influences efficiency, the life cycle of products, services, and business models by facilitating effective human-machine interaction. It involves the utilization of intelligent smart machines to automate the production process.
Kaasinen et al. (2022) [23]	Joint Cognitive Systems	Propose that augmenting the robust cognitive systems engineering approach with the concept of operations design could be particularly beneficial during the initial stages of the design process. The ConOps approach facilitates the engagement of diverse stakeholders in shaping the overall functionality and operational principles of the system.

3. RESEARCH METHODOLOGY

To investigate the collected research articles for analysing and evaluating the effective of AI, the research methodology of this study incorporate two assessment phases which include analysis of AI from the perspective of technological assessment and impact assessment. The first phase has focused on technological assessment of AI in industries. This phase include an existing frameworks of AI that means the effect of automation and AI in industries along with the challenges associated in Industry 5.0. Next phase conducts the impact assessment of AI on the economy, government, and the manufacturing industry.

3.1. Technical Assessment

3.1.1 Artificial Intelligence

As the day pass, the workload steadily accumulates, necessitating a significant need for job automation. The aforementioned need has prompted the development of a new technological advancement known as AI [24]. It is often known as Machine Intelligence, is a scientific discipline concerned with the capacity of machines to acquire knowledge, comprehend information, engage in cognitive processes, and exhibit behavior like to that of human beings. The primary objective of AI is to develop robots that can acquire knowledge from their surroundings and effectively perform assigned tasks, hence optimizing their goal attainment [25]. Machine learning is a computational methodology in which machines independently gain information via their experiences. The aforementioned objective is accomplished via the use of computer programs that access available data and utilize it to support autonomous learning. Deep Learning is a specialized domain within the broader area of Machine Learning that use computational models to process and filter data in a manner akin to the cognitive processes of the human brain. In this context, a computer model is used to process incoming data via many layers in order to make predictions and categorize the information. The areas of Artificial Intelligence, Machine Learning, and Deep Learning have achieved significant technological developments across several sectors, resulting in a transformative impact on the globe. Figure 2 describes the influence of AI [26]. It explains the effects of AI into Process level and Organizational level.

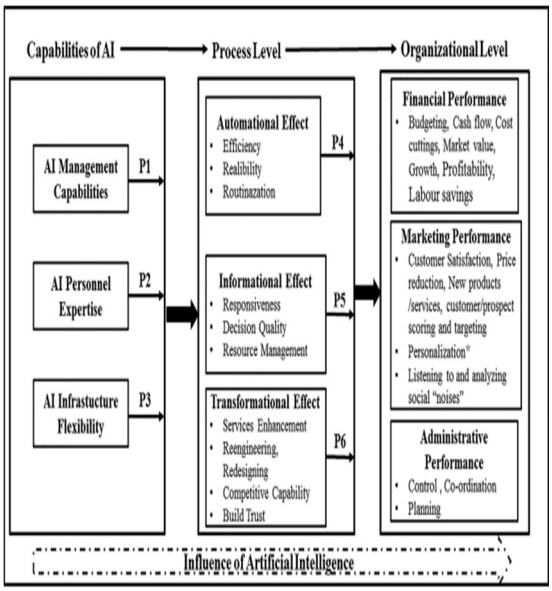

Figure 2: Impact of AI [26]

- **Capabilities of Artificial Intelligence:**

(i) AI Management Capability (AIMC)

AMIC, which stands for Artificial Machine Intelligence Capability, pertains to the ability of a business to proficiently exhibit or replicate intelligent behavior inside computer systems or technological applications. The ultimate objective is to provide added value for the long-term sustainability of the business [27]. The potential of AI management capabilities is distinct in the context of strategic planning, enhancing inter-organizational interactions, making investment decisions, and facilitating coordination and control. The management skills of artificial intelligence (AI) have a noteworthy and favorable impact on the overall capabilities of AI.

(ii) AI personal Expertise (AIPE) Artificial Intelligence Professional Expertise (AIPE), encompasses a broad range of competencies and understanding that individuals inside an organization possess in regard to AI technology, business operations, and relationship domains. These competencies are essential for effectively modeling and utilizing intelligent behavior in computer systems or other technological platforms to successfully carry out assigned tasks [28].

(iii) AI infrastructure Flexibility (AIIF)

The adaptability of implementing artificial intelligence (AI) infrastructure within an organization enables its personnel to quickly assist different system elements and adjust to evolving business circumstances and strategies, including economic constraints, strategic collaborations, acquisitions, global partnerships, or mergers [29].

- **Analysis of AI performance at the process level:**

In the majority of sectors, the assessment of performance enhancement at the process level often involves the use of key performance indicators that pertain to various aspects involving quality, competitiveness, effectiveness, productivity, efficiency, capacity and value.

A. Automation Effect

It is referred as the viewpoint of cost-effectiveness that arises from the use of informatics technology to substitute human-driven processes inside an organization. The automation effect is exemplified via the use of AI and its associated technologies, which facilitate the generation of replicable instructions and procedures, therefore substituting or substantially diminishing the need for human involvement. The impact becomes notably substantial when the use of artificial intelligence is accompanied by tangible improvements in efficiency or dependability resulting from the different article based procedures. This is a kind of financial contribution achieved via the reduction of labor costs and the implementation of budgetary measures.

B. Informational Effect

This phenomenon is often referred to as the capacity of AI to obtain and distribute knowledge, both inside a specific entity and among several external entities. Algorithms use data as a source of input to generate information that is characterized by its reliability, freshness, availability, comprehensiveness, relevance, dynamism, transmissibility, currency, intelligence, and speed. Therefore, companies that possess more capability and proficiency in harnessing the informational benefits of AI and its associated technologies are able to make high-quality judgments in a more efficient and expeditious manner. These decisions, in turn, have a significant impact on the financial and managerial stability of those organizations. Additional advantages of the informational

impact facilitated by artificial intelligence include the management of administrative duties, namely the restoration of organizational oversight over resources.

C. Transformational Effect:

The concept of the transformative impact (TE) pertains to the inherent worth obtained via the utilization of artificial intelligence capabilities, which in turn promotes and empowers the advancement of innovation and the transformation of processes. It serves as a crucial catalyst for the process of reengineering and restructuring the current organizational framework. The transformational impact encompasses several factors, including the augmentation of services, the reengineering and redesigning of processes, the development of competitive capacities, and the establishment of trust. The process level is where the transformative implications of AI capabilities become evident in the manifestation of variables.

3.1.2 Technologies of AI

AI and its technologies, encompassing machine learning, deep learning, chatbots, neural networks, and virtual assistants, significantly impact companies and organizations. These technologies enhance understanding, optimize strategic capabilities, and demonstrate effectiveness in automation and information management. Leveraging AI, organizations adeptly navigate external environments and recognize human relationships. The benefits of incorporating AI in manufacturing are widely acknowledged. However, there exists a dearth of evaluations pertaining to industrial AI (I-AI), which hinders companies from comprehending their current position and strategizing for the future. This section aims to analyze the impact of industrial AI on industries, providing them with valuable insights to evaluate their performance in the journey towards implementing AI technologies. By shedding light on areas for improvement, this study aims to assist these firms in realizing their smart manufacturing visions. The following AI approaches are used to fulfill the objectives of an intelligent automation system. The use of these methods may vary based on the specific situation, either alone or in combination, resulting in a fully automated solution [31]

Computer Vision: A program's capacity to identify input from photographs is known as machine vision. The device builds its organization or methodologies adopted on top of the drill data (pictures). An appropriate example of machine vision may be seen in the context of facial recognition technology included in the iPhone. The use of face recognition technology on iPhones is regarded as a prominent and very effective contemporary feature. The Facebook AI Investigative Database serves as an exemplary demonstration, as it conducts investigations on photographs, categorizes their attributes, and afterwards arranges and elucidates the newly generated visual representations to the user. [30].

Natural Language Processing (NLP): NLP, similar to machine vision, applies comparable techniques to discern human voice and textual inputs as it does for visual representations. Significant progress has been made by individuals in the systematic advancement of NLP. Given the availability of pre-existing data and a dynamic backdrop star, it is now plausible for robots to comprehend the contextual information conveyed in an announcement and then adjust their behavior appropriately. NLP is used by prominent virtual assistants with the intention of providing advantages to businesses [32].

Machine Learning: Machine learning refers to the ability of a computer to enhance its performance by assimilating incoming data, drawing inferences, and considering external variables [33]. The efficacy of existing solutions may be enhanced by the use of machine learning techniques. In the event of an issue arising inside an intelligent automation system necessitating human interaction for resolution, the system will thereafter replicate the processes undertaken by the individual in a mechanized manner. Consequently, there will be a decline in human exertion throughout time due to the enhancement of skills.

Deep Learning: In recent times, deep learning algorithms have shown encouraging outcomes in the domains of robotics and computer vision, specifically as mentioned in research work [34]. The advent of these technologies has provided robots and intelligent machines with the ability to maintain constant cognition and vision, both of which are essential for autonomous applications, including collaborative robots (cobots). The advent of Industry 5.0 is characterized by enhanced collaboration between humans and robots, aimed at optimizing the manufacturing process. This progress is facilitated by the integration of cobots equipped with a comprehensive array of modern sensors, complemented by the use of deep learning

methodologies. Deep learning techniques are mostly grounded on artificial neural networks that include a very substantial number of layers. A notable advantage of deep learning algorithms is in their heightened efficacy relative to traditional learning approaches, particularly when the quantity of training data is increased.

3.1.3 Intelligent Process Automation

Intelligent Process Automation (IPA) is created when AI is incorporated into Robotic Process Automation (RPA) and makes use of various technologies, including Application Programming Interfaces (APIs) for improved forecasting and analysis [35]. This combination, known as Integrated Process Automation (IPA), transforms corporate procedures. AI promotes autonomy over automation in Industry 3.0, which is essential for running autonomous devices. AI techniques revolutionize machine operations by allowing for autonomous execution and learning, which increases productivity. Today, addressing uncertainty is crucial, and deep learning offers assurance in challenging situations. This branch of machine learning uses multi-layered neural networks to process large amounts of data to help with decision-making. In the high-uncertainty environments of Industry 5.0, transfer learning is essential. As the Fifth Industrial Revolution continues, the safe and easy transition of knowledge and expertise from digital or virtual. This imperative task holds significant importance in ensuring a robust and reliable integration between the realms of technology and human labor.

Intelligent Process Automation- Implementation in Industries:

Figure 2 explained the implementation framework process of IPA in industries.

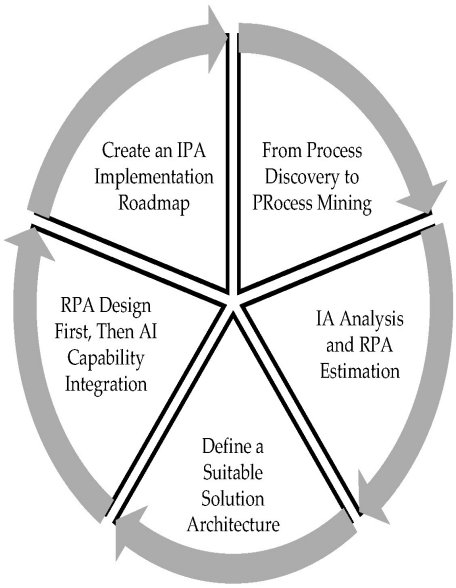

Figure 3: IPA implementation in industries [35]

When developing an IPA roadmap, it is important to take into account the whole end-to-end process rather than focusing just on individual activities. A comprehensive perspective is necessary to demonstrate the enhanced value achieved when a basic RPA solution is insufficient, and when the use of AI becomes imperative to attain more advantages and provide heightened commercial results. Process mining plays a crucial role in the identification of project design and the precise selection of technology for implementation.

Process mining [36] is a methodology that involves using data mining techniques to analyze and extract relevant information from the data created during the execution of business applications. The objective is to accurately reflect the underlying logic of the business processes. Process mining is a methodology that leverages data to automatically generate an as-is process model, therefore improving efficiency and speeding the critical automation phase. During the estimation phase of process mining and RPA projects, it's crucial to examine the integrated AI capabilities within the robot. Follow these recommendations: Prioritize stable applications and projects with a high ROI when leveraging RPA and AI. Evaluate KPIs to justify AI use and assess the cost-effectiveness of AI platform integration. Ensure a sufficient supply of high-quality data, especially for self-learning or machine learning algorithms. Adequate IT resources are vital for implementing sustainable solutions and ensuring smooth transitions. Provide a detailed example of a solution

design for seamless deployment and robustness. Prioritize a straightforward AI application over complex algorithms to maintain RPA sustainability. Proficiency and expertise in establishing a comprehensive framework for intelligent automation are essential for successful IPA execution. Assessing competencies is crucial for businesses to smoothly integrate new technologies into the organizational ecosystem. Implement a comprehensive performance monitoring system in the IT department to oversee intelligent automation initiatives effectively. It is advisable to start implementing RPA before incorporating AI capabilities. The development of an IPA is a complex process that requires the consideration of linked, well-informed, and structured data in order to effectively use cognitive and AI approaches. The use of RPA technology facilitates the mapping of inputs and outputs of various processes, hence enabling the development of data maturity necessary for the successful application of AI systems. The selection of the first set of processes in which AI may be implemented is of utmost importance for the overall success of the program. Upon successful completion of the first integrations, it becomes possible to further enhance the AI capabilities [37].

3.1.4 Different Existing frameworks

The researchers in [38] used the analytical hierarchy approach, a methodology for multi-criteria decision-making, to evaluate and rank the many factors that influence the implementation of automation and AI. Furthermore, a total of 23 sub-criteria were established for each of the five main criteria. The creation of these sub-criteria was informed by consulting earlier research. The current research devised a paired comparison questionnaire using the proposed hierarchical structure. The evaluation of the system included the participation of staff members from 35 prestigious five-star hotels and highly regarded travel agencies in the United Arab Emirates.

The study conducted by the authors in [39] investigates the impact of RAISA (Remote Artificial Intelligence Service Assistant) in industry. The research offers a comprehensive and methodical analysis of the effects of RAISA in this particular setting. The research work undertakes a critical analysis of RAISA's ability to bring about a transformation in the customer experience. It raises essential questions regarding the indispensability of RAISA, as well as its practical implementation and impact on the perception and evaluation of service quality.

The study [33] conducted in 2021 aimed to comprehensively assess and analyze recent advancements in automation within the mining industry. This assessment encompassed various aspects of the industry, such as underground and surface equipment operation, equipment selection, mineral prospecting, mine planning, and among others. The primary objective of this evaluation was to ascertain the existing boundaries of technological progress in these areas. The present research endeavor has been shown to possess deficiencies and obstacles. Deep learning, machine learning, and artificial intelligence have been suggested as potential approaches for advancing cutting-edge technology in the mining industry, with the aim of fostering intelligent and knowledge-driven progress.

The significance of the literature on the Architecture, Engineering, and Construction (AEC) industry is enhanced by the utilization of visualizations and comprehension of trends and patterns. This enables the identification of crucial research topics, prominent journals, institutions, and countries. Furthermore, it illustrates the interconnections among these elements within the existing body of knowledge on AI in the AEC industry. The results of the study [40] highlight the deficiencies in the existing body of knowledge and provide suggestions for future research endeavors. Convolutional neural networks and robotic automation are identified as prospective areas of investigation within the academic discourse. This study provides practitioners, decision-makers, and Research and Development (R&D) organizations with a convenient point of reference for the practical aspects of their respective fields.

In the process of presenting a case study on Deutsche Bank's effective implementation of technology, the referenced research [41] examines the ethical considerations and obstacles associated with intelligent automation and employment. This study illustrates the effectiveness of implementing automated Adverse Media Screening (AMS) at Deutsche Bank in improving the management of unfavorable media coverage, expediting compliance processes, and significantly reducing the occurrence of false positives. This research contributes to the existing knowledge on intelligent automation within the banking sector, offering insights into its development and deployment. The study conducted by researchers [42] examined a range of scholarly works in order to obtain a comprehensive overview of the current utilization of automation in the field of agriculture. The article also discusses a proposed method for the identification and irrigation of

flowers and leaves in botanical farms using Internet of Things (IoT) technology.

3.2 Impact Assessment

3.2.1 Impact on Economy

Over the course of the next decade, there is anticipated to be a substantial expansion in several sectors as they increasingly use artificial intelligence technology. It is projected that the market value of AI software would approach $90 billion by the year 2025. Both data scientists and business managers are attracted to the existence of artificial intelligence (AI) due to their shared desire to automate numerical analysis in order to enhance the overall intelligence of their respective firms.

The convergence of three separate but interconnected innovations paved the way for the progress in artificial intelligence [43]. The power and storage capacity of computers have seen significant growth as a result of the considerable decrease in computing expenses. The computational capabilities of the computer system that enabled the first manned lunar mission are notably inferior to those possessed by even the most rudimentary cellular devices now available for consumer use. As an example, the current production cost of an iPhone 7 is around $220. In the 1980s, the monetary value attributed to the expense of memory for a phone of this kind would have approximated US$1.2 million. In addition, the Internet and other digital communication technologies have seen significant growth and broad adoption, leading to increased accessibility and storage capabilities for digital data. This is particularly evident in centralized storage systems like cloud computing. The advancement of technology has facilitated the ability to compare and analyze substantial volumes of data for the purpose of tracking, a crucial step in the development of AI-based solutions.

3.2.2 Impact on Government

In the near future, it is quite probable that artificial intelligence will emerge as the most significant asset for mankind. Just as it confers advantages onto the administration of any given country, it is necessary for our daily sustenance. Based on a survey, it has been shown that artificial intelligence has the potential to reduce administrative burdens and aid in the resolution of resource allocation challenges. Governmental bodies have derived significant advantages from the aforementioned categories in their pursuit of enhanced job completion efficiency [44]. In the contemporary period characterized by technological advancements, the acquisition and use of vast amounts of data have become imperative. Consequently, the enhancement of AI may be seen as a pathway to steer the future of any economy. According to Accenture's projections, it is projected that by the year 2035, AI would have the potential to effectively double the rates of economic development. However, it is important to note that any effective methodology also incurs a certain expense. The use of AI in public sectors raises many pertinent issues, including potential privacy implications, the accelerated adoption of digital technologies, and the ability of people to effectively collaborate and keep pace with machine-driven advancements. According to study findings, the potential impact of AI on employment during the next two decades spans a range of 9% to 47%.

3.2.3 Impact on Manufacturing Industry

AI is a discipline within the realm of cognitive science that encompasses a wide range of scholarly investigations in areas such as NLP, image and voice recognition, machine learning and among others. Historically, machine learning and AI have been regarded as enigmatic methodologies, often without enough data to convince the business of their consistent efficacy and potential for generating profitable outcomes. Furthermore, the efficiency of machine learning algorithms is significantly influenced by the preferences and expertise of the developer. Consequently, the use of AI in industrial contexts has mostly yielded unsatisfactory outcomes. The systematic field of industrial AI aims to achieve the core goals of developing, verifying, and deploying a range of machine learning algorithms that are varied and capable of delivering long-term performance in industrial applications. It functions as a systematic discipline and methodology for providing solutions for commercial applications, while also serving as a bridge between academic research in artificial intelligence and professionals in the business domain [45].

4. PERFORMANCE ANALYSIS OF AI IN INDUSTRIES

4.1 Comprehensive assessment of benefits and drawbacks of AI implementation

A thorough graphical analysis of several models is also provided in this part, with an emphasis on their high throughput, high portability, low latency, heterogeneity, and adaptability to various technical,

financial, and legal factors. The graphic representations presented in Figures 4a, 4b, and 4c highlight the significant influence of technology on Industry 5.0.

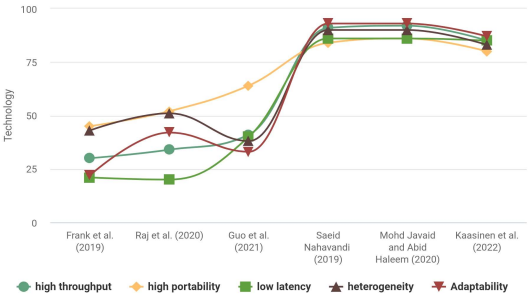

Figure 4a. State-of-the-art models vs Technology [51]

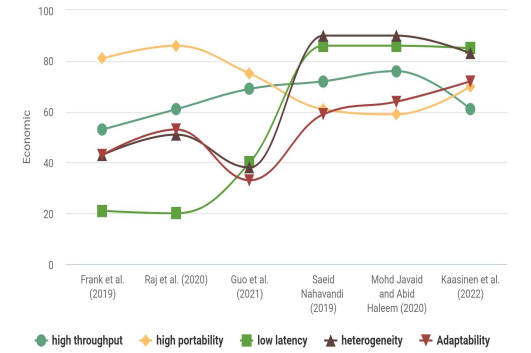

Figure 4b. State-of-art models vs Economic [51]

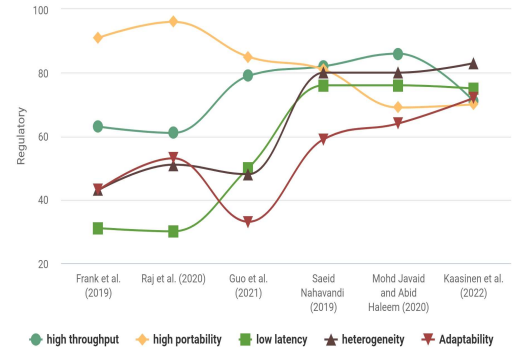

Figure 4c. State-of-art models vs Regulatory [51]

The above figures notably highlight the use of robots and their sophisticated artificial intelligence iterations, in contrast to other existing methodologies. Sophisticated AI iterations are highlighted to highlight robot sophistication. Concerns have been expressed regarding how AI and robots may impact electronic components and materials in terms of the economy. The employment of robots and other artificial intelligence expert systems raises questions about their impact on the economy from an economic perspective, mostly because of the resources used in their construction and other electronic components. In terms of regulations, specific guidelines are necessary to address AI-related business issues. The use of AI improves cost-effectiveness while boosting operational efficiency and competitiveness. Its capacity for long-term innovation and development may outweigh concerns about up-front costs and staff changes. To successfully implement Industry 5.0, a balanced integration needs to be accomplished. Some of the challenges that may arise are the need to address the equitable distribution of economic advantages, potential changes in the workforce, and initial investment expenses [46]. Achieving a balance between minimizing drawbacks and optimizing benefits is essential for the successful integration of artificial intelligence in Industry 5.0 [47].

4.2 Analyzing the Effects on the Environment

This section evaluates the environmental effects of sustainability and energy efficiency with a focus on accuracy. The study identifies research gaps, lays the foundation for future inquiry, and consolidates current insights through a thorough review of the body of existing literature. There are a number of obstacles that must be overcome before AI can be widely used in the smart energy industry. Additionally, the detection and diagnosis of faults in building energy systems present intricate challenges [48]. Major obstacles in the energy system, impacting reliability and performance, are identified as data insecurity and incomplete information. Challenges also stem from subpar quality in controllers, sensors, and controlled devices. The complex interconnections and strong coupling within the power grid, coupled with the high data dimensionality of large-scale simulation grid data, introduce fresh challenges in the energy market [49]. The incorporation of renewable energy sources, such as wind and solar, through AI proves intricate and introduces difficulties in grid operations [50]. The below figure depicts the effect of AI on energy and business sector [51]. Additional significant challenges in the realm of energy and AI encompass [52]: AI's inactive growth in the energy sector is attributed to decision-makers lacking key AI skills, coupled with organizations lacking the technological background to comprehend the benefits of AI applications

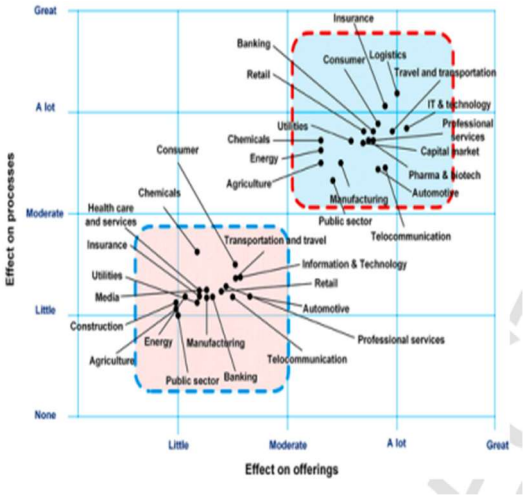

Figure 5: Effect of AI on energy and business sector [51]

Despite professionals possessing in-depth technical knowledge, finding qualified experts to create reliable AI-powered applications with tangible practical benefits is a significant challenge. The high cost of errors in the energy sector makes companies hesitant to explore new strategies without adequate expertise. Outdated power system infrastructure hinders the modernization of the energy sector, as utility companies struggle to manage the vast amount of dispersed, disorganized data produced. The industry's substantial profits coexist with vulnerabilities stemming from outdated systems. Economic pressures arise from the substantial costs associated with integrating innovative energy technologies. This requires a large amount of funding and resources due to the costs associated with finding a reliable software provider, software development, customization, maintenance, and management. The complex issues surrounding the production, transmission, distribution, and consumption of energy on a global scale are caused by decentralization, energy supply diversification, the emergence of AI technology, and rising demand. Because of the reliance on cellular technology, the impact of AI is limited in many developing economies, especially in low-income nations and rural areas. The increasing apprehension regarding cyber-attacks is noteworthy, particularly considering that automated control and smart metering constitute a substantial portion of global grid investment. Because of the flaws in current methods, consumers frequently perceive AI-based applications as being opaque and difficult to understand, requiring strong security measures when integrating them into power systems.

5. RESULTS AND DISCUSSION

A. Investigation of specific mechanisms through which AI contributes to Industry 5.0

Notable changes in business and society have been brought about by the Industrial Revolution. Industrial operations have undergone significant changes as a result of the introduction of digital technology. Major advances in mechanical engineering were made during Industry 1.0, the first industrial revolution, which used steam and water as its main power sources. The second industrial revolution, or "industry 2.0," was dominated by electrical engineering and used steam as a major energy source. It significantly altered many industries and had an impact on people's lives. Notable progress in Industry 2.0 included mass production assembly lines and the integration of electric power systems. Industry 3.0, or the third industrial revolution, introduced automated production and the integration of electronics, computers, and information technology into the manufacturing process. The fourth industrial revolution, denoted as Industry 4.0, centers around the automation of industrial processes, representing a significant advancement in the field of production. Within this paradigm, it is expected that robots will see significant changes in both their communication techniques and their ability to carry out certain activities. Industry 5.0 represents a progressive advancement beyond its antecedent, including a comprehensive array of cutting-edge technologies that foster a harmonious coexistence between humans and machines, while simultaneously prioritizing the imperative of sustainable growth. Historical evidence indicates that industries have undergone consistent transformations towards enhanced productivity and efficiency during past industrial revolutions. Despite the proliferation of conferences and symposia dedicated to the exploration of Industry 5.0, a significant number of manufacturers and industry executives remain skeptical about the timeliness of a new industrial revolution. However, the adoption of the next industrial revolution requires the integration of new technologies, which in turn requires the development of specialized infrastructure and progress.

The results presented in this study demonstrate a substantial correlation between the use of AI models and the technology, economy, regulatory. While the findings of this study align with the research conducted by [53] it is important to note that this

work offers a distinct contribution by elucidating the underlying mechanism via which AI influences industries. Specifically, the research paper investigates the effect of AI on industries from four different perspectives: Technological assessment and impact assessment. Furthermore, this study also conducts an empirical examination of the promotional influence of AI on technical innovation. The findings indicate that the effect of AI on technological innovation varies across different industries, demonstrating industrial heterogeneity. In contrast to high-tech businesses, low-tech sectors see a more pronounced impact from AI in driving technological innovation. Furthermore, industries with higher degrees of AI integration exhibit a heightened capacity to foster technological innovation. The aforementioned points serve as the focal points of this study, as well as an extension of the current body of literature, which encompasses the research conducted by [53] and several other scholars.

Hence, this research provided an analysis of an impact of AI in industries, highlighting the significant advancements and achievements shown by AI in these domains. The exponential progress of emerging technologies has resulted in a substantial increase in their incorporation within many sectors. This study has also included an analysis of the technical aspects and effect evaluation of AI in the context of automation and industry-level domains. Furthermore, this resource will be beneficial for research experts seeking to delve into a comprehensive understanding of AI within the industry. It will empower them to formulate diverse frameworks and conceptual approaches aimed at enhancing the industry-wide implementation of AI.

B.Emphasis on automated production processes and meeting customer demands

In the framework of Industry 5.0, the emphasis on satisfying consumer requests and automated manufacturing processes represents a fundamental change in industrial practices. The most recent phase of industrialization, known as Industry 5.0, places a strong emphasis on integrating cutting-edge technology like collaborative robotics, AI, and the IoT. This paradigm places a strong emphasis on using automated processes to optimize manufacturing while maintaining a high degree of customisation to satisfy individual client needs. With this strategy, human and machine cooperation will be seamless, resulting in more responsive and customized manufacturing processes. By utilizing cutting-edge technology in automated manufacturing, Industry 5.0 seeks to increase productivity, innovation, and customer happiness. Automation is the process of integrating intelligent autonomous robots into shared workspaces with the goal of establishing a culture of trust and dependability among stakeholders. It is expected that this will improve overall process efficiency and encourage more people to return to the workforce by increasing production, decreasing inefficiencies, and enabling customized manufacturing processes. Industry 5.0 focused on automated production processes and satisfying consumer requests while thoroughly examining the engineering, financial, policy, and regulatory aspects of AI in the industrial sector. The research shed light on the state of AI technology today, highlighting their uses, difficulties, and wider ramifications. It critically analyzed the economic implications, such as cost-effectiveness, productivity, and competitiveness, and offered insightful guidance to stakeholders navigating the ever-changing industrial AI landscape.

Some of the challenges and limitations, we identified are:

- Data Quality and Availability
- Ethical and Legal Concerns
- Regulatory Issues
- Interoperability and Integration
- Skill Gaps and Training Needs
- Security Risks
- High Implementation Costs and Return on Investment (RoI)
- Explainability and Transparency
- Social Acceptance and Adaptation

Additionally, the study examined the difficulties and constraints associated with integrating AI into Industry 5.0, which are explained in the following. Data Accessibility and Quality: Since the quality of input data has a significant impact on the accuracy and dependability of AI outputs, ensuring that high-quality data is readily available for AI systems presents a problem. The efficiency of AI applications in decision-making processes may be hampered by limited access to pertinent and clean data. Legal and Ethical Issues: The challenge is managing the legal ramifications of autonomous systems in industrial contexts as well as ethical issues pertaining to AI decision-making and possible biases. Ensuring compliance with changing regulatory frameworks and striking a balance between innovation and ethical norms. Regulatory Concerns: The challenge is in navigating the intricate and dynamic regulatory environments that

oversee AI applications in Industry 5.0 while maintaining compliance with industry-specific norms and laws. As AI technologies develop more quickly than legal frameworks, compliance issues might surface. Integration & Interoperability: Managing heterogeneous technologies presents a challenge: ensuring the smooth integration and interoperability of various AI systems within Industry 5.0 ecosystems. The cohesive operation of networked systems may be hampered by incompatibilities between different AI solutions. Training needs and skill gaps: The challenge is in closing skill gaps in the workforce so that AI-enabled technology can be operated and managed efficiently. This calls for continuous training and upskilling programs. There may be a skills shortage as a result of the workforce's inability to keep up with the rapid improvements in AI. Risks to Security: The challenge is in reducing the cybersecurity risks that are linked to AI systems and protecting against possible weaknesses, cyberattacks, and unapproved access. The incorporation of AI creates new security risks and attack avenues that call for strong defenses to protect the integrity and confidentiality of sensitive data. High ROI (return on investment) and implementation costs: The challenge is in controlling the significant expenses linked to the adoption of AI technology while guaranteeing a favorable return on investment in the form of increased efficiency and productivity. The broad adoption of AI in Industry 5.0 may be hampered by initial investment problems, especially for smaller businesses with tighter budgets. Explaining Capabilities and Openness: The challenge is in making AI decision-making processes transparent and in making sure that AI models can be understood, interpreted, and are answerable to human operators. It may be difficult to comprehend the reasoning behind the decisions made by some sophisticated AI models, such as deep neural networks, due to their lack of transparency. Social Adaptation and Acceptance: Ensuring that the technology is in line with social values while addressing apprehensions and promoting acceptability among the workforce and society over the incorporation of AI. The adoption of AI technology may be impeded by reluctance to change and concerns about job displacement. This calls for the implementation of efficient communication and education programs. Although Industry 5.0 and AI developments have a lot of potential, resolving these issues is essential to ensuring their ethical and sustainable integration into other industries, which will result in Industry 6.0.

6. CONCLUSION AND FUTURE WORKS

This research article provided an analysis of an impact of AI in industries, highlighting the significant advancements and achievements shown by AI in these domains. The exponential progress of emerging technologies has resulted in a substantial increase in their incorporation within many sectors. This study has also included an analysis of the technical aspects and effect evaluation of AI in the context of automation and industry-level domains. Furthermore, this resource will be beneficial for research experts seeking to delve into a comprehensive understanding of AI within the industry. It will enable them to develop diverse frameworks and conceptual approaches aimed at enhancing the implementation of AI at an industry-wide level. Automation defined as the integration of autonomous robots as intelligent entities that work alongside people inside a shared workplace. The development of trust and reliability between the involved parties will lead to improved operational effectiveness, exceptional productivity, reduced inefficiencies, and the capacity to tailor manufacturing procedures. By using this approach, it is anticipated that a larger number of individuals would be encouraged to return to the workforce, thereby leading to enhanced levels of process efficiency.

The goal of this industrialization wave is to optimize and streamline processes by facilitating better human-machine contact. Customizability is taken to the next level by Industry 5.0, which builds virtual experiences, complex computer systems, and cutting-edge computing infrastructure while effectively satisfying highly customized needs. It anticipates the creation of higher-value occupations with more flexibility for design thinking and creativity by integrating big data, AI, the Internet of Things, cloud services, collaborative robots (COBOT), inventive thinking, and imagination. Higher productivity growth and increased chances for client customisation are benefits, but there are drawbacks as well, such as the requirement for a skilled labor, increased cybersecurity concerns, and ethical issues when making decisions. Even if Industry 5.0 gives machines greater autonomy, it nevertheless prioritizes human input into morally important choices. With Industry 5.0, human-machine cooperation is anticipated [54-60]. Some of the future works we identified are:

A. Synthesis of findings into recommendations for stakeholders, policymakers, and researchers

Recommendations are developed in light of Industry 5.0's emphasis on process optimization through improved human-machine interaction and expanded customizability. The problems of an increasingly independent Industry 5.0 are being addressed by encouraging stakeholders to engage in skill development. Regulations that strike a balance between innovation, ethics, and cybersecurity issues ought to be given top priority by policymakers. It is recommended that researchers look at ways to improve human-machine cooperation so that ethically important judgments made by machines as they become more autonomous are guided by human ideals. In summary, the synthesis highlights the necessity of teamwork in order to effectively handle the benefits and difficulties that Industry 5.0 brings.

B. Insights into potential future trajectories of AI in the industrial sector

Looking ahead to Industry 5.0, Industry 6.0 is the next frontier. Industry 6.0 aims to create an even more complex industrial environment with more intricate AI integration. Real-time decision-making, seamless connection, and more autonomy in industrial processes are all anticipated outcomes of this progression. Industry 6.0 will come about via utilizing state-of-the-art technology, improving AI algorithms, and resolving current issues. With the use of more sophisticated technology, Industry 6.0 seeks to attain previously unheard-of levels of production, efficiency, and creativity. To ensure a responsible and sustainable transition, researchers and stakeholders are invited to investigate this trajectory, taking into account ethical, sociological, and economic ramifications.

C. Broader implications for the economy, environment, and society

The incorporation of AI has significant ramifications for several disciplines in Industry 5.0. In terms of the economy, it offers improved competitiveness, cost-effectiveness, and productivity. On the other hand, issues including significant implementation costs and possible staff changes require consideration. Energy efficiency and sustainability are environmental factors, and AI is anticipated to help with resource optimization. These consequences should be addressed in future work as we go toward Industry 6.0. Overcoming Industry 5.0's obstacles would be a primary goal in order to facilitate a more seamless transition. Industry 6.0 attempts to create innovation while tackling societal and environmental issues, all the while striking an even greater balance between possible benefits and negatives. Together, researchers and interested parties should develop appropriate AI integration methods for Industry 6.0 that promote sustainable growth and have a good influence on the environment, the economy, and society at large.

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