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A REVIEW ON ARTIFICIAL INTELLIGENCE: MEANING, CHALLENGES AND APPLICATIONS

Ugwuanyi Fidelis Onyebu, PhD[1] & *Ugwu Daniel[2]
[1]Department of Computer Science Education, Federal University of Education, Pankshin, Plateau State
[2]Department of Business Education, Federal University of Education, Pankshin, Plateau State
***Corresponding Author:** danielugwu61@gmail.com

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ABSTRACT
This study examined Artificial Intelligence (AI), focusing on its concept, evolution, challenges and applications across various industries. The study was guided by three research questions which addressed the meaning and evolution of AI, the challenges associated with its adoption and its key applications in modern industries. A non-empirical research design was adopted, relying on secondary data from academic journals, textbooks and institutional reports. Using qualitative content analysis, the study reviewed and synthesized existing literature to provide a comprehensive understanding of AI. The findings revealed that Artificial Intelligence has evolved significantly over time, progressing from basic computational systems to advanced technologies such as machine learning, natural language processing, robotics and computer vision. The study also found that AI has transformed industries by enhancing efficiency, accuracy and innovation, particularly in sectors such as healthcare, finance, manufacturing, education and cyber security. However, the study identified major challenges associated with AI, including data quality issues, ethical concerns, lack of transparency, privacy risks and societal implications such as job displacement. These challenges were found to limit the effective and sustainable adoption of AI, especially in developing economies. The study concluded that while AI holds great potential, its successful implementation depends on addressing these challenges through proper regulation, ethical considerations and capacity development.

Keywords: artificial intelligence, machine learning, automation, ethics, industry applications

Introduction

Artificial Intelligence (AI) has emerged as one of the most transformative technological innovations in the modern era, significantly reshaping how organizations operate, innovate and deliver value. Across industries such as healthcare, finance, education and manufacturing, AI technologies have enhanced efficiency, improved decision-making and enabled automation of complex processes. The increasing integration of AI into business and societal systems has fundamentally altered traditional modes of operation and created new opportunities for growth and development. Artificial Intelligence (AI) has been transforming various industries, and education is no exception (Crompton & Burke, 2023). AI has the potential to revolutionize the way we learn and teach, making it more personalized, engaging, and efficient (Alneyadi, Wardat, Alshannag, & Abu Al-Aish, 2023)

Artificial Intelligence has to do with the simulation of human intelligence in machines that are designed to think, learn and perform tasks typically requiring human cognitive abilities. It encompasses a wide range of technologies that enable machines to perceive, reason, learn from experience and interact with their environment. AI is also viewed as a multidisciplinary field that integrates computer science, mathematics, psychology and engineering to develop intelligent systems capable of solving complex problems. AI in education refers to the use of artificial intelligence technologies, such as machine learning and natural language processing, to enhance the learning experience (Alneyadi et al., 2023).

The origin of AI can be traced to the mid-20th century, particularly the pioneering work of Alan Turing, who introduced the concept of machine intelligence through the Turing Test. The formal recognition of AI as a discipline occurred in 1956 at the Dartmouth Conference, where the term “Artificial Intelligence” was first coined. Since then, AI has evolved through various phases, including early experimentation, expert systems, neural networks and the modern era of machine learning and deep learning.

Despite its rapid advancement and widespread adoption, AI presents several challenges that affect its implementation and sustainability. These challenges include technical limitations, ethical concerns and societal implications. Nevertheless, AI continues to play a critical role in driving innovation and transforming industries. This study therefore provides a comprehensive review of AI by examining its meaning, challenges and applications.

Statement of the Problem

Artificial Intelligence (AI) is rapidly transforming modern society and reshaping key sectors such as healthcare, education, finance, and agriculture. Despite its vast potential to enhance efficiency and decision-making, there remains a significant gap in understanding its concepts, evolution, and broader implications, particularly in developing contexts.

Limited awareness among students, professionals, and policymakers hinders the effective utilization of AI technologies. At the same time, the rapid advancement of AI presents critical technical, ethical, and societal challenges, including data privacy concerns, algorithmic bias, job displacement, and issues of transparency and accountability, many of which are not adequately addressed. Moreover, although AI applications continue to expand across industries, there is insufficient empirical assessment of their practical impact, and many organizations face challenges in adoption due to limited expertise, high implementation costs, and uncertainty about associated risks and benefits. This study therefore seeks to bridge this gap by providing a holistic examination of Artificial Intelligence, its challenges, and its applications, thereby promoting informed understanding and responsible utilization across sectors.

Objectives of the Study

The main objective of this study is to examine Artificial Intelligence and its applications across various sectors. The specific objectives are to:

1. examine the concept and evolution of Artificial Intelligence;
2. identify the major technical, ethical and societal challenges of Artificial Intelligence; and
3. assess the applications of Artificial Intelligence across different industries.

Research Questions

The study seeks to answer the following research questions:

1. What is Artificial Intelligence and how has it evolved over time?
2. What are the major challenges associated with Artificial Intelligence?
3. What are the key applications of Artificial Intelligence in modern industries?

Literature Review

Theoretical Framework

This study is anchored on the Technology Acceptance Model (TAM), a widely recognized theory developed by Davis (1989) to explain how individuals accept and use new technologies. The model, introduced in 1989, posits that two key determinants—perceived usefulness and perceived ease of use significantly influence users' attitudes toward a technology, which in turn affects their intention to use and actual adoption behavior. Perceived usefulness refers to the degree to which an individual believes that using a particular system would enhance their performance, while perceived ease of use relates to the extent to which the system is free of effort.

Over time, TAM has been extensively validated and applied across various technological contexts, making it a robust framework for understanding technology adoption in both developed and developing environments. Its relevance remains significant in contemporary studies involving emerging technologies such as Artificial Intelligence (AI). In the context of Artificial Intelligence, TAM provides a useful lens for examining how individuals and organizations decide to adopt AI-driven systems. Technologies that are perceived as useful—such as those that improve efficiency, accuracy, and decision-making—and easy to use are more likely to gain acceptance. Conversely, factors such as system complexity, lack of transparency, limited technical knowledge, and ethical concerns (including trust and accountability) may negatively influence perceived ease of use and usefulness, thereby hindering adoption. Thus, the application of TAM (Davis, 1989) in this study helps to explain the behavioural and organizational dynamics influencing the acceptance, integration, and utilization of Artificial Intelligence across different sectors.

Artificial Intelligence

The concept of Artificial Intelligence (AI) can be traced back to 1950 when Alan Turing raised the fundamental question of whether machines can think in his seminal paper on computing machinery and intelligence (Turing, 1950). To address this question, he proposed a heuristic method known as the Turing Test, which evaluates whether a machine can engage in a conversation in such a way that a human would believe it is interacting with another human. In the same year, Claude Shannon introduced the idea of developing a machine capable of playing chess, further advancing early AI thinking. However, the formal birth of AI as a field is widely attributed to the 1956 Dartmouth Conference, where scholars such as John McCarthy, Allen Newell, Arthur Samuel, Herbert Simon and Marvin Minsky laid the foundation for the discipline (McCarthy et al., 2006). Since then, AI has experienced rapid growth and transformation.

Over time, the availability of big data, advancements in cloud computing and improvements in computational power have significantly accelerated the development and impact of AI systems. Technological progress has also led to the development of more efficient and affordable sensors, which generate reliable data for AI applications (Dwivedi et al., 2021). These advancements have strengthened core areas of AI research, including natural language processing, knowledge representation, automated reasoning, machine learning, computer vision and robotics (Dwivedi et al., 2023). Natural language processing enables machines to understand and communicate in human language, while knowledge representation allows systems to store and utilize information effectively. Automated reasoning supports decision-making and problem-solving and machine learning enables systems to adapt and learn from data. Additionally, computer vision allows machines to interpret visual inputs, while robotics focuses on the design of machines capable of performing physical tasks.

Despite its widespread use, there is no universally accepted definition of Artificial Intelligence. In 2018, the Organisation for Economic Co-operation and Development (OECD) established a group of experts to develop a comprehensive and inclusive description of AI systems. According to the OECD (2019), such a definition should be technically accurate, easily understandable and applicable across different contexts and time horizons. The work of these experts led to four major approaches to understanding AI: acting humanly, thinking humanly, thinking rationally and acting rationally. The acting humanly approach focuses on machines performing tasks that require human intelligence, while the thinking humanly approach emphasizes cognitive processes similar to human thinking. The thinking rationally approach is based on logical reasoning, whereas the acting rationally approach focuses on intelligent behavior aimed at achieving specific goals.

Scholars have also clarified misconceptions about AI. According to Russell and Norvig (2022), AI is not merely the development of conventional computer programs, as true AI systems demonstrate a higher level of intelligence comparable to or exceeding human capabilities in certain tasks. Furthermore, AI is not synonymous with disciplines such as psychology or linguistics, although it overlaps with these fields in understanding human cognition and behavior. Artificial Intelligence is inherently interdisciplinary, drawing from various fields such as philosophy, mathematics, economics, neuroscience, psychology, computer engineering, control theory and linguistics (Russell & Norvig, 2022). These disciplines contribute to the development of AI by providing insights into reasoning, learning, decision-making and communication processes.

The evolution of AI has occurred in several phases. The early stage, between 1943 and 1955, marked the inception of AI through foundational theories such as Hebbian learning. The period from 1956 to 1969 was characterized by optimism and rapid experimentation, including the development of symbolic systems and early programming languages like LISP. Between 1966 and 1973, progress slowed due to practical limitations, leading to a period of reassessment. The emergence of expert systems between 1974 and 1986 marked a new phase of development, followed by the resurgence of neural networks in the late 1980s. Subsequent advancements included probabilistic reasoning and machine learning in the late 1980s, the rise of big data in the early 2000s and the emergence of deep learning technologies from 2011 onwards.

Artificial Intelligence can also be classified based on capabilities, functionalities and technologies. Based on capabilities, AI includes narrow (weak) AI, general (strong) AI and superintelligent AI. In terms of functionality, AI can be categorized into reactive machines, limited memory systems, theory of mind systems and self-aware AI. Furthermore, based on

technology, AI encompasses machine learning, deep learning, natural language processing, robotics, expert systems, fuzzy logic, computer vision and generative AI (Russell & Norvig, 2022).

Challenges of Artificial Intelligence

Artificial Intelligence, despite its transformative potential, is not without significant challenges that cut across technical, ethical, and societal dimensions. These challenges not only shape how AI systems are developed but also influence how they are perceived and adopted in real-world contexts (Russell & Norvig, 2021; Floridi et al., 2018).

From a technical standpoint, AI systems face several limitations that can affect their performance and reliability. One of the most pressing issues is data quality. AI systems depend heavily on data, and when the data is incomplete, biased, or inaccurate, the results produced can be misleading or entirely wrong often described as the "Garbage In, Garbage Out" phenomenon (Goodfellow, Bengio, & Courville, 2016). In addition, many AI models are highly complex, making it difficult to understand how they arrive at specific decisions. This lack of transparency, commonly known as the "black box" problem, reduces trust in AI systems (Burrell, 2016). Furthermore, the high cost of implementation, the need for advanced computational resources, and the challenge of integrating AI into existing systems make adoption difficult, especially for organizations with limited resources (Brynjolfsson & McAfee, 2017). The shortage of skilled professionals in AI further complicates the situation, slowing down innovation and deployment.

Ethical challenges add another layer of complexity to the use of AI. One major concern is bias and fairness. When AI systems are trained on biased data, they can unintentionally reinforce discrimination, leading to unfair outcomes in areas such as hiring, lending, and law enforcement (O'Neil, 2016). Privacy is also a critical issue, as AI systems often require vast amounts of personal data to function effectively, raising concerns about how this data is collected, stored, and used (Zuboff, 2019). Moreover, the question of accountability remains unresolved when an AI system makes a wrong or harmful decision, it is often unclear who should be held responsible: the developer, the organization, or the system itself (Floridi et al., 2018).

On a broader scale, AI presents profound societal challenges. Automation driven by AI has the potential to replace human labor in many sectors, leading to job displacement and widening economic inequality (Brynjolfsson & McAfee, 2017). At the same time, AI technologies can be used to spread misinformation, enable mass surveillance, and influence human behavior in subtle but powerful ways (Zuboff, 2019). These developments raise serious concerns about the future of work, privacy, and democracy. As a result, there is an urgent need for strong governance, ethical guidelines, and policy frameworks to ensure that AI is developed and used in ways that benefit society as a whole (Floridi et al., 2018).

Applications of Artificial Intelligence

Artificial Intelligence has rapidly evolved into a powerful tool with wide-ranging applications across multiple sectors of the economy, transforming how tasks are performed and decisions are made. Its ability to analyze large volumes of data, recognize patterns and make intelligent predictions has made it indispensable in today's digital age. In the healthcare sector, AI is revolutionizing patient care through applications such as diagnostic imaging, robotic surgery and personalized medicine. By assisting doctors in detecting diseases early and recommending tailored treatment plans, AI significantly improves accuracy and patient outcomes. In banking and finance, AI plays a crucial role in enhancing operational efficiency and security. It is widely used for fraud detection, risk assessment, algorithmic trading and customer

service through chatbots, helping financial institutions make faster and more reliable decisions while improving customer experience. The manufacturing industry also benefits greatly from AI through predictive maintenance, quality control and supply chain optimization. By anticipating equipment failures and ensuring product standards, AI helps reduce downtime, minimize waste and increase productivity. In the field of education, AI is transforming teaching and learning processes by enabling personalized learning experiences, automated grading systems and intelligent tutoring platforms. These innovations allow educators to better address individual student needs and improve learning outcomes.

There is no doubt that artificial intelligence (AI) has transformed industries, improved efficiencies and opened up new possibilities. This section examines how AI has impacted various sectors of industry (Dwivedi et al., 2021). In the healthcare and medicine sector, AI has significantly changed the way services are delivered. Healthcare professionals can now provide more accurate and effective care by incorporating AI technologies into their practices. Applications of AI include robotic surgery, virtual nursing assistants, treatment plan formulation and patient data management. These developments have led to better patient outcomes, reduced healthcare costs and improved access to medical services. The contribution of AI to healthcare continues to expand, offering further improvements in both medical administration and treatment (Topol, 2019).

In diagnostic imaging and radiology, the use of AI has greatly increased the accuracy and speed of diagnosis. AI systems are capable of analyzing medical images such as MRIs, CT scans and X-rays with high precision, enabling radiologists to detect abnormalities more quickly and reliably (Topol, 2019). Furthermore, artificial intelligence is revolutionizing drug discovery and development by enabling researchers to analyze large datasets rapidly. AI algorithms can predict how different molecules will interact, thereby accelerating the identification of potential drug compounds. In addition, AI techniques improve the accuracy of drug development by allowing scientists to predict the safety and effectiveness of drugs at early stages using machine learning models (Topol, 2019).

AI also plays a vital role in hospital management and patient care by streamlining operations such as staff scheduling, inventory management and patient appointments. This leads to increased efficiency and better service delivery within healthcare institutions (Topol, 2019).

In the banking and finance sector, technological advancements—particularly the integration of AI and machine learning—have significantly transformed operations. These technologies not only enhance customer satisfaction but also improve operational efficiency and risk management (West & Allen, 2018).

For instance, in investing and trading, AI-driven algorithmic trading enables financial institutions to make decisions at speeds and frequencies beyond human capability. These algorithms analyze vast amounts of data to identify trading opportunities and execute transactions automatically based on prevailing market conditions (West & Allen, 2018).

Additionally, AI enhances fraud detection and risk assessment in the financial sector. By analyzing data patterns and trends, AI systems can identify unusual activities that may indicate fraudulent behavior. This capability is crucial for protecting financial institutions and their customers from increasingly sophisticated fraud schemes and cyber threats (West & Allen, 2018).

Methodology

This study adopted a non-empirical (review-based) research design, relying exclusively on secondary sources of data to provide a comprehensive analysis of Artificial Intelligence and

its applications across various sectors. Data for the study were obtained from reputable academic and scholarly databases, including Google Scholar, Scopus, Web of Science, and EBSCO, as well as textbooks, institutional reports, conference papers, and other credible online sources.

The review focused primarily on literature published within the period of 2015 to 2025 in order to ensure the inclusion of recent developments and contemporary perspectives in the field of Artificial Intelligence. However, seminal works published prior to this period were also considered where necessary to provide theoretical grounding and historical context.

To ensure rigor and relevance, specific inclusion and exclusion criteria were applied. Included sources comprised peer-reviewed journal articles, scholarly books, and authoritative institutional publications that directly address Artificial Intelligence, its challenges, and its applications across industries. Conversely, non-scholarly materials, opinion-based articles without empirical or theoretical support, and sources lacking credibility or relevance were excluded from the review.

A systematic search and selection process was employed, yielding approximately 45 relevant sources, which were carefully screened based on their abstracts, methodologies, and contributions to the study objectives. The selected literature was then analyzed using a qualitative content analysis approach, which enabled the researcher to critically examine, interpret, and synthesize existing findings. This method facilitated the identification of key themes, patterns, and gaps in the literature, thereby providing a coherent and comprehensive understanding of Artificial Intelligence and its cross-sectoral applications.

Discussion of Findings

The findings revealed that Artificial Intelligence (AI) has undergone significant evolution, transitioning from rule-based systems to more advanced data-driven approaches such as machine learning and deep learning. This progression has enhanced the capability of AI systems to perform complex tasks, thereby improving efficiency, accuracy, and innovation across various sectors. This finding aligns with existing literature which emphasizes the transformative role of AI in reshaping industries and enabling intelligent decision-making processes.

In relation to the concept and evolution of AI, the study revealed that AI is not a static technology but a continuously evolving field driven by advancements in computational power, data availability, and algorithmic sophistication. The evolution of AI has expanded its scope from basic automation to more autonomous and adaptive systems capable of learning and improving over time. This supports earlier studies that highlight the dynamic nature of AI and its growing relevance in modern society.

Regarding the constrained in the adoption of AI which ranges from technical, ethical and societal challenges. Key technical issues identified include poor data quality, system complexity, and lack of transparency, often referred to as the “black box” problem. Ethical concerns such as bias, privacy violations, and lack of accountability were also found to significantly affect trust in AI systems. Additionally, societal challenges such as job displacement and inequality were highlighted. These findings are consistent with existing research, which underscores the need for responsible AI development and stronger regulatory frameworks, particularly in developing economies where such challenges are more pronounced.

With respect to the applications of AI across industries, the findings revealed that AI has been widely adopted in sectors such as healthcare, finance, education, agriculture, and manufacturing. In these sectors, AI applications have improved productivity, enhanced service delivery, and enabled data-driven decision-making. However, the study also found that the extent

of AI implementation varies across regions and organizations, largely due to differences in technological infrastructure, expertise, and financial capacity.

Conclusion

This study examined Artificial Intelligence (AI) and its applications across various sectors, with a focus on its evolution, associated challenges, and practical uses in modern society. The findings revealed that AI has evolved significantly from basic rule-based systems to advanced, data-driven technologies such as machine learning and deep learning, thereby enhancing its capacity to improve efficiency, accuracy, and innovation across industries. In addressing the major challenges of AI, the study identified critical technical, ethical, and societal issues, including data quality limitations, lack of transparency, algorithmic bias, privacy concerns, and potential job displacement. Furthermore, the study found that AI has wide-ranging applications in sectors such as healthcare, finance, education, agriculture, and manufacturing, where it contributes to improved productivity and data-driven decision-making, although the level of adoption varies across contexts.

The study contributes to knowledge by providing a holistic and integrated perspective that combines the conceptual evolution of AI, its key challenges, and its cross-sectoral applications within a single framework. This comprehensive approach helps to bridge existing gaps in the literature, particularly by offering insights relevant to both developed and developing environments. However, the study is not without limitations but it relied on a relatively small number of secondary sources, which may limit the breadth of perspectives considered. Additionally, the review was restricted to English-language literature, thereby excluding potentially valuable studies published in other languages. The study also did not focus on any specific industry or country, which may limit the depth of contextual analysis. Furthermore, the absence of a fully systematic search protocol may affect the replicability and comprehensiveness of the review.

Recommendations

Based on the findings, the study recommends that:

1. Governments and regulatory bodies should develop comprehensive policies and frameworks to guide the ethical use of Artificial Intelligence in Nigeraia
2. Organizations should invest in capacity building and skill development to enhance AI adoption and utilization in Nigeria.
3. Efforts should be made to improve data quality and transparency to enhance the reliability of AI systems in educational sector.
4. Stakeholders should promote responsible AI practices that prioritize fairness, accountability and societal well-being.

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