Review of How AI-Driven Technologies Enhance Productivity, Optimize Resource Utilization, and Foster Innovation in Industrial Sector

Naveed Uddin Mohammed[1], Osita Miracle Nwakeze[2], Nwafor Anthony Chigozie[3], Obaze Caleb Akachukwu[4]

[1]Department of Computer Science, Lindsey Wilson University, Columbia, Kentucky, USA

[2,3]Department of Computer Science, Chukwuemeka Odumegwu Ojukwu University, Uli

[4]Department of Computer science, Dennis Osadebay University Asaba, Delta State, Nigeria

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ABSTRACT

The application of Artificial Intelligence (AI) in energy, science and technology has become a key driver for the development of smart industry and economic changes in the digital age. In this research, we conduct a systematic review of the literature to explore the impacts of AI-powered technologies on improving productivity, resource efficiency, and innovation in major industrial domains. Using a Systematic Literature Review (SLR) approach, the research examined relevant publications from 2019 to 2026 to highlight key trends, use cases, and challenges relating to the use of AI. The results show that AI enhances industrial productivity through the use of smart manufacturing, predictive maintenance, energy-efficient systems and data analytics for decision-making. Moreover, AI fosters economic development through innovative business models, skill development, and sustainable practices through energy efficiency and environmental monitoring. But the research also highlights key challenges such as barriers to infrastructure development, data security, energy-intensive AI operations and potential job losses. However, the findings verify AI as a disruptive technology that can bring sustainable industrial development and economic resilience. The reseach finds that targeted investments in digital infrastructure, policy support and human resource development are crucial to taking full advantage of the potential of AI to advance smart industry and transform economies, especially in emerging markets.

Keywords: Artificial Intelligence (AI); Smart Industry; Industry 4.0; Economic Transformation; Energy Systems

INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) technologies has marked a new technological revolution, which is profoundly changing the nature of industry and economic development (Trabelsi, 2024; Rabbani and Miftahuddin, 2024). Around the world, the integration of AI with energy, research and industry is giving rise to smart industries that automate processes, use data analytics to inform decisions, and improve efficiency (Chowdhury, 2024; Lindberg, 2025). This transformative process, also known as Industry 4.0, harnesses sophisticated computational methods including machine learning, deep learning and smart data analytics to enhance processes and system performance in various domains (Chen et al., 2019).

Within the energy industry, AI is helping overcome legacy challenges in power generation, transmission and distribution. By incorporating AI into smart grids, renewable energy systems, and energy management strategies, predictive analytics, real-time monitoring, and resource allocation become possible (Ajao, 2024; Adewoyin et al., 2025; Vasilescu et al., 2025). Likewise, in science and technology, AI drives innovation by improving data analytics, facilitating simulations, and automating experiments (Song et al., 2026; Nwakeze et al., 2025). Such advancements not only lower the time and financial risks of research and development but also encourage innovation in fields like climate science, materials science and technology, and medical technologies (Qin et al., 2023).

Moreover, the integration of AI-powered technologies into industrial systems is driving economic change by enhancing productivity, lowering costs, and facilitating the development of new business models (Aldoseri et al., 2024; Jiang and Chen, 2024). Smart manufacturing, enabled by AI and the Industrial Internet of Things (IIoT), allows machines, systems and people to communicate with each other to enable efficiency and agility in production (Lindberg, 2025). In the quest for sustainable economic growth and competitiveness, especially in developing countries, the deployment of AI in the energy, science and technology sectors offers a promising avenue for the advancement of smart industry and sustained economic growth (Mdladla et al., 2024; Achebo, 2025).

LITERATURE REVIEW

The impact of Artificial Intelligence (AI) on economic growth and industrial advancement has been extensively discussed in recent academic literature. Trabelsi (2024) conducted a detailed analysis on the macroeconomic effects of AI, noting its capacity to boost global GDP by 7% per year for the next ten years and productivity by as much as 40% in some industries. Likewise, Qin et al. (2023) observed a surge in AI research, especially in domains like sustainability, innovation and decision-making. Also, Rabbani and Miftahuddin (2024) substantiated these insights by showing that adopting AI technologies improves operational efficiency and productivity in several sectors. However, these studies also highlight the risks of AI, such as structural unemployment, inequality, and ethical concerns, and thus underline AI's potential to both contribute to economic growth and cause socio-economic disruption.

For emerging and developing countries, AI has been identified as a key enabler of inclusive development and structural transformation. Mdladla et al. (2024) identified AI's transformative potential in areas like agriculture, healthcare and financial technology, where it enhances productivity, cost efficiency, and access to services. For example, VetAfrica showed the benefits of AI-driven diagnostic solutions in improving livestock health and productivity. Likewise, Achebo (2025) investigated AI integration in Nigeria across various sectors, showing advances in precision agriculture, medical diagnostics, financial services, and online education. It forecasted significant economic growth, with AI potentially contributing to a higher GDP. However, both studies highlighted the importance of overcoming infrastructural bottlenecks, skills deficits and regulatory hurdles to harness the full potential of AI in these regions.

AI has also significantly contributed to research and innovation. Chen et al. (2019) found that convolutional neural networks (CNNs) were effective in medical diagnosis, especially using time-series data, where the CNN models outperformed conventional methods in terms of accuracy and false-positive rates. Meanwhile, Aldoseri et al. (2024) noted the significance of key AI capabilities including predictive analytics, learning and data processing in improving efficiency and innovation within organisations. Likewise, Chowdhury (2024) noted the use of AI technologies such as robotics, machine learning and computer vision in streamlining manufacturing processes, enhancing product quality and minimising downtime. Such innovations highlight the contribution of AI to speed up the process of discovery and development of adaptive intelligent systems.

Moreover, AI has emerged as a key factor of production in industrial systems. Lindberg (2025) showed that AI is a direct factor of production in manufacturing, with rising levels of AI association leading to greater productivity and sales. It also identified complementarities between AI, labor and hardware, reflecting the emerging trend in Industry 4.0. In line with this argument, Kovalevskyy (2024) demonstrated that AI-powered intelligent manufacturing systems deliver superior performance through increased automation, integration, and resource efficiency. These results underline the increasing relevance of AI as a key enabler of industrial competitiveness in the creation of smart factories and digital integrated manufacturing.

The use of AI for energy and sustainability has also been extensively studied. Ajao (2024) noted that AI-based predictive maintenance has led to up to 40% reduction in equipment downtime and that demand forecasting models have an average accuracy rate of 90%, thus enhancing energy supply. Adewoyin et al. (2025) also showed that AI improves renewable energy prediction, bolsters smart grid resilience, and facilitates distributed energy systems (microgrids and peer-to-peer energy trading). Moreover, Jiang and Chen (2024) found that AI-driven optimisation optimises productivity and cuts carbon emissions, with precision ratios above 97%. Together they highlight the vital role of AI in energy infrastructure modernization, efficiency improvements, and enabling the shift to sustainable energy systems.

In recent empirical studies, the links between AI, green innovation, and sustainability transformation have also been explored. Song et al. (2026) found that AI policy measures greatly promote green innovation in firms by helping them seize environmentally sustainable opportunities. Similarly, Zhou et al. (2025) confirmed this by proposing an AI-driven Environmental, Social, and Governance (ESG) assessment model with high classification accuracy that also identified environmental performance enhancements. In addition, Vasilescu et al. (2025) validated the strong relationship between AI investment, renewable energy consumption and economic growth in several countries, showing the benefits for developed economies, and catch-up opportunities for emerging economies. In conclusion, these findings validate that AI is a key driver of sustainable development that integrates economic growth with environmental protection while requiring effective policy settings and targeted investments to deal with new challenges.

RESEARCH METHODOLOGY

The study uses a Systematic Literature Review (SLR) method to critically analyse the role of Artificial Intelligence (AI) in energy, science and technology to enhance smart industry development and economic transformation. The SLR was chosen to provide a rigorous, systematic, and transparent approach to identifying, assessing and synthesising existing literature. A thorough search was performed in leading databases such as IEEE Xplore, Scopus, Web of Science, and Google Scholar, using selected keywords like "Artificial Intelligence", "smart industry", "energy systems", "economic transformation", and "Industry 4.0". Peer-reviewed journal articles, conference proceedings and reputable reports published from 2019 to 2026 were included, while studies with poor methodology or relevance were excluded. The identified studies were plotted through thematic content analysis to map emerging trends, approaches, applications, and areas for future research. This methodology guarantees that the results are based on credible evidence, enabling a deeper understanding of the advancements in AI-related developments across various fields.

Figure 1: Block Diagram of the Methodology

The Concept of AI in Energy, Science, and Technology

Artificial Intelligence (AI) is the design and use of intelligent systems that can perform tasks that are usually considered to be the domain of human intelligence, such as learning, reasoning, problem-solving, and decision-making (Zoccolotti et al., 2021). In energy, science, and technology, AI is conceptualised as a holistic approach that combines sophisticated algorithms (such as machine learning, deep learning and reinforcement learning) with big data systems to improve efficiency, precision and flexibility (Biswas et al., 2024). The notion is grounded in the capacity of AI systems to analyse large volumes of structured and unstructured data, detect patterns, and provide predictive insights to inform real-time and autonomous decision-making in complex systems (Pasqualetto et al., 2024).

AI is defined in the energy domain as a tool to support the development of smart and sustainable energy systems. It enables the creation of smart grids that can monitor and predict demand and control electricity generation and delivery in real-time (Bishaw, 2024). AI models enhance the integration of renewable energy resources like solar and wind by forecasting generation patterns and matching supply and demand (Wang et al., 2025). Furthermore, AI enables predictive maintenance of energy systems, thereby decreasing system outages and costs, and increasing system reliability and resilience (Dong et al., 2024). This makes AI an essential component in addressing energy challenges, such as efficiency, sustainability, and low-carbon energy systems (Zhong et al., 2024).

More broadly, in the fields of technology and industrial systems, AI drives the development of smart industries, often referred to as Industry 4.0. It facilitates the convergence of digital technologies like the Internet of Things (IoT), cyber-physical systems, robotics and cloud computing into integrated and smart systems (Doğan et al., 2025). AI-driven technologies such as smart manufacturing, digital twins, and automated inspection boost efficiency, agility and productivity (Jiang and Chen, 2024). Moreover, AI-based technologies facilitate decision-making, resource allocation, and the development of adaptive systems that can adjust to changing circumstances (Zhou et al., 2025). In summary, the notion of AI in energy, science and technology represents its role as an enabler of innovation, sustainability and economic growth in the new digital economy.

Application of AI in Smart Industry

AI in smart industry is one of the fundamental elements in contemporary industrial revolution, facilitating the creation of smart, highly automated and connected manufacturing systems. Under the paradigm of Industry 4.0, AI is combined with other technologies like the Industrial Internet of Things (IIoT), robotics, cloud computing and cyber-physical systems to build smart factories that process data in real-time and make decisions independently (Aldoseri et al., 2024). These technologies use machine learning techniques and data analytics to track processes, streamline operations and boost productivity, thus decreasing human involvement and increasing speed and precision (Chowdhury, 2024).

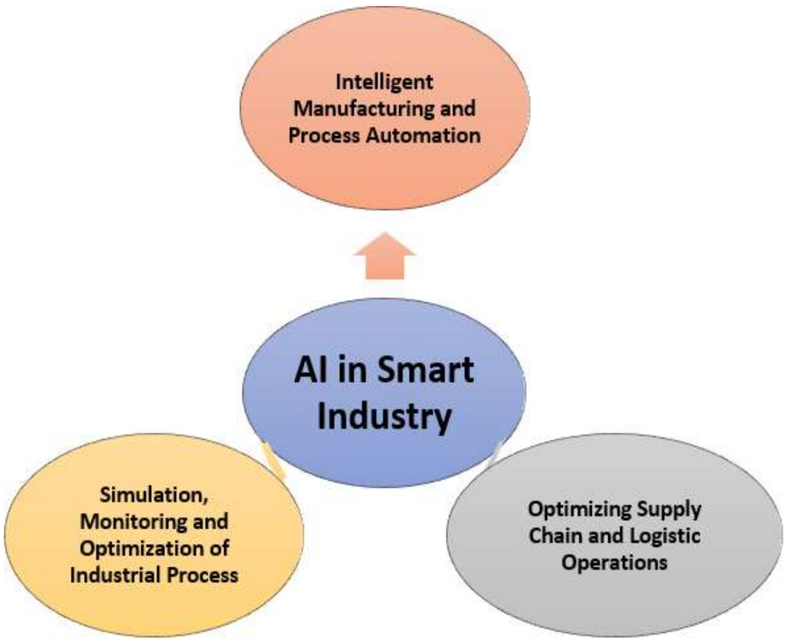

Figure 2: Smart Industry Applications of Artificial Intelligence

Intelligent Manufacturing and Process Automation: AI-based robots and automation systems are employed to execute routine and precision tasks at high speed and accuracy, reducing errors and improving product quality (Acemoglu and Restrepo, 2019). Similarly, AI-based computer vision technologies are extensively used for inspection and defect detection, allowing real-time product quality monitoring during manufacturing (Chen et al., 2019). Predictive maintenance is also a crucial application where AI algorithms use sensor data from machinery to identify anomalies and predict future breakdowns to prevent downtime and maintenance expenses (Biswas et al., 2024).

Optimizing Supply Chain and Logistics Operations: AI is also essential in improving supply chain and logistics management in smart industries. By leveraging predictive technologies and demand forecasting, AI can help industries predict future market trends, manage inventory, and improve distribution efficiency (Afjal, 2023). This results in better resource management, minimisation of waste, and responsiveness to market signals. In addition, AI supports better decision-making by offering insights from vast amounts of data, allowing managers to make strategic decisions that enhance efficiency and competitiveness (Doğan et al., 2025).

Simulation, Monitoring, and Optimization of Industrial Processes: AI is also used in smart industry for the creation of digital twins, virtual models of real systems that enable simulation, monitoring and optimization of industrial processes (Vîrjan et al., 2023). These virtual models allow industries to simulate various scenarios, detect process inefficiencies, and make improvements without interrupting production processes. Furthermore, AI plays a role in energy management in industrial settings by optimising energy use, cost reduction and sustainability (Dong et al., 2024; Zhong et al., 2024). In summary, the use of AI for smart industry not only increases productivity and innovation, but also sustainable industrial development and economic transformation (Parmová et al., 2024).

Application of AI for Economic Transformation

Artificial Intelligence (AI) is critical in economic growth as it increases productivity, efficiency and innovation in various industries (Mdladla et al., 2024; Achebo, 2025). Figure 3 shows the application of AI for Economic Transformation.

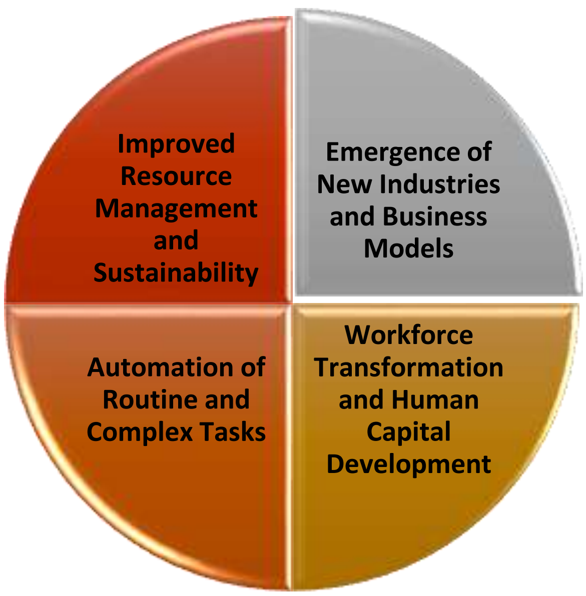

Figure 3: AI Application for Economic Transformation

Automation of Routine and Complex Tasks: A key role is the automation of routine and complex tasks, which lowers the cost of operations and improves the quality and speed of production. Companies use AI systems (e.g. machine learning algorithms, intelligent analytics) to enhance business operations, decision-making, and competitive strategies (Trabelsi, 2024; Qin, Xu, Wang, & Skare, 2023). This results in increased productivity at both company and country levels, which translates into an increase in output, Gross Domestic Product (GDP), and economic growth (Kovalevskyy, 2024).

Emergence of New Industries and Business Models: AI also enables the creation of new industries and business models, especially in the digital economy. Innovations like fintech, e-marketplaces and AI-based service platforms have transformed business models and value creation (Rabbani and Miftahuddin, 2024). For instance, in banking, AI facilitates fraud prevention, credit assessment and customer service automation and thereby enhances financial inclusion and participation in the economy. Likewise, AI-enabled platforms support entrepreneurship and small and medium enterprises (SMEs) through data analytics, market connections and efficiencies, facilitating economic diversification and growth (Achebo, 2025).

Workforce Transformation and Human Capital Development: Automation may displace some routine jobs, but it also opens new job opportunities in sectors like data science, AI engineering, maintenance of AI systems and digital services. This requires the acquisition of new skills, especially digital literacy and human-machine skills (Acemoglu and Restrepo, 2019). As such, governments and organisations are advised to focus on education and training initiatives to equip the workforce with the necessary AI skills, enabling inclusive economic growth and reducing the risks of job loss and inequality (Song et al., 2026).

Improved Resource Management and Sustainability AI enhances resource efficiency in agriculture, energy and manufacturing sectors, through precision farming and resource allocation, waste reduction and waste treatment (Adewoyin et al., 2025). For example, AI enables precision agriculture for higher yields and lower resource use, and AI-powered energy management systems for better power distribution and reduced losses (Vasilescu et al., 2025). These use cases promote sustainable economic development by improving productivity while preserving resources (Zhou et al., 2025).

Lastly, AI improves governance, policy-making and public service delivery, all critical aspects of economic development. Policy makers also use AI systems for evidence-based policy, economic projections and resource planning (Aldoseri et al., 2024). AI technologies enhance the health, education and urban development sectors, which in turn boost the quality of life and economic prosperity of people (Jiang and Chen, 2024). Consequently, AI is a strategic platform to ensure sustainable economic transformation and innovation, and for countries to remain competitive in the global digital economy (Chowdhury, 2024; Lindberg, 2025).

CONCLUSION

The application of Artificial Intelligence (AI) in energy, science and technology has proven to be a transformative factor for smart industry development and economic growth. This research has shown that AI boosts efficiency, optimises decision-making processes, and facilitates automation in key industries, including manufacturing, energy, healthcare and finance. AI applications like predictive maintenance, smart manufacturing, smart grids, and data analytics play a critical role in cost reduction, productivity enhancement, and sustainable growth. Also, the literature examined confirms that AI is not only a technological innovation but also a strategic asset that promotes innovation, competitiveness and resilience in the economy.

Moreover, the research shows that AI drives economic transformation by enabling new business models, enhancing resource efficiency, and promoting inclusive development. The uptake of AI offers many benefits but also raises concerns including employment displacement, ethical considerations, privacy and security, and infrastructure constraints, especially in developing countries. To overcome these challenges, governments, industry and academia need to collaborate to build effective policies, digital infrastructure and capacity. In summary, the integration of AI in energy, science and technology is crucial to ensure sustainable industrial development and economic wellbeing.

Future Research Directions

a) Energy-efficient AI to minimise energy consumption and environmental footprint.
b) Progress of Explainable AI (XAI) to enhance transparency, accountability and trustworthiness in AI.

c) Research on the changing jobs landscape, including reskilling and upskilling for the AI-driven economy.
d) Development of policies for AI-based ethical governance, privacy, and compliance.

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