Artificial Intelligence and Sustainable Development Goals

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***Abstract*—The emergence of artificial intelligence (AI) and its progressively wider impact on many sectors requires an assessment of its effect on the achievement of the Sustainable Development Goals. Using a consensus-based expert elicitation process, we find that AI can enable the accomplishment of 134 targets across all the goals, but it may also inhibit 59 targets. However, current research foci overlook important aspects. The fast development of AI needs to be supported by the necessary regulatory insight and oversight for AI-based technologies to enable sustainable development. Failure to do so could result in gaps in transparency, safety, and ethical standards.**

***Key Words*— Artificial Intelligence, Sustainable Development Goals (SDGs), Regulatory Oversight, Ethical Standards, Transparency**

I. INTRODUCTION

Artificial Intelligence (AI) is transforming industries worldwide by increasing productivity, fostering economic inclusion, supporting environmental sustainability, and promoting social equity. With capabilities such as perception, decision-making, prediction, pattern recognition, and interactive communication, AI technologies are now applied to some of the world's most complex problems, including those related to healthcare, climate change, education, and governance. As a result, AI holds significant potential to support the United Nations Sustainable Development Goals (SDGs), a global agenda comprising 17 goals and 169 targets to be achieved by 2030.

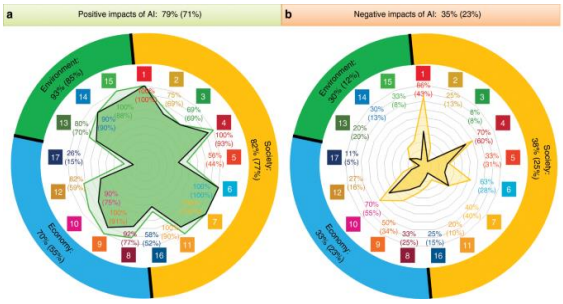
Despite this potential, there is limited comprehensive evaluation of AI's full impact on the SDGs. This research seeks to fill that gap by examining both the positive and negative effects of AI on sustainable development. Using a consensus-based approach supported by expert insights and ethical frameworks, the study evaluates AI's role in advancing—or hindering—progress toward each SDG.

For the purpose of this study, AI is defined as any software exhibiting at least one of the following capabilities:

- Perception (e.g., image recognition, speech-to-text),
- Decision-Making (e.g., credit scoring, medical diagnostics),
- Prediction (e.g., weather or financial forecasting),
- Pattern Recognition (e.g., fraud or misinformation detection),
- Interactive Communication (e.g., chatbots, virtual assistants),
- Problem Solving (e.g., AI-generated legal analysis or scientific research).

AI technologies, including machine learning, NLP, and generative AI, offer strong potential to support sustainable development goals. They improve healthcare (SDG 3) with diagnostic tools, aid climate action (SDG 13) through environmental modeling, and enhance education (SDG 4) by personalizing learning. AI also promotes economic growth (SDG 8) via task automation and job creation. However, challenges persist, including job displacement, algorithmic bias (SDG 10), privacy concerns, and environmental costs (SDG 7). Addressing these requires ethical frameworks, transparency, and inclusive policies. Public-private partnerships and investments in digital infrastructure and skills, especially in developing nations, are vital to ensure equitable AI benefits.

Fig. 1: Summary of positive and negative impact of AI on the various SDGs.



Documented evidence of the potential of AI acting as (a) an enabler or (b) an inhibitor on each of the SDGs. The numbers inside the colored squares represent each of the SDGs (see the Supplementary Data 1). The percentages on the top indicate the proportion of all targets potentially affected by AI and the ones in the inner circle of the figure correspond to proportions within each SDG. The results corresponding to the three main groups, namely Society, Economy, and Environment, are also shown in the outer circle of the figure. The results obtained when the type of evidence is taken into account are shown by the inner shaded area and the values in brackets.

Documented connections between AI and the SDGs

Artificial Intelligence (AI) is playing a growing role in advancing the United Nations Sustainable Development Goals (SDGs). Research shows that AI could positively influence about 79% of the SDG targets (approximately 134 out of 169) by introducing technological solutions that address existing challenges. However, about 35% of the targets (around 59) could face setbacks due to risks linked to AI adoption. To better understand AI's influence, the SDGs are grouped into three main areas: Society, Economy, and Environment. This classification helps highlight the areas where AI can have the most significant impact. A detailed analysis of the supporting evidence, along with its relevance, is provided in the methods section and illustrated in Figure 1. The following sections explore AI's effects on the Society, Economy, and Environment categories with specific examples.

AI's Role in Social Development

AI holds significant promise for advancing social development, with the potential to positively influence around 82% of SDG-related social targets. It can enhance areas such as poverty reduction (SDG 1), quality education (SDG 4), clean water and sanitation (SDG 6), and sustainable urban development (SDG 11). For instance, AI can optimize energy consumption in smart cities and enable smart grids to align usage with renewable availability, advancing SDGs 7, 11, and 13. However, challenges remain. AI systems demand vast computing power, increasing electricity usage and straining efforts to ensure affordable and clean energy. This raises concerns for SDGs 7 and 13, especially as ICT energy consumption could rise to 20% by 2030. Additionally, AI may exacerbate inequality by automating jobs and marginalizing low-skilled workers. While AI can help identify underserved communities, equitable access and inclusive policy frameworks are essential to ensure its benefits support all populations and reduce, rather than widen, social disparities.

Fig. 2: Detailed assessment of the impact of AI on the SDGs within the Society group.

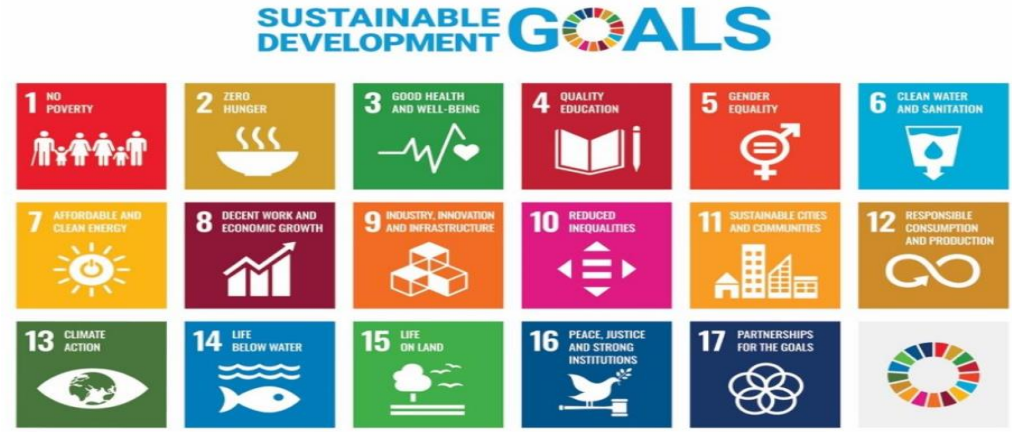
AI can support or hinder progress toward various SDG targets, including health, education, gender equality, and clean energy. While AI can improve access to healthcare, education, and climate solutions, it also raises concerns about bias, privacy, and inequality. For example, biased algorithms can reinforce gender stereotypes (SDG 5), and unequal access to AI tools in agriculture may widen economic gaps (SDG 2). In regions lacking ethical oversight, AI may threaten democracy and human rights through practices like citizen scoring or psychological manipulation ("big nudging"). Inclusive, transparent, and ethical AI development is essential for achieving sustainable development equitably.

AI's Economic Impact

AI is reshaping economic development by improving efficiency, boosting productivity, and driving innovation, benefiting around 70% of economic-related SDG targets. However, it also poses risks, including increased inequality and job displacement. Wealthier nations with more data access may gain disproportionate advantages, while lower-income

countries struggle to compete. Domestically, AI favors high-skilled workers and concentrates wealth among tech owners, widening wage and employment gaps. For example, tech firms generate more revenue with fewer workers than traditional industries. To promote equitable growth, inclusive policies, better education, and fair access to AI technologies are essential to balance innovation with social and economic fairness.

Fig. 3: Detailed assessment of the impact of AI on the SDGs within the Economy group.



AI positively influences many economic-related SDG targets, but trade-offs exist. For example, AI can reinforce social divisions by tailoring online content to users' biases, potentially increasing political polarization and impacting SDG 10 (Reduced Inequalities). Conversely, AI can help uncover inequality sources and simulate policy impacts. However, using biased data for human behavior prediction poses risks. Studies show that AI in job advertising may replicate discriminatory patterns seen in traditional recruitment. Addressing this requires better data preparation and adapting algorithms to ensure fairness. Thus, while AI supports development, ethical design and governance are vital to minimizing unintended social consequences.

AI and Environmental Outcomes

AI holds promise for environmental sustainability by enhancing data analysis and decision-making for SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land). It improves climate predictions, optimizes renewable energy, detects marine pollution, and monitors ecosystems using satellite and acoustic data. AI supports forest conservation and land restoration through remote sensing. However, its high energy demands, especially when powered by non-renewables, may undermine climate efforts. There's also concern over the misuse of ecological data. Promoting energy-efficient models, renewable energy reliance, and ethical governance is essential to ensuring AI contributes positively to environmental protection and sustainability.

Research Gaps in AI and Sustainable Development

Despite AI's potential in advancing Sustainable Development Goals (SDGs), research gaps persist. Concerns include systemic failures, ethical risks, and limited real-world applicability. Current AI studies often favor commercial over social impact, sidelining issues like poverty and education. Most research is concentrated in wealthier nations, potentially widening global inequality. There's also a lack of frameworks to address privacy, cybersecurity, and long-term ecological effects. Moreover, ethical and environmental dimensions are often underexplored. To ensure AI supports sustainable development, interdisciplinary collaboration and inclusive policies are essential. AI research must prioritize equity, adapt to diverse contexts, and balance innovation with human and environmental values.

Towards Sustainable AI

As artificial intelligence (AI) reshapes industries and influences societal structures, ensuring that its adoption remains sustainable, fair, and ethically sound has become a major global priority. While AI presents valuable opportunities for boosting economic development, enhancing social outcomes, and supporting environmental goals, it also introduces risks such as reinforcing inequality, perpetuating biases, and facilitating manipulation. Overcoming these challenges demands a strategic shift toward greater collaboration, openness, and ethical oversight in the development and use of AI technologies.

AI and Economic Inequality

AI has the potential to generate massive wealth, but its benefits may primarily accrue to those who already possess access to advanced education and technological resources. Meanwhile, the displacement of jobs due to automation could worsen economic disparities, leaving large segments of the population vulnerable. Additionally, AI research and development are concentrated in technologically advanced nations, making it difficult for less wealthy countries to benefit from AI-driven progress. Without intentional policies to promote equitable AI adoption, the digital divide may deepen, increasing socio-economic inequalities at both national and global levels.

Bias, Discrimination, and Misinformation

AI models are often built on large datasets that reflect existing social and historical biases, which can reinforce inequalities in areas such as hiring, criminal justice, and healthcare. When AI systems make biased decisions in these fields, the consequences can be severe and far-reaching. Moreover, AI can be exploited to create "big nudging" strategies, where social media algorithms influence public opinion and deepen political divides. While the direct connection between AI and misinformation remains uncertain, the broader societal effects are not well understood due to insufficient research methods. To address these challenges, transparent AI governance, ethical design standards, and accountability-focused regulations are essential.

Data Privacy and AI Ethics

AI depends heavily on large volumes of personal data, which raises significant concerns about data ownership, privacy, and security. This issue is especially critical in healthcare, where AI-powered tools can enhance diagnosis and treatment but may also compromise patient confidentiality and informed consent. Similar challenges arise in AI-driven finance (Finance 4.0), where ensuring data transparency and maintaining individual control over financial information are essential. Achieving a balance between AI-driven innovation and personal data protection requires strong legal frameworks that safeguard individuals' right to control how their data is collected and used.

Regulatory Challenges and Governance

AI is advancing at an unprecedented pace, often outstripping the ability of governments to regulate it effectively. The lack of appropriate legislation means that AI development is largely guided by corporate interests rather than societal needs. Governments must play a proactive role in establishing policy frameworks that align AI advancements with sustainable development goals (SDGs). However, regulatory oversight must be preceded by regulatory insight, ensuring that policymakers fully understand AI's complexities before enacting legislation. Key areas for policy development include:

- Transparency and accountability in AI decision-making
- Ethical guidelines for AI development and deployment
- Standards for data governance and privacy protection
- AI's role in strengthening (or weakening) democratic institutions
- Legislation to prevent AI-driven discrimination and bias

AI and Environmental Sustainability

AI's environmental impact is another critical issue. While AI can help optimize resource use, monitor climate change, and improve energy efficiency, its development requires significant computational power, leading to high energy consumption and carbon emissions. Sustainable AI should focus on:

- Developing energy-efficient AI models
- Reducing the carbon footprint of data centers
- Aligning AI innovation with circular economy principles

Guiding the future of AI demands a unified global effort based on scientific insights and inclusive discussions involving all nations and stakeholders. Effective international cooperation is crucial to guarantee that AI development remains:

- Ethical and responsible – Maintaining moral integrity and focusing on human well-being.
- Transparent and inclusive – Encouraging open decision-making and equal representation from diverse communities.
- Aligned with global sustainability goals – Advancing AI solutions that contribute to environmental, social, and economic stability worldwide.

The IEEE ethical AI framework, the EU's trustworthy AI guidelines, and efforts by the Future of Life Institute mark significant progress toward establishing sustainable AI governance. However, ongoing collaboration among governments, private sector leaders, researchers, and civil society is

essential to ensure that AI serves humanity equitably rather than deepening existing inequalities.

The decisions made about AI development by 2030 will shape whether it becomes a catalyst for positive change or a source of further socio-economic and environmental challenges. Achieving a future where AI is sustainable, ethical, and inclusive requires active participation from all stakeholders—governments, businesses, researchers, and individuals—in guiding its direction.

II. METHODS

This section outlines the methodology used to obtain the results presented in this study, including the approach for assessing AI's role as an enabler or inhibitor for the 169 targets within the 17 Sustainable Development Goals (SDGs). The study employed a consensus-based expert elicitation process, informed by previous research on SDG interlinkages and following best practices from expert-driven evaluations.

Expert Elicitation and Literature Search

The study was conducted by a diverse team of academics with expertise spanning engineering, natural sciences, and social sciences. Each SDG was assigned to a main contributor, with additional contributors assisting in literature review and analysis. The process involved:

1. Literature Search: Contributors conducted a structured review of existing studies linking AI with specific SDG targets. Acceptable sources included:
    - Peer-reviewed research on real-world applications
    - Controlled/laboratory studies with verified results
    - Reports from accredited organizations (e.g., UN, government bodies)
    - Documented commercial-stage AI applications Unverified claims, media sources, and public beliefs were not considered as valid evidence.
2. Review and Refinement: After contributors assessed AI's impact on a specific SDG, a separate reviewer with complementary expertise evaluated the findings. The reviewer's role was to critically examine the analysis, propose alternative viewpoints, and refine the conclusions through a process of iterative discussion.
3. Consensus and Categorization: Once a consensus was reached, the results were analyzed to calculate the percentage of targets where AI serves as an enabler or inhibitor. The SDGs were then organized into three main categories—Society, Economy, and Environment—based on established frameworks in sustainability research.

Classification and Weighting of Evidence

Since the sources of evidence varied in rigor, each reference was classified based on the strength and generalizability of its findings:

- (A) Studies using sophisticated tools and robust data with broad applicability.
- (B) Data-driven studies, but with limited generalizability.
- (C) Qualitative or anecdotal studies.
- (D) Theoretical or speculative references.

To quantify the strength of the connections between AI and SDG targets, weighted scores were assigned to each category:

- (A) = 1.00
- (B) = 0.75
- (C) = 0.50
- (D) = 0.25

For each target, the largest positive and negative weight among references determined AI's overall impact. For example, if a target had:

- One (B) reference supporting a positive AI impact (0.75)
- One (A) and one (D) reference indicating a negative AI impact (1.00 and 0.25, respectively)

The final assessment for that target would be:

- Positive impact = 0.75
- Negative impact = 1.00

This methodology ensured that AI's role in sustainable development was evaluated with rigor while minimizing bias from uneven literature availability across SDG targets.

Limitations of the Research

This study represents the perspective of the authors based on the available literature. While a comprehensive review was conducted, it is possible that some studies examining AI's impact on certain SDGs were missed or have not yet been published. However, efforts were made to minimize subjectivity through:

- A structured expert elicitation process to assess AI's role in SDG delivery.
- Multiple rounds of review and discussion among contributors and reviewers.

- Consensus-driven analysis of interlinkages between AI and SDGs.

Another limitation arises from the framework used for analysis. While the SDGs provide a valuable lens for evaluating sustainable development, they are a political compromise and may not fully capture the complex interdependencies among targets. Therefore, the SDGs should be considered alongside other frameworks, such as previous and ongoing international agreements on sustainability and human rights. As noted in UN Human Rights reports, human rights considerations are deeply embedded in the SDGs but should be complemented by broader frameworks like the United Nations Universal Human Rights Charter.

Data Availability

The authors confirm that all data supporting the findings of this study are available within the paper and its Supplementary Data 1 file.

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