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Research Article

Application of Artificial Intelligence (AI) in Environment and Societal Trends: Challenges and Opportunities

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ABSTRACT

Artificial Intelligence (AI) is increasingly pivotal in addressing global challenges by integrating technological advancements into environmental conservation and societal development. This paper explores the dual nature of AI's role—its capacity to foster sustainability and societal improvement, alongside the challenges it introduces. The research highlights AI applications in environmental management, such as optimizing resource use, monitoring ecosystems, and enhancing renewable energy efficiency. In societal contexts, AI's transformative potential extends to healthcare, education, and urban planning, fostering equitable access to essential services. However, significant barriers, including data scarcity, limited technical infrastructure, regulatory gaps, and socio-economic inequalities, hinder widespread AI adoption. By analyzing secondary data from recent literature, this study identifies critical challenges and presents actionable policy recommendations to ensure inclusive, ethical, and impactful AI integration. The findings underscore the urgency of collaborative efforts among governments, industries, and academia to leverage AI for achieving the United Nations Sustainable Development Goals (SDGs) and addressing pressing global issues.

1. INTRODUCTION

The 2030 Agenda outlines a plan for over 190 countries to take specific steps to end extreme poverty, fight inequality and injustice, strengthen universal peace by addressing underlying drivers of conflict, and achieve greater environmental sustainability. There are 17 interlinked Sustainable Development Goals (SDGs) that are increasingly being used by policymakers at the local, national, and international scale to drive a coordinated response to these challenges[1]. Meeting the objectives of these goals by 2030 will require the smart application and integration of existing and new technologies, including information and communication technologies. Technologies such as artificial intelligence will have applications that pervade virtually all SDG tenets, leading to positive and negative environmental and societal outcomes[2]. AI technologies hold the potential to enhance our understanding of the broad range of interactions that underpin human existence and support collaborations across its diversity.

Furthermore, AI provides new tools to improve the ways in which we move, live, power, and feed our world. Consequently, supporters of AI argue that these technologies can advance economic and environmental efficiencies for a better, healthier planet[3]. However, the deployment of AI also poses risks by introducing new environmental and social vulnerabilities. These technologies can lead to data and information monopolies, exacerbating information asymmetries. It may also lead to a new stratification of society by creating a new elite while leaving behind vast swaths of the population. Security is another major concern; preventive measures must be in place to guard against distinctive new vulnerabilities.

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The ongoing technological innovation for application in artificial intelligence (AI) systems is creating tremendous benefits. The AI application in increasingly diverse sectors of the global industry, the farm, and the entire civil society has a set of advances in deep learning that are changing the operations of global services, securities, health, and financial sectors. Increased business productivity is promoted by analyzing data from digital services at every stage and making better-informed business and financial decisions. AI is used to handle repetitive tasks efficiently and with higher quality and precision[4]. Despite the benefits mentioned, research is needed to determine how to simulate, train, and facilitate dialogue and process communication with AI instructed by human interactions. This creates a valuable tool for reporting that contributes to achieving predetermined results. Although some previous research has worked on AI development, research on issues of critical AI social consequences and potential optimization of AI benefit applications is still needed.

The increasing use of big data is the driving factor of change in AI use, which is particularly good at identifying pattern recognition from data sets. The clearer and more complex data encoded with AI are, the higher the value of information for users. The data that operate AI to execute tasks are a critical and essential asset to maximize the value and benefits that AI provides[5]. AI cannot function without generating insights and solving particular issues. Without well-organized data, AI use only provides partial solutions, and its performance declines. Consequently, the more advanced and integrated the information and communication technology, the wider the AI use will become. The countries in particular, all of these technology and industry initiatives, have already led the path. They have priority access to AI systems technology, qualifications, along with research and development, targeted skilled experts in the related industry, and are well-positioned to grow. They can also apply AI to social benefits and narrowly promote commercial activities to the exclusion of other players. AI could further exploit the widespread consequences and benefits, particularly for the public, and bear the potential for detrimental impacts.

There is a surge of AI applications for solving business-focused problems, such as process optimization, decision making, data privacy, and security. In parallel to business-driven innovations, societal trends including compromised biodiversity, recurrent natural disasters, inequalities in income, and lack of access to basic services, such as healthcare and education, come to the fore[5]. Given these conflicting trends, AI techniques can be applied not only to support and sustain businesses' competitiveness, but also to address societal needs, prompting the transition to use-oriented innovation. The potential of AI as an enabler for sustainable development and the achievement of the UN Sustainable Development Goals is manifold and has been recognized globally.

This paper is structured as follows: The first section introduces the application of AI in environment and societal trends. The second section outlines the methodology used in the study. The third section presents a review of the relevant literature on challenges and opportunities. Finally, the concluding section offers conclusions and discusses the policy implications of the study.

2. METHODOLOGY

AI Application in Environmental and Social Trends: Challenges and Opportunities This study adopted a literature review approach, inspired by the work of Chavula and Turyasingura (2022). The secondary data analytical methodology regarding the application of AI in environmental and social trends is harnessed through a systematic search across various databases such as Web of Science, Scopus, Dimensions, Google Scholar, and JSTOR. It includes keywords such as "Artificial Intelligence," "environmental impact," "societal trends," "challenges," and "opportunities." The search strategy will be further refined with Boolean operators, namely AND or for instance, using terms like "AI AND environmental sustainability" or "AI AND social impact." Inclusion criteria are limited to peer-reviewed articles, reviews, and conference papers between 2015 and 2024 in the English language and relevant to AI applications either in the environment or society. Exclusion criteria omit studies outside the specified timeframe, non-English sources, and articles focused solely on AI technology without societal or environmental context. This strategy ensures a comprehensive, up-to-date understanding of both the challenges and opportunities AI presents within environmental and social spheres, addressing recent developments and implications. Therefore, a total of 1895 documents were researched about but only 26 were used for this study because they were relevance.

3. LITERATURE REVIEW

The integration of Artificial Intelligence, AI into environmental conservation efforts is not merely a technological advancement but a necessity evolution to enhance the efficacy of sustainability initiatives. AI's role in environmental conservation is multifaceted, encompassing the monitoring of ecosystems, protection of endangered species, and management of natural resources[6]. AI is the biggest influence on the global economy. AI plays a very important role in achieving environmental sustainability from ending hunger and poverty to achieving sustainable energy and gender equality for the protection and preservation of biodiversity[7]. AI finds application in a wide array of environmental sectors, which include natural resource conservation, energy management, wildlife protection, pollution control and agriculture, clean energy, and waste management[8]

Amidst human-induced climate change and deterioration of our natural environment are critical problems, advanced technologies, such as artificial intelligence (AI), offer potential for the development of solutions. Machines that learn by acquiring knowledge and perform human-like tasks can help humans reduce their intense use of natural resources and improve environmental governance for more sustainable living[9]. Artificial Intelligence such as, machines can learn from data, extract information, solve problems, adapt to changes, and predict behavior. One area of AI that focuses on learning and perception is Machine Learning (ML) and Computer Vision. Machines can learn from data, extract information, solve problems, adapt to changes, and predict behavior. One area of AI that focuses on learning and perception is Machine Learning (ML) and Computer Vision7[10]. Innovative computer programs provide us with a solution for achieving precise predictions, constant monitoring, risk evaluations, and other valuable advantages. AI techniques possess the ability to reason, make decisions, and learn from data. They can transform real-world information into machine-understandable and usable knowledge and make decisions through planned pathways of optimization and solution searching. Nature conservation tasks can also benefit from machine learning algorithms, which can help map habitats, model species distribution, and monitor forest health. Additionally, ML models can assist in decision-making processes for creating no-take zones and implementing protective measures to preserve local biodiversity[11]. AI has also advanced traditional spatial modelling by collecting environmental data at very high temporal and spatial resolutions, helping with the automation of precision agricultural operations, afforestation, and managing bushfires and deforestation[12].

In power quarter, AI can help enhance electricity efficiency in buildings and industries by using predicting strength utilization patterns and optimizing power consumption. It also can become aware of regions of electricity waste and recommend methods to lessen it. For instance, Google's DeepMind has used AI to optimize the cooling structures in its records facilities, reducing energy intake and carbon emissions. Tesla makes use of AI-driven self-sufficient riding functions in its electric powered cars to optimize driving styles, main to extended energy efficiency and reduced emissions [13]. AI aids inside the improvement of renewable energy resources inclusive of wind and solar strength with the aid of predicting power output, optimizing overall performance, and enhancing upkeep. GE Renewable Energy makes use of AI in its wind turbines to enhance their performance. These turbines are geared up with sensors and AI algorithms which could predict adjustments in wind conditions and alter the turbine's operation consequently. This predictive capability allows optimize strength output and guarantees that the generators operate at maximum efficiency. Additionally, AI-pushed preservation scheduling is used to proactively identify and cope with problems, reducing downtime and preservation costs. This utility of AI contributes to the boom and efficiency of renewable energy assets like wind energy [14]. AI can help create smarter strength grids through reading statistics from sensors, meters, and other devices. This can help utilities higher manage the deliver and demand of power, reduce strength waste, and improve reliability. Microsoft has been using AI to improve strength efficiency in its statistics facilities and has set formidable sustainability goals, aiming to be carbon bad by means of 2030 [15].

In waste management, AI can assist to research facts on waste production, collection, and disposal. This can assist cities and municipalities optimize their waste control systems, lessen waste, and increase recycling prices. Waste Robotics employs AI-powered robots to kind and separate recyclable materials from waste streams, improving recycling performance and reducing landfill waste[8]. AI also can useful resource in water management through analyzing information on water usage, excellent, and availability. This can help cities and municipalities higher manage their water assets, reduce water waste, and enhance water first-class. Ocean Cleanup, for example, deploys AI-powered systems to song and gather plastic waste in the ocean, contributing to efforts to smooth up marine environments [16].

AI can also address weather alternate with the aid of inspecting information on greenhouse gas emissions, climate styles, and different environmental factors. This can help tell rules and techniques for reducing emissions and mitigating the influences of climate exchange. In various programs, which include weather forecasting and climate modeling, the know-how and prediction of weather styles and climate trade impacts are aided with the aid of IBM's Watson[17]. AI can also useful resource in biodiversity conservation by way of investigating records on species populations, habitats, and threats. This can help tell conservation strategies and enhance our knowledge of the complicated relationships among extraordinary species and their environments. Conservation International uses AI for Environmental Sustainability, employing superior algorithms to analyze biodiversity data and song changes in ecosystems. This technology performs a vital position within the conservation and protection of critical herbal habitats[18].

4. CHALLENGES HINDERING THE APPLICATION OF AI IN ENVIRONMENT AND SOCIETY

The software of AI in managing water assets faces sizable demanding situations, especially concerning information availability and excellent. AI fashions rely on large datasets, but in many regions, there is a lack of complete statistics on water float, fine, and intake. Researchers such as Adnan and Rizvi (2021) spotlight that this scarcity is specially said in growing nations in which tracking infrastructure is insufficient. Additionally, AI tools for hydrological modeling regularly require integration with spatial and temporal datasets, which can be either inaccessible or incomplete. Poor information exceptional results in inaccurate predictions of water availability and vulnerability, similarly undermining efforts to optimize water usage. Moreover, soil monitoring suffers from comparable problems, wherein the uneven distribution of soil high-

quality data prevents AI fashions from handing over vicinity-unique tips for agriculture and land control. The price of superior sensors and satellite tv for pc records subscriptions further limits their tremendous use in aid-constrained settings.

Another venture in those domains is the reluctance to adopt AI-based answers because of a loss of accept as true with and technical knowledge among customers. Farmers, for example, may additionally hesitate to depend on AI-generated advice for soil fertility or irrigation due to inadequate understanding of the technology. This is exacerbated through restricted training possibilities and language limitations, as most AI structures aren't localized to meet the linguistic and cultural desires of various communities. Despite advancements in person-friendly AI interfaces, there may be an urgent need for greater inclusive potential-building projects to ensure that these technologies are accessible and beneficial to stop users.

Government policies significantly influence the application of AI in environmental management, but they regularly lag behind technological advancements. In many countries, regulatory frameworks governing AI use are either old or absent, leading to ambiguity concerning moral, legal, and operational standards. Studies by way of Williams et al. (2022) emphasize that uncertain policies prevent AI adoption by using growing uncertainty for developers and users. Furthermore, a loss of coverage alignment among sectors—such as agriculture, water, and electricity—impedes the mixing of AI for holistic environmental management. Governments may additionally prioritize brief-time period profits over long-time period sustainability, neglecting the capacity of AI to address systemic environmental issues such as deforestation or urbanization impacts.

Limited economic assets present every other vital venture, especially in gaining access to top class AI tools and subscriptions. Many superior AI structures require large funding, that's prohibitive for individuals and agencies in low-profits areas. For instance, smallholder farmers, who stand to gain maximum from AI-driven solutions like precision farming, often can't have enough money the associated prices. This venture is compounded with the aid of bad AI utilization stemming from insufficient schooling and recognition. Without proper steerage, users may additionally misuse or underutilize AI equipment, main to useless consequences. To bridge these gaps, there's a need for sponsored AI services, public-personal partnerships, and strong capability-constructing applications to democratize access to AI technologies.

Investment in digital technology in standard and AI particularly remains low within African countries. The absence of powerful computers to train big-scale models is one of the most important boundaries to Africa. As of 2023, one hundred% of the arena’s supercomputers reside in handiest 30 international locations. There are no mechanisms for collaboration and information change among researchers, academia and innovators. There are few facilities of virtual innovation which inhibit the price and impact of African innovation[19].

5. SOME OF THE AI OPPORTUNITIES

There are promising signs of AI growth especially in Africa, with an increase in AI-focused startups, tech hubs, and research initiatives. African governments and policy-makers are beginning to recognize the importance of AI, as evidenced by the adoption of national strategies and policies aimed at promoting AI development and integration[20]. Partnerships between African universities, international institutions, and private sectors are fostering an environment conducive to AI innovation and education, indicating a positive trajectory for AI’s role in sustainable development across Africa[21]. The ingredients for a successful startups’ ecosystem include the availability of capital and Digital Innovation Hubs (DIHs), government support and incentives, strong universities that produce breakthrough ideas and tools that can be readily commercialized and scaled, and an educated population that produces entrepreneurs and engages in debates about AI[22].

AI gives transformative opportunities in environmental management by way of enhancing efficiency, accuracy, and sustainability. For example, AI-driven equipment can examine satellite imagery and sensor information to screen deforestation, are expecting climate styles, and examine biodiversity. According to Zhang et al. (2021), device getting to know models can method extensive datasets to pick out early symptoms of ecological degradation, making an allowance for timely interventions. AI also plays a vital function in water resource management by using optimizing irrigation systems and predicting water shortage thru hydrological modeling. In precision agriculture, AI technology enhance crop yields by using offering farmers with actual-time statistics on soil health, weather situations, and pest manipulate. Additionally, AI-powered equipment such as drones and autonomous automobiles streamline conservation efforts by lowering the human attempt required for environmental monitoring. These talents align with global sustainability desires, offering scalable solutions for urgent environmental challenges[23].

In society, AI has the capacity to foster monetary improvement, enhance public offerings, and beautify choice-making. AI-powered structures are revolutionizing healthcare by using allowing early ailment diagnosis, personalized treatment plans, and green aid allocation. Similarly, in education, AI facilitates personalized mastering stories, bridging information gaps among diverse populations. Urban planning blessings from AI packages in traffic management, waste reduction, and power-efficient infrastructure. Moreover, AI's ability to investigate social facts promotes better policymaking, as governments can use predictive analytics to cope with poverty, inequality, and catastrophe preparedness. For marginalized groups, AI-driven solutions provide get right of entry to vital resources which includes financial services and digital literacy packages. According to Deloitte (2022), AI has the potential to generate inclusive boom through automating routine responsibilities,

liberating up human assets for innovative and strategic roles. This highlights AI's ability to drive societal transformation at the same time as addressing some of its maximum chronic challenges [24-26].

6. CONCLUSION AND POLICY RECOMMENDATIONS

6.1 Conclusion

The integration of AI into environmental management and societal development gives tremendous opportunities but is hindered by different challenges. Key limitations include data scarcity, inadequate infrastructure, limited monetary sources, and outdated regulations, especially in developing regions. However, there are promising developments, consisting of increasing investments in AI-centered projects, public-personal partnerships, and virtual innovation hubs, which recommend a growing popularity of AI's capacity. The role of AI in improving environmental sustainability, optimizing resource management, and riding economic increase is undeniable. By leveraging AI's skills, which includes real-time tracking and predictive analytics, stakeholders can deal with urgent challenges like weather change, useful resource depletion, and societal inequalities. Nevertheless, addressing barriers like get admission to technology, consider-constructing, and localized schooling is essential to make sure equitable and effective AI adoption. A collaborative, inclusive approach regarding governments, private sectors, and academia is critical to unlocking AI's complete ability for sustainable development and societal transformation. Therefore, there is need to investigate how AI can improve resilience to climate change impacts, particularly in flash food regions, and also another study maybe conducted on the ethical implications of AI in decision-making processes and its effects on marginalized populations.

6.2 Policy recommendations

1) Enhance Data Infrastructure: Invest in robust systems for collecting and managing high-quality environmental and societal data to support AI applications.
2) Subsidize AI Technologies: Introduce financial incentives and subsidies to make AI tools accessible to low-income users and small-scale enterprises.
3) Develop Inclusive AI Policies: Create clear, sector-aligned regulatory frameworks to guide ethical AI adoption and integration into environmental and societal projects.
4) Promote Capacity Building: Organize localized training programs to equip communities with technical knowledge and skills to utilize AI effectively.
5) Foster Public-Private Partnerships: Strengthen collaboration between governments, private firms, and research institutions to drive AI innovation and scaling.

Conflicts Of Interest

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