THE IMPORTANCE OF ARTIFICIAL INTELLIGENCE IN THE ECONOMY FOR PROMOTING SUSTAINABLE DEVELOPMENT AND SOLVING ENVIRONMENTAL PROBLEMS

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Abstract: The growing intensity of environmental challenges such as climate change, ecosystem degradation, and resource depletion necessitates the integration of advanced digital technologies into economic systems. This study analyses the role of artificial intelligence (AI) in promoting sustainable economic development and environmental protection. The research examines key application areas of AI, including energy system optimization, efficient resource management, reduction of carbon emissions, environmental monitoring, and sustainable agriculture. Using a qualitative analytical approach based on international reports and academic literature, the study demonstrates that AI technologies significantly enhance decision-making efficiency and contribute to the development of a green economy. The findings indicate that AI serves as a strategic tool for improving environmental sustainability; however, its effective implementation requires appropriate regulatory frameworks, data availability, and social responsibility. The results of this study contribute to the growing body of research on digital transformation and sustainability and may be useful for policymakers, researchers, and practitioners.

Keywords: environmental sustainability, resource efficiency, carbon emissions, ecosystem monitoring

1. Introduction

Sustainable development has become one of the central priorities of the global economic agenda due to escalating environmental risks, including climate change, pollution, and the depletion of natural resources. Traditional economic growth models have proven insufficient to address these challenges, leading to the emergence of the green economy concept, which emphasizes environmental protection, social inclusion, and long-term economic efficiency. In recent years, artificial intelligence (AI) has emerged as a transformative technology capable of reshaping economic and environmental governance. AI-driven systems enable the processing of large-scale data, predictive analytics, and optimization of complex processes, making them particularly valuable for addressing sustainability-related challenges. The purpose of this study is to analyze the role of artificial intelligence in economic processes aimed at achieving sustainable development and environmental protection. The article focuses on key domains where AI applications demonstrate the greatest potential impact and discusses both opportunities and limitations associated with their implementation.

2. Literature Review

The integration of artificial intelligence (AI) into economic and environmental systems has become a central focus of sustainability research due to increasing climate risks, resource depletion, and ecosystem degradation. The existing literature emphasizes AI as a transformative instrument that enhances efficiency, supports data-driven decision-making, and accelerates the transition toward a green economy. The economic foundations of environmental sustainability were comprehensively analysed by Stern (2007), who demonstrated that the long-term economic costs of climate change significantly outweigh the costs of early mitigation and adaptation. The Stern Review highlights the importance of incorporating technological innovation into economic policy frameworks to reduce greenhouse gas emissions and ensure sustainable economic growth. This work provides a theoretical basis for understanding the role of advanced technologies, including artificial intelligence, in addressing climate-related economic challenges.

Institutional studies further emphasize the strategic importance of digital technologies in sustainability transitions. The International Energy Agency (IEA, 2017) identifies digitalization and AI-based solutions as critical tools for optimizing energy systems, improving electricity demand forecasting, and facilitating the integration of renewable energy sources. According to the IEA, intelligent energy management systems contribute to increased energy efficiency and reduced carbon emissions, reinforcing the role of AI in achieving climate and energy policy objectives. Similarly, the International Transport Forum (ITF, 2017) highlights the potential of AI-driven transport systems to reduce congestion, fuel consumption, and emissions in urban environments. The report argues that shared autonomous vehicles and intelligent traffic management systems can significantly improve urban mobility while lowering environmental impacts, positioning artificial intelligence as a key component of sustainable transport development.

In the agricultural sector, the Food and Agriculture Organization (FAO, 2017) stresses that technological innovation is essential for meeting global food demand while minimizing environmental pressure. AI-enabled precision agriculture allows for the optimized use of water, fertilizers, and land resources, thereby increasing productivity and reducing ecological damage. These conclusions are reinforced by the FAO's Global Forest Resources Assessment (2020), which demonstrates the growing role of artificial intelligence and remote sensing technologies in monitoring forest conditions, detecting illegal deforestation, and supporting sustainable forest management. Climate science literature further supports the relevance of artificial intelligence in environmental analysis. The Intergovernmental Panel on Climate Change (IPCC, 2021) emphasizes the increasing application of machine learning and advanced data analytics in climate modelling and scenario forecasting. AI-based approaches enhance the accuracy of projections related to temperature change, precipitation patterns, and sea-level rise, thereby supporting evidence-based climate adaptation and mitigation strategies. Marine and environmental pollution is another area where AI technologies have demonstrated considerable potential. The United Nations Environment Programme (UNEP, 2021) highlights the use of artificial intelligence for monitoring marine litter and plastic pollution. According to UNEP, AI-assisted data analysis enables real-time tracking of pollution flows and improves the effectiveness of environmental protection policies at regional and global levels. Academic research complements these institutional perspectives by offering critical and analytical insights. Hutchins (2019) argues that artificial intelligence strengthens environmental protection mechanisms through automated monitoring systems, early-warning technologies, and improved enforcement of environmental regulations. At the same time, Hao (2021) draws attention to the dual nature of AI, emphasizing its capacity to support sustainability goals while also raising concerns regarding the energy intensity and environmental footprint of large-scale computational systems. Purdy (2020) positions artificial intelligence as a strategic enabler of sustainable development, particularly in the context of achieving the United Nations Sustainable Development Goals. The author highlights that AI-driven solutions can address complex global challenges such as climate change, clean energy access, and responsible resource consumption, provided that ethical considerations and governance frameworks are adequately addressed. From a resource management perspective, Wang et al. (2020) demonstrate that machine learning techniques significantly improve water resource forecasting and allocation efficiency. Their findings indicate that AI-based models enhance resilience in water management systems, which is especially important under conditions of climate variability and increasing water scarcity.

3. Objectives of the Study

1. To examine the role of artificial intelligence (AI) in promoting sustainable economic development and environmental protection.
2. To analyze the application of AI technologies in key sectors such as energy system optimization, resource management, environmental monitoring, carbon emission reduction, and sustainable agriculture.
3. To evaluate how AI improves decision-making efficiency and supports the development of a green and sustainable economy.

4. To identify the environmental and economic benefits of integrating AI into modern economic systems.

5. To explore the challenges and requirements for the effective implementation of AI, including regulatory frameworks, data accessibility, and social responsibility.

6. To contribute to the existing academic discussion on digital transformation, sustainability, and environmentally responsible economic development.

7. To provide recommendations and insights that may assist policymakers, researchers, and practitioners in applying AI for sustainable development goals.

4. Methodology

This study employs a qualitative research methodology based on a comprehensive review and analysis of academic literature, international reports, policy documents, and case studies related to artificial intelligence (AI), sustainable development, and environmental protection. Secondary data sources from international organizations, research institutions, and scientific journals were examined to evaluate the role of AI technologies in supporting environmental sustainability and economic efficiency. The study focuses on identifying major application areas of AI, including energy optimization, carbon emission reduction, environmental monitoring, resource management, and sustainable agriculture. Comparative and analytical methods were used to interpret existing findings and assess the effectiveness of AI-driven solutions in achieving sustainable economic development.

5. Research Design

The research is designed as a descriptive and analytical study. It aims to describe the current applications of AI in environmental and economic systems and analyze their contribution to sustainable development. The descriptive component provides an overview of AI technologies and sustainability challenges, while the analytical component evaluates the opportunities, benefits, and limitations associated with AI implementation. The study also considers policy and institutional factors influencing the successful integration of AI into sustainable development strategies.

6. Research Approach

The study adopts a qualitative analytical approach. This approach allows for an in-depth understanding of the relationship between AI technologies and sustainability objectives through conceptual analysis and interpretation of existing research. The qualitative approach is appropriate because the study focuses on examining trends, policies, and practical applications rather than collecting numerical or experimental data. Through critical analysis of relevant literature and international experiences, the research identifies key patterns, challenges, and future prospects for the use of AI in promoting environmental sustainability and green economic growth.

7. Results and discussions

Efficient resource utilization is a cornerstone of sustainable development. Artificial intelligence contributes to resource optimization by enhancing forecasting accuracy, improving operational efficiency, and minimizing environmental externalities. In the energy sector, AI is widely used to optimize power generation and distribution, predict demand, and facilitate the integration of renewable energy sources. These applications reduce energy losses and contribute to decarbonisation efforts [1]. In agriculture, AI technologies support precision farming by optimizing water use, fertilizer application, and pest control. This leads to increased productivity while reducing soil degradation and water pollution [2]. In the transport sector, AI-driven traffic management systems and autonomous vehicle technologies contribute to lower emissions and improved urban mobility [3].

Environmental monitoring is critical for timely identification of ecological risks. AI technologies enable real-time analysis of vast datasets obtained from satellites, sensors, and remote monitoring systems. Machine learning algorithms are increasingly applied to climate modeling, allowing for more accurate predictions of temperature changes, precipitation patterns, and sea-level rise. These capabilities support the development of adaptive climate strategies [4]. Computer vision techniques are used to analyze satellite imagery for monitoring forest health, detecting illegal logging, and assessing wildfire

risks [5]. Similarly, AI tools assist in tracking marine pollution and plastic waste distribution in oceans [6].

Agriculture accounts for a significant share of environmental pressure, making sustainability in this sector particularly important. AI-based yield prediction models analyze climatic and soil data to improve decision-making related to crop selection and planting schedules. The use of AI-powered drones and robotic systems enables precise application of fertilizers and pesticides, reducing chemical overuse and environmental contamination. These technologies enhance productivity while minimizing the ecological footprint of agricultural activities.

8. Challenges and limitations

Despite its potential, the widespread adoption of AI in sustainability-oriented economic systems faces several challenges. These include limited access to high-quality data, high implementation costs, insufficient regulatory frameworks, and ethical concerns related to data privacy and employment displacement. Addressing these issues requires coordinated efforts involving governments, private sector stakeholders, and academic institutions to ensure responsible and inclusive AI deployment.

9. Conclusions

Artificial intelligence plays a critical role in advancing sustainable economic development and environmental protection. Its applications in energy management, resource optimization, environmental monitoring, and sustainable agriculture demonstrate significant potential to support the transition toward a green economy. However, the effective use of AI requires a comprehensive approach that combines technological innovation with appropriate regulatory mechanisms and societal engagement. Future research should focus on quantitative assessments of AI's environmental impact and the development of policy frameworks that ensure equitable and sustainable outcomes.

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