Artificial Intelligence (AI) and Sustainable Development (SD): A Systematic Review of Opportunities and Risks across SDGS 8, 10, and 12

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ABSTRACT

This study critically examines the relationship between artificial intelligence (AI) and sustainable development (SD) by exploring the extent to which sustainable development initiatives, especially SDGs 8, 10, and 12, remain "sustainable" in the context of the growing emergence of AI technologies. Specifically, the study identifies the various ways in which AI applications can contribute to promoting sustainable development initiatives, while also examining the potential risks through which AI may undermine the achievement of SD objectives. The study adopts a qualitative research approach based on a systematic review of recent scholarly literature on AI and SD. A total of 64 peer-reviewed articles were selected and analyzed for the study after screening and exclusion processes from the initial 136 identified database search. The screening process followed defined inclusion and exclusion criteria, including: i) relevance to AI and SD, ii) publications within the last ten years to ensure currency; iii) publications in peer-reviewed journals and reputable academic sources like WoS articles; and availability of full-text articles in English; thereby excluding sources that were duplicated, non-scholarly, or not directly related to research objectives. To ensure comprehensive coverage of relevant studies, structured keyword-based strategy was used such as, "artificial intelligence", "AI governance", "Digital inequality", "SDGs 8,10, and 12", "sustainable development", etc. Data sources also included relevant information gathered from books and credible Internet materials. The findings reveal that AI has significant potential to support sustainable development through provisions of powerful tools that can promote sustainable development. At the same time, the research equally reveals critical challenges associated with AI that could pose risks to sustainable development, including high energy consumption, environmental impacts of data centers, labor market disruptions caused by automation, digital inequalities between developed and developing countries, and ethical concerns related to algorithmic bias and governance. The study concludes that, the relationship between AI and SD is characterized by both opportunities and risks, only through responsible governance, ethical regulatory frameworks, and the development of environmentally sustainable AI infrastructure can AI truly support SD. Without these safeguards, the rapid growth of AI technologies may undermine the core principles of sustainability. Thus, the paper recommends: governments and technological companies should promote sustainable AI infrastructure; there should be international regulatory frameworks to ensure ethical and responsible deployment of AI technologies; inter alia.

Keywords: *Artificial Intelligence (AI), AI governance, Digital inequality, Sustainable AI, Sustainable Development, Sustainable Development Goals (SDGs).*

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INTRODUCTION

Sustainable development has emerged as a central framework for addressing global challenges such as decent work and economic growth to reduce poverty, social inequality, and to promote sustainable production and consumption patterns that minimize environmental degradation -- as exemplified in SDGs 8, 10, and 12, respectively. Since the adoption of the 2030 Agenda for Sustainable Development, governments, international organizations, and development practitioners have increasingly focused on achieving the Sustainable Development Goals (SDGs) as a comprehensive blueprint for global progress. The SDGs consist of seventeen (17) interconnected goals. However, as the global technological landscape evolves, emerging technologies—particularly artificial intelligence (AI)—are transforming the ways in which development challenges are addressed. These transformations raise important questions regarding the sustainability of sustainable development itself in an era characterized by rapid technological change.

Artificial intelligence has become one of the most influential technological innovations of the twenty-first century. AI systems, particularly recent developments in generative artificial intelligence (GenAI) and large language models, are increasingly capable of performing complex cognitive tasks, analyzing large datasets, generating content, and supporting decision-making processes across various sectors. Scholars have argued that AI has the potential to significantly accelerate progress toward the SDGs by enabling data-driven policy making, improving resource efficiency, and enhancing the delivery of essential services such as healthcare, education, and environmental management (Greif et al., 2024). Through advanced analytics and predictive modelling, AI can support governments and organizations in identifying patterns within large datasets and developing more effective solutions to complex development problems.

In recent years, researchers and international organizations have increasingly highlighted the transformative potential of AI in addressing sustainability challenges. For instance, AI technologies have been applied to climate monitoring, agricultural optimization, disaster prediction, and healthcare diagnostics, thereby supporting several SDGs including climate action, food security, and good health and well-being (Ziemba et al., 2024). Similarly, AI-driven tools have been utilized in sustainable education systems to improve learning outcomes and expand access to educational resources, particularly in underserved regions (Iqbal et al., 2025). These developments illustrate the capacity of AI to enhance the efficiency and effectiveness of development initiatives by improving the collection, analysis, and application of data across multiple sectors. Furthermore, generative AI technologies are increasingly being recognized as powerful tools for advancing innovation and knowledge production. Generative models can assist in generating research insights, optimizing energy systems, developing climate models, and improving governance processes. According to Khan et al. (2025), generative AI applications have demonstrated significant potential to support sustainable development by improving decision-making, enhancing digital inclusion, and enabling innovative solutions across sectors such as healthcare, education, and environmental management. Through these capabilities, AI can help accelerate the implementation of sustainability initiatives and contribute to addressing complex global challenges more efficiently. This claim can be supported with empirical evidences; particularly, in relation to SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), and SDG 12 (Responsible Consumption and Production): For example, an empirical Delphi study by Ametepey et al. (2024), with a strong expert consensus (mean score of 78.8%), found that AI significantly enhances productivity, innovation, and resource optimization, thereby contributing to SDG 8 through improved economic efficiency and the creation of new digital job opportunities. The study further highlights AI's role in optimizing resource use and waste reduction in industrial processes, aligning with SDG 12 by promoting more sustainable production and consumption patterns. Additionally, Vinuesa et al. (2020), through a large-scale empirical assessment of AI applications across all SDGs, demonstrate that AI can reduce inequalities (SDG 10) by improving access to services such as healthcare, education, and financial inclusion, particularly in underserved regions. At the same time, their findings show that AI-driven systems enhance efficiency in supply chains and industrial processes, thereby supporting SDG 12, while also fostering economic growth and innovation ecosystems relevant to SDG 8. Collectively, therefore, these empirical studies confirm that AI is already playing a significant, measurable role in accelerating key sustainability goals, particularly in economic productivity, inequality reduction, and sustainable resource consumption and production patterns.

Despite these promising opportunities, the emergence of AI also raises critical concerns regarding the long-term sustainability of development initiatives. Scholars increasingly warn that while AI may contribute to sustainable development, it also presents significant risks that could undermine sustainability goals if not properly governed. One major concern relates to the environmental footprint of AI technologies. The development and operation of large AI systems require substantial computational power, leading to high energy consumption and carbon emissions associated with data centers and digital infrastructure (Toderas, 2025). As AI technologies continue to expand globally, their environmental impact may potentially contradict the environmental sustainability objectives embedded within the SDGs. In addition to environmental concerns, the rapid expansion of AI

technologies raises significant socio-economic challenges. Automation and algorithmic decision-making may disrupt labor markets by replacing certain categories of jobs, thereby increasing unemployment and economic inequality in some contexts. Reports suggest that advanced AI systems could significantly alter labor demand across sectors, creating transitional disruptions that disproportionately affect vulnerable populations (Bengio et al., 2024). Such developments could undermine progress toward key SDGs related to decent work, reduced inequalities, and inclusive economic growth. Another important concern is the potential for AI technologies to exacerbate global digital inequalities. The development and deployment of advanced AI systems are heavily concentrated in technologically advanced countries and large multinational corporations. This uneven distribution of technological resources may widen the gap between developed and developing countries, limiting the ability of some nations to fully benefit from AI-driven development innovations. As a result, there is growing debate regarding whether AI will serve as a catalyst for inclusive global development or reinforce existing structural inequalities within the international system. Moreover, ethical and governance challenges surrounding AI deployment have become increasingly prominent in discussions of sustainable development. Issues such as algorithmic bias, data privacy, lack of transparency, and limited regulatory frameworks pose significant challenges to the responsible use of AI technologies. Without adequate governance mechanisms, AI systems may reinforce social biases, compromise privacy rights, and produce unintended social consequences that undermine sustainable development objectives.

Consequently, the relationship between artificial intelligence and sustainable development remains complex and contested. While AI offers powerful tools for addressing global challenges, its rapid expansion also introduces new environmental, social, and economic risks. This dual character of AI—as both an enabler and a potential threat to sustainability—necessitates a critical examination of how emerging technologies interact with development frameworks. Against this background, this study seeks to critically examine the extent to which sustainable development remains truly "sustainable" in the context of the growing influence of artificial intelligence. Specifically, the study aims to identify the various ways in which generative uses of AI can support and promote sustainable development initiatives, while also examining the ways in which the emergence of AI may undermine or complicate the achievement of sustainable development objectives. By exploring both the opportunities and challenges associated with AI-driven development, this research contributes to ongoing debates on the future of sustainable development in an increasingly digital and technologically driven world.

Statement of the Problem

Sustainable development has become a central framework guiding global development policies since the adoption of the United Nations Sustainable Development Goals (SDGs). The SDGs emphasize balancing economic growth, social inclusion, and environmental protection to ensure that development meets present needs without compromising the ability of future generations to meet their own needs. However, the rapid advancement of digital technologies—particularly artificial intelligence (AI)—is transforming global economic and social systems in ways that raise new questions about the sustainability of development itself. Artificial intelligence has increasingly been recognized as a powerful tool for addressing complex global challenges. AI systems can process large datasets, identify patterns, and generate predictive insights that support decision-making in areas such as climate monitoring, healthcare, agriculture, and education (Greif et al., 2024). These capabilities suggest that AI could significantly accelerate progress toward several SDGs by improving efficiency, enhancing innovation, and enabling data-driven governance. To be sure, recent research demonstrates that AI technologies can contribute to sustainable development through applications such as smart energy management, precision agriculture, disaster prediction, and digital financial inclusion (Khan et al., 2025; Toderas, 2025; Ametepey et al., 2024; Vinuesa et al., 2020).

Despite these promising potentials, the emergence of AI also presents significant challenges that could undermine sustainable development objectives. One major concern relates to the environmental impact of AI infrastructure. The development and deployment of large-scale AI systems require massive computational resources, resulting in increased electricity consumption, water usage, and carbon emissions associated with data centers and cloud computing infrastructure (Bashir et al., 2025; Toderas, 2025). Estimates indicate that global data center electricity consumption could approach 1,050 terawatt-hours by 2026, largely driven by the growing demand for generative AI technologies (MIT News, 2025). Such trends raise concerns about whether the expansion of AI technologies is compatible with environmental sustainability goals. Furthermore, AI may contribute to socio-economic inequalities and labor market disruptions. Automation and algorithmic decision-making systems have the potential to replace certain categories of jobs, particularly in administrative and routine sectors, thereby creating new forms of unemployment and economic inequality (Ferreira et al., 2026). In addition, the global distribution of AI infrastructure and expertise remains highly uneven, with technologically advanced countries dominating AI research, development, and deployment. This imbalance raises concerns that developing countries may not fully benefit from AI-driven development innovations, potentially widening the global digital divide. Additionally, the ethical and governance challenges concerns associated with AI deployment. AI systems may reproduce or amplify social biases embedded in training

data, leading to discriminatory outcomes in areas such as employment, finance, and public services. More so, insufficient regulatory frameworks for AI governance may limit accountability and transparency in algorithmic decision-making processes (Kiden et al., 2024). Notwithstanding, in the growing body of literature on AI and sustainable development, a critical gap remains in the existing scholarship. Current studies (like Vinuesa et al.,2020) have largely examined the contributions of AI to individual SDGs or broadly mapped its positive and negative impacts without sufficiently interrogating the sustainability of sustainable development itself in the age of AI. In particular, there is limited integrative analysis that simultaneously evaluates AI's environmental costs, socio-economic disruptions, and governance challenges within a unified sustainability framework, especially across SDGs 8, 10, and 12.

Furthermore, there is a lack of critical, holistic assessments that move beyond technological narratives to question whether AI-driven development pathways may inadvertently undermine long-term sustainability objectives. Therefore, this study advances beyond the foundational work of Vinuesa et al. (2020), which primarily provides a global mapping of AI's potential interactions with the SDGs, by offering a critical and integrative examination of the trade-offs, contradictions, and sustainability tensions inherent in AI deployment. While Vinuesa et al. (2020) focus on identifying where AI can enable or inhibit SDGs, the present study goes further by interrogating the extent to which AI-driven progress may simultaneously generate environmental externalities, deepen inequalities, and challenge governance structures. In doing so, this research shifts the discourse from identifying AI's contributions, to critically evaluating whether such contributions are themselves sustainable in the long term.

Objectives of the Study

The general objective of the paper is to critically examine, the extent to which sustainable development is "sustainable" with the emergence of artificial intelligence (AI). However, specific objectives equally designed to guide the study in achieving the main objective include the following:

1. To identify the various ways by which AI applications can 'sustain' sustainable development (SD)

2. To find out the various ways by which AI uses can hamper or pose a potential threat to the achievement of SD objectives

3. To propose policy-based recommendations that could help to achieve a balance in the intersection of AI technological innovations and sustainable development, so as to have AI applications that can support a sustainable and equitable future.

Methodology

Research Design

This study adopted a qualitative research design based on a systematic literature review (SLR) approach, guided by the PRISMA (Preferred Reporting Items for Systematic and Meta-Analyses) framework. The methodology involves the collection, evaluation, and synthesis of existing academic literature on artificial intelligence and sustainable development. The data sources included relevant literature obtained from major academic databases like, Scopus, Web of Science, Google Scholar, and ScienceDirect. These databases were selected because they provide access to peer-reviewed scholarly articles in the fields of sustainability, artificial intelligence, and development studies.

Database Search Strategy:

The literature search was conducted using a structured keyword-based strategy to ensure comprehensive coverage of relevant studies. Search strings included combinations of keywords such as "artificial intelligence," "sustainable development," "SDGs," "AI AND sustainability," "AI AND SDG 8," "AI AND SDG 10," and "AI AND SDG 12." Boolean operators (AND, OR) were used to refine search results, while database-specific filters were applied to limit results to peer-reviewed journal articles published in English. The search process was conducted between January and March 2026. The data inclusion criteria considered only peer-reviewed articles published between 2018 and 2026 in order to capture recent developments in AI technologies. Besides, data sources that discuss the relationship between AI and sustainable development, and that examine AI applications relevant to the SDGs, including data that analyze environmental, social, or economic impacts of AI technologies (addressing the 3 pillars of SD), were equally considered.

Number of Articles Reviewed:

The initial database search yielded a total of 136 articles. After applying inclusion and exclusion criteria, removing duplicates, and screening for relevance, a final sample of 64 articles was selected for in-depth analysis in this study.

Screening Stages:

The study followed a multi-stage screening process. First, titles and abstracts were reviewed to eliminate clearly irrelevant studies. Second, duplicate records across databases were identified and removed. Third, full-text screening was conducted to ensure that selected articles met the inclusion criteria and were directly relevant to the research objectives. Finally, only studies that provided substantial empirical or theoretical insights into AI and

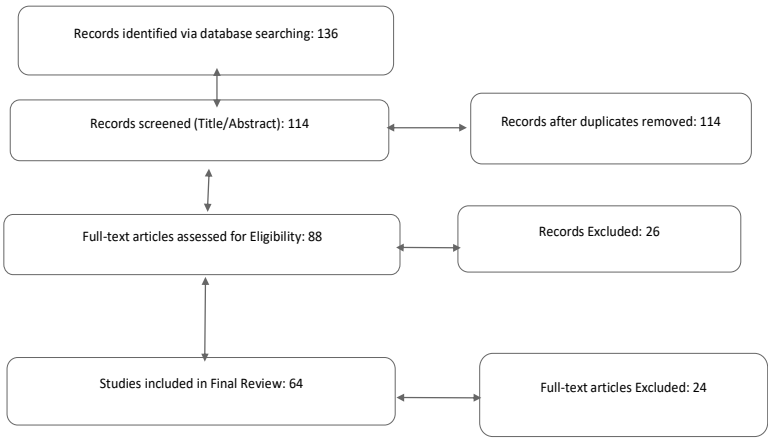

Figure 1: Prisma Flow Diagram; Source**:** Researcher's SLR (PRISMA) Construct

sustainable development was retained for analysis.

Analytical Approach:

The selected literature was analyzed using thematic content analysis, which allowed the researcher to identify recurring themes regarding: Positive contributions of AI to sustainable development; potential risks or threats associated with AI; including governance and ethical considerations in AI deployment.

Thematic Coding Process:

The analysis involved a systematic coding process in which selected articles were carefully read and coded into thematic categories. An initial open coding phase was used to identify emerging concepts, followed by axial coding to group related codes into broader themes such as economic impacts (SDG 8), inequality and inclusion (SDG 10), and sustainable production and consumption (SDG 12). These themes were then refined through iterative comparison to ensure consistency and analytical depth.

Bias Minimization:

To minimize potential bias, the study employed several strategies, including the use of clearly defined inclusion and exclusion criteria, systematic database search procedures, and transparent documentation of the screening process. Additionally, reliance on peer-reviewed WoS-indexed sources helped ensure the credibility and quality of the data. The researcher also maintained consistency in coding by repeatedly cross-checking themes against the original data sources to reduce subjective interpretation and enhance reliability. The PRISMA framework that guided the methodology is graphically represented in the following PRISMA flow diagram (Figure 1).

Conceptual Clarifications

For a more epistemic insight into the discourse, certain terms that are preponderant in this essay are hereby demystified. These terms include, Artificial Intelligence; AI Applications; Sustainable Development; and Sustainable Development Goals (SDGs). We shall address them in sequence:

Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to a branch of computer science concerned with the design and development of machines or systems capable of performing tasks that normally require human intelligence. These tasks include learning from data, reasoning, problem-solving, decision-making, and understanding natural language. AI systems typically rely on algorithms, machine learning, and data processing techniques to detect patterns and generate predictions or actions based on input data (Maslej et al., 2024; Triguero et al., 2023). AI technologies are widely used in areas such as healthcare, finance, education, robotics, and transportation, where they help automate complex processes and improve efficiency. As AI continues to advance, it increasingly influences economic, social, and technological development worldwide.

AI Governance

AI governance refers to the frameworks, policies, institutional arrangements, and ethical guidelines designed to regulate the development, deployment, and use of artificial intelligence systems in ways that align with societal values and public interest. AI governance also involves multi-level coordination among governments, corporations, and international bodies to steer AI toward

beneficial outcomes, including sustainable development goals (Camilleri, 2023; Ulnicane et al., 2023). It is therefore both a regulatory and normative process that shapes how AI technologies are controlled and integrated into society to maximize benefits while minimizing harm.

Digital Inequality

Digital inequality refers to the unequal access to, use of, and benefits derived from digital technologies across different social groups, regions, and countries. Beyond mere access to devices or the internet, it includes disparities in digital skills, data access, algorithmic representation, and the ability to leverage digital tools for economic and social advancement. In the context of AI, digital inequality is increasingly manifested through "algorithmic divides," where marginalized populations are excluded or disadvantaged by biased data systems and automated decision-making processes, thereby reinforcing existing socio-economic inequalities (García-Alonso, 2026). This multidimensional divide highlights how technological advancement (like AI technologies), if not inclusively governed, can exacerbate structural inequalities rather than reduce them.

Sustainable AI

Sustainable AI refers to the design, development, and deployment of artificial intelligence systems in ways that minimize environmental impact, promote social equity, and ensure long-term economic viability. Example, it involves reducing the carbon footprint and energy consumption of AI systems, ensuring ethical data practices, and aligning AI applications with sustainability goals. Besides, Sustainable AI also emphasizes the need for responsible lifecycle management of AI technologies, from data sourcing to model deployment, to ensure that AI contributes positively to sustainable development without creating unintended environmental or societal harm (Daniel et al., 2026; Andonova et al., 2022). Thus, it represents a shift from using AI for sustainability to making AI itself sustainable.

Sustainable Development

Sustainable development is a development approach that aims to meet the needs of the present generation without compromising the ability of future generations to meet their own needs. This widely accepted definition was introduced by the 1987 World Commission on Environment and Development in the Brundtland Report. The concept emphasizes balancing three key pillars: economic growth, social inclusion, and environmental protection. Sustainable development promotes responsible resource use, social equity, and long-term ecological stability to ensure continued human well-being (Sachs, 2015).

Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs) are a set of 17 global goals adopted by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development. The goals provide a universal framework for addressing major global challenges such as poverty, inequality, climate change, environmental degradation, peace, and justice (United Nations, 2015). Each goal has specific targets and indicators designed to guide governments, organizations, and individuals in promoting sustainable economic growth, social development, and environmental protection by the year 2030. The SDGs serve as a comprehensive roadmap for achieving sustainable development worldwide (Sachs et al., 2023). The 17 SDGs (in the order of their number references) include as follow:

1. No Poverty – End poverty in all its forms everywhere.
2. Zero Hunger – End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
3. Good Health and Well-being – Ensure healthy lives and promote well-being for all at all ages.
4. Quality Education – Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. Gender Equality – Achieve gender equality and empower all women and girls.
6. Clean Water and Sanitation – Ensure availability and sustainable management of water and sanitation for all.
7. Affordable and Clean Energy – Ensure access to affordable, reliable, sustainable, and modern energy for all.
8. Decent Work and Economic Growth – Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all.
9. Industry, Innovation and Infrastructure – Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
10. Reduced Inequalities – Reduce inequality within and among countries.
11. Sustainable Cities and Communities – Make cities and human settlements inclusive, safe, resilient, and sustainable.
12. Responsible Consumption and Production – Ensure sustainable consumption and production patterns.
13. Climate Action – Take urgent action to combat climate change and its impacts.
14. Life Below Water – Conserve and sustainably use oceans, seas, and marine resources for sustainable development.
15. Life on Land – Protect, restore, and promote sustainable use of terrestrial ecosystems.
16. Peace, Justice and Strong Institutions – Promote peaceful and inclusive societies for sustainable development.
17. Partnerships for the Goals – Strengthen the means of implementation and revitalize the global partnership for sustainable development.

Given these observations; in what follows, it becomes

imperative to review the existing scholarly and policy literatures to understand the conceptual, theoretical, and empirical foundations that critically demonstrate the interplay of the two variables: artificial intelligence and sustainable development. To that we now proceed.

Literature Review

Corpuses of literatures (like, Nedungadi et al., 2024; Greif et al., 2024; Ferreira et al., 2026) have increasingly dwelt mainly on the positive side of AI technologies to humanity; especially, from the frame of reference of AI contributions towards accelerating the achievement of sustainable development goals; but the critical examination of the nexus between AI and sustainable development -- especially, literatures highlighting how 'sustainable' SD is with the emergence of artificial intelligence -- is yet to receive major epistemic focus from many writers. Hence, it is the thrust of this paper to contribute to knowledge by filling the missing knowledge gap in literature, exposing both the opportunities and potential threats AI applications pose to the global sustainable development initiatives, with the following sub-themes.

Artificial Intelligence - An Overview

Artificial Intelligence (AI) has emerged as one of the most transformative technologies of the twenty-first century, reshaping industries, economies, and social systems. Broadly, AI refers to the field of computer science that focuses on designing machines and systems capable of performing tasks that typically require human intelligence, such as reasoning, learning, perception, and decision-making (Russell & Norvig, 2021). Through the integration of advanced algorithms, large datasets, and powerful computing infrastructures, AI systems are able to analyze complex patterns and generate solutions that enhance efficiency and innovation across various domains.

The concept of artificial intelligence dates back to the mid-twentieth century when researchers began exploring whether machines could simulate aspects of human cognition. Early AI research relied heavily on rule-based systems, where machines followed predefined instructions to perform tasks. However, advancements in computing power, availability of large datasets, and improvements in algorithmic design have led to the emergence of more sophisticated AI techniques, particularly machine learning and deep learning (LeCun et al., 2021). These approaches enable computers to learn from data and improve their performance over time without explicit programming. Consequently, modern AI systems are capable of performing complex tasks such as image recognition, speech processing, language translation, and predictive analytics with high levels of accuracy. Artificial intelligence encompasses several subfields that contribute to its capabilities. Machine learning (ML) is one of the most prominent branches and focuses on developing algorithms that allow computers to learn from data patterns. Within machine learning, deep learning utilizes artificial neural networks modeled loosely on the structure of the human brain to process large volumes of data and identify complex relationships (LeCun et al., 2021). Other key areas include natural language processing (NLP), computer vision, and robotics, which collectively expand AI's functional scope across digital and physical environments.

In recent years, artificial intelligence has experienced rapid growth due to breakthroughs in generative AI and large language models. These technologies can generate human-like text, images, and other forms of content, demonstrating the increasing sophistication of AI systems. The integration of such technologies has expanded AI's application across numerous sectors including healthcare, education, agriculture, transportation, and environmental management (Dwivedi et al., 2023). As a result, AI is increasingly viewed as a general-purpose technology with the potential to significantly influence productivity, innovation, and sustainable development. AI systems are often categorized into different types based on their capabilities. The most widely deployed form is Artificial Narrow Intelligence (ANI), which is designed to perform specific tasks such as facial recognition, recommendation systems, or language translation. In contrast, Artificial General Intelligence (AGI) refers to a hypothetical form of AI that could perform any intellectual task that a human can perform, although such systems remain largely theoretical (Bubeck et al., 2023). Current AI applications therefore remain specialized, focusing on particular tasks where machine learning models can be trained using large datasets.

Despite its enormous potential, the widespread adoption of AI also raises important ethical, social, and governance concerns. Issues such as algorithmic bias, data privacy, transparency, and accountability have become major topics in AI research and policy discussions (Floridi et al., 2021). Since AI systems rely heavily on data, biases present in training datasets may lead to discriminatory outcomes if not properly addressed. Additionally, the growing autonomy of AI systems has raised questions regarding human oversight and responsible deployment. Consequently, researchers and policymakers increasingly emphasize the development of ethical frameworks and responsible AI practices to ensure that AI technologies are used in ways that benefit society.

Furthermore, AI is increasingly recognized as a key enabler of sustainable development. By improving decision-making, optimizing resource management, and enabling predictive analytics, AI technologies can support solutions to global challenges such as climate change, food security, and healthcare accessibility. For instance, AI-driven systems are being used to monitor environmental changes, optimize energy consumption, and enhance agricultural productivity through precision farming techniques (Vinuesa et al., 2020). These applications highlight AI's capacity to contribute to the achievement of sustainable development goals when

deployed responsibly. Thus, while AI presents significant opportunities for innovation and sustainable development, its responsible implementation remains essential to address ethical concerns and maximize its societal benefits.

AI Governance Frameworks

AI governance frameworks are pivotal to ensuring that artificial intelligence contributes effectively to sustainable development by embedding ethical, legal, and socio-technical safeguards across its lifecycle. Recent scholarship emphasizes that AI governance operates across multiple levels—organizational, national, and international—requiring coordinated mechanisms for accountability, risk management, and transparency (Batool et al., 2025). Within this context, global institutions such as the OECD and UNESCO have advanced complementary governance models that increasingly shape both policy and practice. As a corollary to that, the 2024 update of the 'OECD AI Principles' reinforces a human-centered and trustworthy AI paradigm, emphasizing robustness, accountability, transparency, and respect for human rights. Typically, the revised framework responds to emerging risks from generative AI and data-intensive systems by incorporating concerns such as privacy, information integrity, and intellectual property protection, thereby strengthening its alignment with sustainability objectives (Čorba et al., 2024). As an intergovernmental standard adopted by dozens of jurisdictions, the OECD framework functions as a flexible "soft law" instrument that promotes policy convergence across countries.

Similarly, the (UNESCO's 2024) updates shift the focus from normative principles to implementation-oriented governance. Through initiatives such as global consultations on AI regulation, governance toolkits, and capacity-building platforms, UNESCO underscores the need for actionable mechanisms, including standards, monitoring systems, and institutional oversight. These efforts highlight that effective AI governance must integrate technical standards, multi-stakeholder participation, and continuous supervision to address persistent gaps in fairness, transparency, and accountability. Furthermore, the joint OECD–UNESCO G7 Toolkit exemplifies collaborative governance by embedding transparency, inclusivity, and public trust into AI deployment in the public sector. Complementing this approach, recent Web of Science-indexed (WoS) studies support this shift toward hybrid governance approaches, combining ethical principles with risk-based and lifecycle-oriented regulatory mechanisms. For instance, research in Environmental Science & Policy highlights that AI governance is increasingly intertwined with sustainability discourses, reinforcing institutional coordination and policy integration across global frameworks (Vinuesa et al., 2023). Similarly, systematic reviews on AI and Ethics stress the importance of embedding governance across the entire AI lifecycle—from design to deployment and monitoring—to ensure responsible innovation (Batool et al., 2025). Collectively, these developments indicate a convergence toward adaptive, multi-level governance systems that are essential for leveraging AI in achieving sustainable development goals while mitigating systemic risks.

Sustainable Development (SD) -- An Overview

Sustainable development has become a central concept in global policy and academic discourse, particularly in addressing contemporary environmental, economic, and social challenges. The term gained global prominence through the 1987 report Our Common Future by the World Commission on Environment and Development (WCED), which defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Mensah, 2020; Purvis et al., 2021). This definition emphasizes the importance of balancing present development needs with long-term environmental and societal sustainability. At its core, sustainable development integrates three fundamental dimensions: environmental protection, economic growth, and social equity. These three pillars are interdependent and must be pursued simultaneously to ensure long-term sustainability. Environmental sustainability focuses on the responsible management of natural resources, protection of ecosystems, and reduction of environmental degradation. Economic sustainability involves promoting stable and inclusive economic growth that generates employment opportunities while maintaining responsible resource use. Social sustainability, on the other hand, aims to improve quality of life through equitable access to education, healthcare, and social justice (Purvis et al., 2021, Leal Filho et al., 2022).

The concept of sustainable development emerged partly as a response to the negative environmental consequences of rapid industrialization and economic expansion during the twentieth century. Increasing concerns about climate change, biodiversity loss, resource depletion, and social inequality highlighted the need for development models that balance economic progress with environmental conservation. Sustainable development therefore promotes a holistic approach that considers the interconnectedness of ecological systems, economic activities, and social well-being (Mensah, 2020). One of the most significant global initiatives promoting sustainable development is the United Nations' 2030 Agenda for Sustainable Development, adopted in 2015. This agenda introduced the Sustainable Development Goals (SDGs), a set of 17 global goals designed to address major challenges such as poverty, hunger, health, education, gender equality, clean energy, climate action, and sustainable cities. These goals provide a comprehensive framework for governments, organizations, and stakeholders to coordinate efforts toward achieving sustainable and inclusive global development by the year

2030 (Sachs et al., 2022). The SDGs emphasize that sustainable development requires integrated solutions and collective action across sectors and disciplines. Achieving these goals involves coordinated efforts from governments, international organizations, the private sector, civil society, and academic institutions. Furthermore, sustainable development is increasingly viewed as a multidisciplinary field that integrates insights from environmental science, economics, public policy, technology, and social sciences. Interdisciplinary collaboration is therefore essential in addressing complex global challenges such as climate change, resource scarcity, and socio-economic inequalities (Leal Filho et al., 2022).

Another key principle underpinning sustainable development is intergenerational equity. This principle emphasizes that current development activities should not compromise the environmental resources and opportunities available to future generations. It promotes responsible consumption and production patterns, sustainable resource management, and long-term environmental stewardship. In addition, sustainable development encourages inclusive participation, ensuring that marginalized groups and vulnerable populations are involved in decision-making processes related to development policies and practices (Mensah, 2020).

However, despite significant global efforts, achieving sustainable development remains a major challenge. Many countries, particularly in the Global South, continue to face persistent issues such as poverty, environmental degradation, and unequal access to resources. Rapid population growth, urbanization, and industrial expansion have intensified pressures on natural ecosystems, making it increasingly difficult to balance economic growth with environmental protection. Moreover, disparities in technological capacity, financial resources, and governance structures across countries hinder progress toward sustainable development goals (Sachs et al., 2022).

Therefore, in recent years, emerging technologies—including artificial intelligence, big data analytics, and digital innovations—have been identified as important tools for advancing sustainable development. These technologies can support more efficient resource management, improve environmental monitoring, and enhance data-driven decision-making processes (Vinuesa et al., 2020). However, while integrating technological innovations such as AI into sustainable development strategies which offers significant opportunities, it also presents potential risks, reinforcing the notion that technological advancement has immanent or latent consequences in sustainability transitions.

Examining The Extent to Which Sustainable Development is 'Sustainable' With the Emergence of AI.

In concrete terms, recent scholarly discussions (like, Ferreira et al., 2026; Toderas, 2025; Greif et al., 2024) increasingly highlight the growing intersection between artificial intelligence and sustainable development. AI technologies have been identified as important tools for addressing global sustainability challenges through data analytics, automation, and predictive modeling (Toderas, 2025). AI applications in sustainability include environmental monitoring, climate modeling, renewable energy optimization, smart transportation systems, and sustainable urban planning. Similarly, Greif et al. (2024) emphasize that AI techniques can significantly contribute to environmental sustainability by enabling more efficient resource management and improving environmental monitoring systems. For instance, machine learning algorithms can analyze satellite imagery to track deforestation, detect environmental pollution, and monitor biodiversity loss. These capabilities allow policymakers to make more informed decisions regarding environmental conservation and climate mitigation strategies. In the same vein, Ferreira et al. (2026) highlight the importance of human-centered artificial intelligence in promoting sustainable development. Human-centered AI focuses on designing AI systems that prioritize social well-being, fairness, and ethical considerations. This approach aims to ensure that AI technologies support inclusive development rather than exacerbate social inequalities. In fact, the above utterances exemplify the growing popularity of AI technologies in 'sustaining' sustainable development. But we shall like to subject this into an epistemic scrutiny. Does AI have iron-cast benefits in 'sustaining' sustainable development; or, can AI equally have unintended, latent threats or risks that could hamper the achievement of the global sustainable development goals?

Thus, under this rubric, we shall like to critically examine the extent to which AI emergence can sustain sustainable development (or not), bringing out the specific ways by which SD can be sustained by AI, as well identifying the specific ways by which AI applications can hamper or pose a potential threat to sustainable development. To achieve the aim of this investigation, we propose to throw our investigative lenses on some SDGS, selected purposively. These are - goals numbers 8, 12, and 10. The justification for selecting these specific goals for investigation is because, the three SDGs address the three (3) pillars of Sustainable Development, namely: 'Economic growth'; 'Environmental protection'; and 'Social Inclusion'. For instance, Goal 8 on 'Economic growth' (addresses, "Decent Work and Economic Growth"); Goal 12 on 'Environmental protection' (addresses, "Responsible Consumption and Production"); while Goal 10 on 'Social Inclusion' (addresses, "Reduced Inequalities"). In what follows, we shall use these 3 identified SDGs as specimen for our investigation. The investigation shall be double-piped: at one hand, we shall use the specimen to identify the various ways by which AI applications can 'sustain' sustainable development; at the other hand, we shall use the specimen to identify the various ways by which AI

applications can hamper or pose potential threats to sustainable development. To that we now proceed.

AI and Sustainable Development: The Ways by Which AI Can Promote Sustainable Development.

Decent Work and Economic Growth (SDGs No. 8) and AI Supports:

Sustainable Development Goal 8 seeks to promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all. In recent years, artificial intelligence (AI) has emerged as a powerful technological driver capable of accelerating progress toward this goal. By improving productivity, fostering innovation, enhancing labor market efficiency, and creating new economic opportunities, AI applications can contribute significantly to achieving sustainable economic growth and better employment outcomes. Thus, one of the most significant ways AI supports SDG 8 is through increased productivity and economic efficiency. AI-powered systems can analyze large volumes of data, automate complex processes, and optimize operational workflows across industries such as manufacturing, agriculture, healthcare, and finance. These improvements enable organizations to produce goods and services more efficiently while reducing operational costs. According to Brynjolfsson et al. (2021), AI-driven automation and machine learning technologies enhance productivity by enabling faster decision-making, improving accuracy, and minimizing human errors in production systems. Higher productivity levels, in turn, stimulate economic growth and competitiveness within both developed and developing economies.

Besides, AI also contributes to job creation and the emergence of new industries. While concerns often focus on job displacement due to automation, AI simultaneously generates new employment opportunities in fields such as data science, AI development, cybersecurity, robotics engineering, and digital services. The expansion of AI-related sectors has led to increased demand for skilled professionals who can design, manage, and maintain intelligent systems. Research by Acemoglu and Restrepo (2020) suggests that technological advancements, including AI, can create complementary tasks and entirely new occupations that did not previously exist, thereby expanding employment opportunities in emerging digital economies.

Another important contribution of AI to SDG 8 lies in improving labor market efficiency and workforce development. AI-powered platforms can analyze labor market trends, identify skill gaps, and match job seekers with suitable employment opportunities. Online recruitment platforms increasingly use AI algorithms to screen job applications, assess candidate qualifications, and recommend job opportunities based on individuals' skills and experiences. These systems help reduce information asymmetry in labor markets and improve the efficiency of job matching processes (Kässi and Ledhdonvirta, 2018). As a result, both employers and job seekers benefit from more transparent and efficient employment systems. More so, AI technologies also support entrepreneurship and innovation, which are key drivers of sustainable economic growth (Cockburn et al., 2018). Startups and small businesses increasingly leverage AI tools to analyze market trends, automate customer service through intelligent chatbots, and optimize supply chains. These capabilities enable small and medium-sized enterprises (SMEs) to compete more effectively in global markets and expand their operations. According to Kässi and Ledhdonvirta (2021), AI adoption has the potential to contribute significantly to global economic output by improving innovation capacity and enabling businesses to develop new products and services.

Furthermore, AI can enhance workplace safety and job quality, which are essential components of decent work. AI-driven monitoring systems and predictive analytics can identify potential workplace hazards, reduce accidents, and improve occupational safety in industries such as mining, construction, and manufacturing. For instance, AI-enabled sensors and computer vision technologies can detect unsafe conditions in real time, allowing organizations to implement preventive measures before accidents occur. These technologies help create safer working environments while protecting workers' health and well-being (Dwivedi et al., 2023). Moreover, AI also facilitates inclusive economic participation, particularly for marginalized groups. Digital platforms powered by AI can provide remote work opportunities, online education, and digital skill development programs that empower individuals to participate in the global digital economy. Such opportunities are particularly important for developing countries, where access to traditional employment may be limited. By supporting digital entrepreneurship, online freelancing, and remote employment, AI-enabled technologies can broaden access to economic opportunities and contribute to inclusive growth.

Responsible Consumption and Production (SDGs No. 12) and AI Supports:

Sustainable Development Goal 12 aims to ensure sustainable consumption and production patterns by promoting efficient resource use, reducing waste generation, and encouraging environmentally responsible industrial practices. Artificial intelligence (AI) has increasingly been recognized as a transformative technology capable of supporting these objectives. By enabling data-driven decision-making, improving resource efficiency, and optimizing production processes, AI applications can play a significant role in advancing sustainable consumption and production across various sectors. In fact, one of the most important contributions of AI to SDG 12 is improving resource efficiency in production

systems. AI-powered analytics can process vast amounts of operational and environmental data to optimize the use of raw materials, energy, and water in manufacturing processes. Machine learning algorithms can identify inefficiencies in production lines and recommend adjustments that reduce resource waste and energy consumption. According to Vinuesa et al. (2020), AI technologies have strong potential to enhance sustainable industrial practices by optimizing resource management and reducing environmental impacts associated with production activities. Besides, AI also facilitates sustainable supply chain management, which is essential for responsible production. Supply chains often involve complex networks of suppliers, transportation systems, and distribution channels. AI-driven systems can analyze supply chain data in real time to improve logistics planning, demand forecasting, and inventory management. These capabilities help organizations reduce overproduction, minimize excess inventory, and improve the efficient distribution of goods. Improved demand forecasting enabled by AI reduces unnecessary production and transportation, thereby lowering carbon emissions and resource consumption (Baryannis et al., 2019).

Another significant application of AI in achieving SDG 12 is waste reduction and improved recycling systems. AI-powered computer vision and robotics technologies are increasingly used in waste management facilities to automatically sort recyclable materials such as plastics, metals, and paper. These intelligent systems can identify different types of waste with high accuracy and separate them more efficiently than manual sorting processes. As a result, recycling rates can be increased while reducing the amount of waste sent to landfills. Research by Niu et al. (2021) highlights that AI-enabled waste classification technologies can significantly enhance recycling efficiency and support the development of circular economy systems. Moreover, AI also contributes to sustainable consumption patterns by influencing consumer behavior and decision-making. Digital platforms powered by AI can analyze consumer preferences and provide personalized recommendations that encourage environmentally friendly choices. For example, AI-driven recommendation systems used in e-commerce platforms can suggest sustainable products, highlight energy-efficient alternatives, and provide information about the environmental impact of different goods. Such tools help raise consumer awareness and promote responsible purchasing decisions, which are essential for reducing unsustainable consumption patterns (Kristoffersen et al., 2020). Furthermore, AI supports the transition toward a circular economy, which is closely aligned with the goals of SDG 12. In a circular economy, resources are reused, repaired, refurbished, and recycled to extend product life cycles and reduce waste. AI technologies can monitor product usage, predict maintenance needs, and optimize product life cycles through predictive analytics. These capabilities allow businesses to design more durable products, improve maintenance schedules, and reduce resource extraction. Kristoffersen et al. (2020) noted that digital technologies, including AI, are essential enablers of circular economy practices that support sustainable production and consumption systems. Additionally, AI can also improve environmental monitoring and regulatory compliance in production processes. Advanced AI systems can analyze environmental data collected from sensors, satellite imagery, and industrial monitoring systems to track pollution levels, emissions, and resource consumption. These tools enable regulators and organizations to detect environmental violations and implement corrective measures more effectively. By providing real-time insights into environmental performance, AI helps industries adopt more sustainable production practices and meet environmental standards.

Reduced Inequalities (SDGs No. 10) and AI Supports:

Sustainable Development Goal 10 focuses on reducing inequalities within and among countries by promoting social, economic, and political inclusion for all individuals regardless of age, gender, disability, race, ethnicity, or economic status. AI has emerged as a powerful technological tool that can help address structural inequalities by improving access to services, expanding economic opportunities, and supporting inclusive policy development. When applied responsibly, AI technologies can contribute significantly to reducing disparities and promoting equitable development. One of the key ways AI contributes to reducing inequalities is through improving access to essential services, particularly in healthcare and education. AI-driven technologies can expand access to quality services in underserved or remote communities where traditional resources may be limited. For instance, AI-powered diagnostic tools and telemedicine platforms allow healthcare professionals to remotely analyze medical data and provide medical guidance to patients in rural or disadvantaged regions. Such technologies can help reduce disparities in healthcare access and improve health outcomes for marginalized populations (Topol, 2019). Similarly, AI-powered educational platforms can deliver personalized learning experiences and adaptive teaching tools that help students from diverse backgrounds access high-quality educational resources regardless of their geographic or socio-economic circumstances (Holmes et al., 2022).

Additionally, AI also supports financial inclusion, which is an important component of reducing economic inequality. Many individuals in developing countries lack access to traditional banking services due to limited credit histories or geographic barriers. AI-driven financial technologies (fintech) can analyze alternative data sources, such as mobile phone usage or transaction histories, to assess creditworthiness and provide microloans or digital financial services to previously underserved populations. According to Frost et al. (2019), AI-enabled fintech solutions can expand access to credit and financial services, enabling individuals and small

businesses to participate more actively in economic activities and improve their financial stability. Another significant contribution of AI to SDG 10 lies in supporting inclusive labor markets and economic participation. AI-based digital platforms can help connect job seekers with employment opportunities by analyzing skills, qualifications, and labor market trends. These systems can help reduce information asymmetry in labor markets and enable individuals from disadvantaged backgrounds to access job opportunities that match their abilities. In addition, AI-driven online platforms facilitate remote work, freelancing, and digital entrepreneurship, which can provide income opportunities for people who face barriers to traditional employment, including individuals living in rural areas or those with disabilities (Kässi and Ledhdonvirta, 2018). More so, AI technologies also play an important role in supporting evidence-based policymaking aimed at reducing inequality. Governments and international organizations increasingly use AI-powered data analytics to analyze social and economic data, identify inequality patterns, and design targeted social policies. By processing large datasets related to income distribution, education access, healthcare availability, and employment trends, AI systems can help policymakers identify vulnerable populations and develop more effective interventions. Vinuesa et al. (2020) emphasize that AI-driven data analysis can enhance the ability of governments to monitor social disparities and design inclusive development strategies aligned with the Sustainable Development Goals. Thus, when implemented responsibly and inclusively, AI technologies can therefore serve as important tools for fostering more equitable societies and supporting global efforts to reduce inequality.

AI and Sustainable Development: The Ways by Which AI Can Hamper or Pose Threats to Sustainable Development.

Decent Work and Economic Growth (SDG 8) and AI Threats

Artificial Intelligence (AI) has emerged as a transformative technology with the potential to reshape economies and labor markets. While it offers opportunities for innovation and productivity, its rapid adoption also poses significant risks to achieving Sustainable Development Goal 8, which promotes sustained economic growth and decent work for all. Several scholars argue that AI may undermine this goal through job displacement, labor market polarization, widening inequality, and deterioration of job quality. One major risk is technological unemployment caused by automation. AI systems can perform routine and repetitive tasks more efficiently than humans, leading firms to replace workers with automated systems. Empirical evidence shows that automation and AI adoption can reduce labor demand in routine-intensive occupations, contributing to job displacement and employment instability (Acemoglu & Restrepo, 2020). Such displacement threatens SDG 8 by reducing employment opportunities and increasing economic insecurity among workers. Another significant concern is labor market polarization and skills inequality. AI tends to increase demand for highly skilled workers while reducing opportunities for low- and middle-skilled employees. This creates a "skills divide," where workers lacking digital competencies face declining employment prospects. Studies show that automation disproportionately affects middle-skill jobs, contributing to labor market polarization and wage inequality (Autor & Salomons, 2022). Besides, AI can also exacerbate socioeconomic inequality between countries and social groups. Technological benefits are often concentrated in advanced economies with strong digital infrastructure and research capabilities, while developing countries face barriers to adoption. This uneven distribution of AI capabilities risks widening global inequality and limiting inclusive economic growth (UNCTAD, 2021).

Furthermore, AI technologies can negatively affect working conditions and job quality. AI-driven monitoring and algorithmic management systems allow employers to track worker productivity in real time. While improving efficiency, such practices may reduce worker autonomy, increase stress, and undermine labor rights. Research highlights that algorithmic management in digital platforms can create precarious working conditions and erode job quality (Kellogg et al., 2020).

Responsible Consumption and Production (SDG 12) and AI Threats

Although AI can enhance efficiency in production systems, it also poses risks that may hinder the achievement of SDG 12. One major concern is the high energy consumption associated with AI systems. Training large-scale AI models and operating data centers require significant computational power, leading to increased electricity consumption and carbon emissions. Studies show that the environmental footprint of AI, particularly from deep learning models, is substantial and growing (Strubell et al., 2020). In addition, the expansion of AI infrastructure contributes to broader environmental pressures. Data centers consume large amounts of energy and water resources, raising sustainability concerns about long-term scalability (Masanet et al., 2020). These energy-intensive processes contradict the principles of efficient resource use emphasized in SDG 12. More so, AI technologies also contribute to environmental degradation through material extraction and electronic waste. The production of AI hardware requires rare earth minerals and critical materials, increasing pressure on natural ecosystems and global supply chains (Crawford, 2021). This lifecycle impact-from resource extraction to disposal—poses significant challenges to sustainable production systems.
Moreover, AI-driven digital platforms may encourage unsustainable consumption patterns. Personalized

recommendation systems can stimulate overconsumption by promoting targeted advertising and consumerism, thereby reinforcing resource-intensive lifestyles (Mont et al., 2020). Such dynamics undermine efforts toward responsible consumption and circular economy practices.

Reduced Inequalities (SDG 10) and AI Threats

Artificial Intelligence presents significant risks to achieving SDG 10, particularly through unequal access, algorithmic bias, and concentration of technological power. One major concern is the digital divide. Access to AI technologies remains uneven across regions, with developing countries facing limited infrastructure, technical expertise, and financial resources. This disparity restricts participation in AI-driven economies and reinforces global inequality (UNCTAD, 2021).

Another critical issue is income and wealth inequality. AI technologies tend to benefit highly skilled workers and capital-intensive firms, leading to unequal distribution of economic gains. Empirical research shows that digital technologies, including AI, can increase income concentration and widen wealth disparities (Aghion et al., 2021). Moreover, AI-driven automation also exacerbates labor market inequalities. Low-skilled and routine workers are more vulnerable to displacement, while high-skilled workers benefit from increased demand. This dynamic contributes to widening employment and wage gaps (Autor & Salomons, 2022). Additionally, algorithmic bias poses risks to social equity. AI systems trained on biased data may produce discriminatory outcomes in areas such as hiring, lending, and law enforcement. Research emphasizes that biased algorithms can reinforce existing social inequalities if not properly regulated (Mehrabi et al., 2021). Ultimately, the concentration of AI development within a small number of large technology firms and advanced economies raises concerns about power imbalances. This concentration limits equitable access to AI benefits and may reinforce global economic dominance by a few actors (Crawford, 2021). Addressing these risks requires inclusive AI governance, ethical frameworks, and investment in digital infrastructure and skills development. Without such interventions, AI may deepen inequalities rather than reduce them.

Theoretical Framework

The theoretical framework for this study draws primarily from Sustainable Development Theory and Technological Determinism Theory, which together provide a foundation for understanding the complex relationship between artificial intelligence and sustainable development.

Sustainable Development Theory

Sustainable development theory emerged from global concerns about environmental degradation, social inequality, and unsustainable patterns of economic growth. The concept gained international prominence through the report of the World Commission on Environment and Development (WCED), which defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development emphasizes the integration of three fundamental dimensions of development: economic sustainability, social sustainability, and environmental sustainability. These dimensions are often referred to as the three pillars of sustainability. Economic sustainability focuses on long-term economic growth and productivity; social sustainability emphasizes equity, human well-being, and social inclusion; while environmental sustainability involves the conservation of natural resources and protection of ecosystems (Sachs et al., 2022).

The adoption of the 2030 Agenda for Sustainable Development further institutionalized this framework through the establishment of the seventeen Sustainable Development Goals. These goals provide a comprehensive global development agenda that addresses issues such as poverty reduction, climate action, quality education, gender equality, and sustainable economic growth (United Nations, 2015). Within this framework, technological innovation is widely recognized as a critical driver of sustainable development. Emerging technologies can support sustainability by improving resource efficiency, enabling environmental monitoring, and facilitating data-driven decision-making processes (Greif et al., 2024). Artificial intelligence therefore represents a potentially powerful tool for advancing sustainability initiatives across multiple sectors.

However, sustainable development theory also highlights the importance of balancing technological advancement with environmental protection and social equity. If technological innovations generate new environmental risks or exacerbate social inequalities, they may contradict the fundamental principles of sustainable development. This theoretical perspective is particularly relevant for examining the implications of AI technologies, which have both positive and negative impacts on sustainability.

Technological Determinism Theory

Technological determinism provides another important theoretical lens for understanding the relationship between artificial intelligence and sustainable development. Technological determinism suggests that technological innovations play a central role in shaping social structures, economic systems, and cultural transformations (Hallstrom, 2022). According to this perspective, technological advancements drive societal change by transforming production systems, communication networks, governance structures, and social interactions. Major technological revolutions—such as the Industrial Revolution and the digital revolution—have historically reshaped economic systems and social institutions.

Artificial intelligence represents the latest stage in this technological transformation. Hence, scholars argue that AI technologies have the potential to fundamentally reshape global economic and social systems through automation, predictive analytics, and intelligent decision-making systems (Brynjolfsson, 2021). These technological changes can improve efficiency and productivity, thereby supporting economic development and innovation. However, technological determinism also highlights the unintended consequences of technological change: While new technologies can generate significant benefits, they may also produce new social and environmental challenges. For example, automation technologies may disrupt labor markets, while digital infrastructures may increase energy consumption and environmental impacts. Therefore, applying technological determinism to the context of artificial intelligence suggests that the expansion of AI technologies will inevitably reshape development processes and sustainability strategies. Consequently, the impact of AI on sustainable development depends not only on technological capabilities but also on governance frameworks, policy interventions, and institutional arrangements that guide the responsible use of AI.

Integrating the Theoretical Perspectives to the Study

The integration of sustainable development theory and technological determinism provides a comprehensive framework for analyzing the relationship between artificial intelligence and sustainable development. Sustainable development theory emphasizes the need to balance economic growth, social inclusion, and environmental protection, while technological determinism highlights the transformative power of technological innovations such as AI. Together, these perspectives suggest that AI can act as both an enabler and a potential threat to sustainable development. On one hand, AI can enhance sustainability through improved resource management, environmental monitoring, and social service delivery. On the other hand, the rapid expansion of AI infrastructure may create new environmental pressures, socio-economic inequalities, and governance challenges. This theoretical framework therefore supports the central objective of this study: to critically examine whether sustainable development remains sustainable in the context of the rapid emergence of AI technologies.

Discussion of Findings

The findings of the study reveal that artificial intelligence plays a dual role in sustainable development:

1. On one hand, AI provides powerful tools for addressing complex global challenges. AI-driven analytics can support increased productivity and economic efficiency (e.g, this addresses support to SDGS No. 8); support improving resource efficiency in production systems, environmental monitoring and regulatory compliance in production processes (e.g, this addresses support to SDGS No. 12); promotes inclusive job opportunities and equal economic participation; improves equal access to essential services such as healthcare, education, and financial inclusion (e.g, this addresses support to SDGS No. 10). These applications demonstrate that AI can significantly contribute to achieving several SDGs. Supporting these claims, Vinuesa et al. (2020) affirmed that, AI technologies have strong potential to enhance sustainable industrial practices by optimizing resource management and reducing environmental impacts associated with production activities. More so, research by Acemoglu and Restrepo (2020) suggests that AI technologies can create complementary tasks and entirely new occupations, thereby expanding employment opportunities in emerging digital economies. Complementing these claims further, Topol (2019) affirmed that, AI technologies can help reduce disparities in healthcare access and improve health outcomes for marginalized populations. Additionally, according to Cockburn et al. (2018), AI technologies also support entrepreneurship and innovation, which are key drivers of sustainable economic growth.

2. On the other hand, the rapid expansion of AI technologies presents significant sustainability challenges that can hamper or pose threats towards achieving sustainable development. For instance, the environmental impact of AI infrastructure, particularly energy-intensive data centers, raises concerns about increased carbon emissions and resource consumption (this addresses threat to SDGS No. 12). Additionally, the socio-economic implications of AI automation may disrupt labor markets and exacerbate global inequalities (again, this addresses threat to SDGS No. 10); and more so, AI can exacerbate technological unemployment and job displacement, low income growth for some countries and corporations due to unequal market share, income and wealth inequalities between AI powered advanced countries (including their firms) and non AI powered developing countries (this addresses threat to SDGS No. 8). Supporting these claims, empirical evidence exemplified by Acemoglu and Restrepo (2020), shows that automation and AI adoption can reduce labor demand in routine-intensive occupations, contributing to job displacement and employment instability. More so, studies conducted by Strubell et al. (2020) show that, the environmental footprint of AI, particularly from deep learning models is substantial and growing-- this needs operating data centers requiring significant computational power, leading to increased electricity consumption and carbon emissions. Additionally, empirical research conducted by Aghion et al. (2021) shows that, digital technologies, including AI, can increase income concentration and widen wealth disparities. For further empirical analysis of the findings, the following table shows a comparative analysis of the findings with recent WoS Studies (2020 - 2026): -
Thus, Table 1 highlight the importance of adopting responsible AI governance frameworks that prioritize

Table 1: Comparative Analysis of the Findings with Recent WoS Studies (2020 - 2026)

STUDY	METHOD	KEY FINDINGS	ALIGNMENT WITH CURRENT STUDY	GAP IDENTIFIED
Vinuesa et al (2020)	Quantitative mapping	AI supports 79% SDGs	Strong	Lack update
Wang et al (2024)	Econometrics	AI increases emissions.	Matches	No quantification
Greif et al (2024)	SLR	AI enhances SDG efficiency.	Matches	Lacks metrics
Ferreira et al (2026)	Conceptual	Human centered AI, critical	Matches	No empirical validation
Carmeno et al (2026)	SLR	Environmental trade-offs	Matches	Missing lifecycle analysis

Source: Researcher's Adaption from Reviewed Recent WoS Studies (2020 - 2026).

sustainability, transparency, and ethical considerations. Without appropriate regulatory mechanisms, the expansion of AI technologies may undermine the long-term goals of sustainable development.

Summary and Conclusion

This study critically examined the relationship between artificial intelligence and sustainable development by analyzing existing literature on AI applications and its critical impacts on sustainable development (SD), with specific emphasis on the 3 SD pillars: environmental impacts, economic and social inclusion implications. The findings indicate that AI has the potential to significantly support sustainable development initiatives through innovations in environmental monitoring, healthcare, education, and financial inclusion. However, the study also identified several challenges associated with AI expansion, including increased energy consumption, environmental impacts, labor market disruptions, and global digital inequalities. These challenges suggest that while AI can contribute to sustainable development, its emergence may also undermine sustainability objectives if not properly governed. Hence, the sustainability of AI-driven development remains uncertain. The environmental footprint of AI infrastructure, the socio-economic implications of automation, and the ethical challenges associated with algorithmic decision-making raise important concerns regarding the long-term sustainability of AI technologies. The study therefore concludes that, the relationship between artificial intelligence and sustainable development is characterized by both opportunities and risks. Achieving a balance between technological innovation and sustainability requires responsible governance, ethical frameworks, and inclusive global cooperation. Only through such efforts can artificial intelligence truly support a sustainable and equitable future.

Contributions of the Study

This study makes important contributions to both policy and theory in the field of AI and sustainable development. From a policy perspective, it provides evidence-based insights that can guide governments, international organizations, and stakeholders in designing regulations and strategies that promote the responsible use of artificial intelligence to achieve sustainability goals, particularly in areas such as environmental monitoring, resource efficiency, and social inclusion. It highlights the need for governance frameworks that balance innovation with ethical considerations, data privacy, and equitable access. Theoretically, the study advances existing knowledge by integrating concepts from artificial intelligence and sustainable development into a unified analytical framework, demonstrating how AI can act as both an enabler and a risk factor in sustainability transitions. It also extends current literature by identifying key mechanisms, challenges, and pathways through which AI influences economic, environmental, and social systems, thereby offering a foundation for future interdisciplinary research.

Recommendations

Based on the findings of this study, a few recommendations are hereby proposed:

1. Promote Sustainable AI Infrastructure: Governments and technology companies should invest in renewable energy sources and energy-efficient computing systems to reduce the environmental impact of AI data centers.
2. Strengthen Global AI Governance: International regulatory frameworks should be developed to ensure ethical and responsible deployment of AI technologies.
3. Reduce Digital Inequality: Developing countries should be supported through technology transfer, capacity-building programs, and digital infrastructure investments. This will help mitigate the widening inequality gap between AI powered advanced countries and the non-AI powered developing countries.
4. Encourage Responsible AI Innovation and Accountability. AI research should prioritize sustainability-oriented applications such as climate modeling, renewable energy management, and environmental monitoring;

including AI deploying organizations should take responsibility regarding the environmental and social impacts of their technologies.

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