International Journal of
Technology and Systems
(IJTS)

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International Journal of Technology and Systems
ISSN 2518-881X (Online)
Vol.10, Issue 2, No.4, pp 55 – 62, 2025

www.iprjb.org

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Article History

Received 17th December 2024

Received in Revised Form 20th January 2025

Accepted 24th February 2025

How to cite in APA format:

Al-Kindy, S. (2025). The Dichotomous Potency of Artificial Intelligence (AI) on Polarising Social-Ecological Value Creation. *International Journal of Technology and Systems*, *10*(2), 55–62. https://doi.org/10.47604/ijts.3244

Abstract

Purpose: Artificial Intelligence (AI) plays a pivotal role in shaping social-ecological value, offering both opportunities and challenges in its application. Originating in the mid-20th century, AI has evolved significantly, finding widespread adoption across various sectors such as healthcare, finance, and environmental science. While AI holds promise in enhancing ecological monitoring, conservation efforts, and economic growth, it also presents risks such as job displacement, income inequality, and environmental degradation.

Methodology: To navigate these complexities, a holistic systematic review approach anchored on ecological modernisation theory is crucial, emphasising ethical considerations, regulatory frameworks, and sustainability principles.

Findings: Investment in education and workforce development is essential to equip individuals with the necessary skills for an AI-driven future. Collaboration between stakeholders, including governments, businesses, and civil society organisations, is paramount to address emerging challenges and promote responsible AI development and deployment.

Unique Contribution to Theory, Practice and Policy: By embracing innovation while safeguarding human welfare and environmental integrity, society can harness the transformative potential of AI to create a more equitable, resilient, and sustainable future.

Keywords: *Artificial Intelligence, Social-Ecological Value, Sustainability*

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INTRODUCTION

Artificial Intelligence (AI) has emerged as a transformative force shaping social-ecological value creation in today's digital economy. Initially conceptualized in the mid-20th century, AI has evolved with breakthroughs in machine learning, neural networks, and natural language processing, enabling widespread adoption across healthcare, finance, transportation, and environmental science. The Ecological Modernization Theory suggests that AI-driven technologies can contribute to environmental conservation and resource efficiency, thereby fostering social-ecological value (Spaargaren, 2000). This theory provides a framework for analyzing how AI can both create and destroy social-ecological value, emphasizing the need for sustainable resource management practices that minimize environmental impact while maximizing productivity.

As AI continues to redefine industries, it enhances environmental monitoring, optimizes resource management, and mitigates climate change impacts through predictive modeling and data-driven insights. However, the increasing reliance on AI also raises critical concerns regarding job displacement, ethical dilemmas, and environmental risks. Studies indicate that AI-driven automation has eliminated traditional jobs, contributing to economic polarization and workforce instability (Bélisle-Pipon, 2025). Additionally, AI systems often exhibit biases and ethical shortcomings, exacerbating social inequalities (Roseth, 2024). Furthermore, the environmental footprint of AI, including high energy consumption in training machine learning models, poses sustainability challenges (Kim et al., 2024). Given these dual outcomes, understanding AI's role in creating and destroying social-ecological value is essential for navigating both the opportunities and risks of an AI-driven future.

Despite AI's potential to drive social-ecological value, research on its negative consequences, including job displacement, ethical concerns, and environmental impacts, remains fragmented. While existing studies discuss AI's contributions to efficiency and sustainability, there is limited exploration of the trade-offs, particularly in how AI affects labor markets, ethical governance, and ecological sustainability. This study seeks to bridge this gap by providing a comprehensive analysis of AI's positive and negative implications within the ecological modernization framework. The study will benefit policymakers, by guiding ethical AI governance and sustainable digital strategies; business leaders, by helping them navigate AI-driven labor transformations; and environmental organizations, by providing insights into AI's ecological footprint. Additionally, academics and researchers will gain a theoretical foundation to explore AI's dual impact on society and the environment, ensuring sustainable technological progress.

Role of AI in Creating Social Ecological Value

AI has significantly contributed to environmental conservation by enhancing real-time monitoring and predictive analysis. AI-driven tools such as drones, satellite imagery, and sensors enable automated tracking of ecological patterns, assisting in the early detection of deforestation, pollution, and habitat degradation (Green, 2022). The United Nations Environment Program (UNEP) employs AI through the World Environment Situation Room (WESR) to aggregate and visualize environmental trends, improving long-term ecological planning (UNEP, 2023). In Zambia's Kafue National Park, AI supports anti-poaching efforts by establishing virtual fences, enhancing wildlife protection. Additionally, Brazil's Amazon Rainforest Conservation Program integrates AI-based satellite surveillance to combat illegal logging and deforestation, demonstrating AI's global impact on sustainability efforts. AI-based

climate modeling enhances the accuracy and efficiency of weather forecasting and climate predictions. Unlike traditional climate models, which rely on static, physics-based simulations, AI utilizes machine learning algorithms to process vast amounts of climate-related data (Jain et al., 2023). AI models can detect non-linear climate patterns, improving predictions of extreme weather events, sea-level rise, and biodiversity shifts (Materia et al., 2023). Research has shown that AI-driven climate models outperform conventional methods, especially in predicting localized climate changes and reducing computational costs (Li & Chung, 2024). In Kenya, organizations such as the Kenya Meteorological Department and Kenya Climate Innovation Center (KCIC) are leveraging AI for drought prediction and agricultural planning, enabling farmers to adapt to shifting climate conditions. Similar efforts are underway in India and China, where AI is improving monsoon forecasting and flood risk assessments, supporting proactive disaster management.

AI is transforming the energy sector by optimizing renewable energy generation, consumption, and distribution. AI-driven smart grids analyze weather data, energy demand patterns, and grid performance, allowing for efficient allocation of solar, wind, and hydroelectric resources (Green, 2022). In the United States, energy companies use AI-powered predictive analytics to optimize power plant designs and integrate renewable energy sources, reducing energy wastage. Similarly, in Germany's Energiewende initiative, AI enables real-time adjustments to renewable energy supply, ensuring a stable and efficient grid system. The adoption of AI in energy management minimizes carbon footprints, reinforcing its role in environmental sustainability. Businesses globally are leveraging AI to enhance efficiency, personalize customer experiences, and expand market reach. Amazon's AI-powered recommendation engines analyze customer preferences to boost sales and optimize supply chains (Dash et al., 2019). Similarly, Netflix and Twitter employ AI algorithms to curate personalized content, improving user engagement and retention. AI-driven market intelligence tools enable companies to predict consumer behavior and economic trends, allowing businesses to respond to market demands proactively.

Beyond commercial success, AI contributes to social-ecological value by reducing waste in production, optimizing supply chains, and improving energy efficiency in manufacturing (Vrontis et al., 2022). In the mining sector, AI enhances resource extraction efficiency while minimizing environmental damage, as seen in Australia's BHP Billiton's AI-driven mineral exploration programs (Mining Review Africa, 2024). In Kenya, AI has the potential to control rising public debt, stabilize oil prices, and mitigate unemployment, further reinforcing economic resilience (Mayaka, 2023).

Role of AI in Destroying Social Ecological Value

AI-driven automation is significantly impacting employment, particularly in industries reliant on manual labor. Empirical studies show that automation-related job displacement is affecting both developed and developing economies, with an estimated 14% of jobs worldwide at high risk of automation (Butt, 2024). In Kenya's agriculture sector, AI-driven precision farming, robotic harvesting, and automated irrigation systems are replacing traditional labor-intensive methods. Companies like SunCulture, which produces solar-powered irrigation systems with AI algorithms, improve efficiency but reduce the demand for farm laborers (Kroppf et al., 2023). Similarly, the manufacturing sector has experienced worker displacement due to robotic automation and AI-driven logistics systems. Companies such as Twiga Foods, which utilize AI-powered supply chain management systems, have streamlined distribution processes,

reducing the need for manual labor in transportation and inventory management (Ozor et al., 2023). A study by Dosz (2024) highlights that automation disproportionately affects low-skilled workers, making workforce reskilling and government intervention essential to mitigate economic restructuring.

AI has exacerbated the skills gap, as demand for AI-related expertise, including data analytics, machine learning, and programming, continues to rise. The World Economic Forum (2022) predicts that by 2025, 50% of all employees will need reskilling due to technological advancements. In Kenya, companies such as Cellulant, a leading fintech firm, require data scientists and AI engineers to develop digital finance solutions, yet there is a shortage of professionals with these technical skills (Korinek et al., 2021). Similarly, the healthcare sector, with its growing use of AI-powered diagnostics, telemedicine, and health informatics, faces a shortage of trained professionals proficient in digital health solutions. Without investments in AI-specific education and vocational training programs, the skills gap will continue to hinder AI adoption in Kenya's economy. However, ongoing efforts such as the Ajira Digital program and the Kenya AI and Robotics Society are working to bridge the gap by providing AI-related training and capacity-building initiatives.

While AI creates new employment opportunities, it also worsens income inequality, as technological benefits are concentrated among highly skilled individuals and large corporations. High-paying AI-related jobs are largely available to those with specialized education, leaving low-skilled workers at risk of job loss in traditional sectors (Robinson et al., 2015). Large corporations such as Google, Amazon, and Microsoft dominate the AI industry, controlling significant market shares in AI-driven products and services, consolidating wealth and economic power (Naude, 2021). Empirical research by Manning (2024) found that AI adoption has widened the wage gap in the U.S. job market, where high-tech professionals saw a 20% wage increase, while wages in manual labor sectors stagnated. In Kenya, the lack of inclusive AI adoption policies risks deepening social inequalities, necessitating policy interventions to promote equitable AI-driven economic opportunities.

AI-driven misinformation campaigns pose a significant risk to democratic institutions and public trust. Deepfake technology, powered by advanced AI algorithms, can create highly realistic fabricated content, making it difficult for individuals to distinguish fact from fiction (ADF, 2024). During the COVID-19 pandemic, AI-generated misinformation spread false narratives about the virus's origins, treatments, and transmission, undermining trust in health institutions (UNESCO, 2020). Similarly, in Kenya, AI-driven misinformation has manipulated public opinion during elections, fueling social divisions and political instability. In response, social media platforms and fact-checking organizations are increasingly deploying AI-based tools to detect and counteract fake news. However, regulatory frameworks must be strengthened to mitigate AI-driven disinformation effectively.

The increasing dependence on AI-driven systems is eroding traditional knowledge systems and human problem-solving skills, reducing societal resilience. Overreliance on AI-based climate modeling and disaster response can lead to neglect of traditional, community-based adaptation strategies (Afroogh et al., 2023). For example, while AI-powered ecological monitoring tools enhance environmental conservation, their dominance risks marginalizing indigenous knowledge that has sustained ecosystems for generations (Nderu et al., n.d.). In Kenya, local farming communities have historically relied on indigenous weather prediction techniques, but increased dependence on AI-driven forecasts has led to reduced engagement with traditional

knowledge, potentially weakening community preparedness for climate-related disasters. A balanced integration of AI and indigenous knowledge systems is crucial for sustainable environmental management and long-term resilience.

Future Prospects

Looking forward, the future of AI holds both promise and challenges in shaping social-ecological value. In terms of creating value, AI is expected to continue advancing environmental monitoring and conservation efforts, with increased emphasis on predictive analytics and real-time data processing. AI-driven climate models are anticipated to become more accurate and sophisticated, enabling better predictions of climate change impacts and facilitating more effective policy interventions to mitigate environmental risks. Researchers suggest that a synergy between AI and ecology could strengthen AI and help solve complex global challenges such as disease outbreaks, loss of biodiversity, and climate change impacts (Cary Institute of Ecosystem Studies, 2023). Additionally, AI technologies are poised to revolutionise energy optimisation and distribution with advancements in innovative grid systems, renewable energy integration, and demand-side management. These developments are expected to drive significant reductions in greenhouse gas emissions and promote sustainable energy practices worldwide.

Moreover, AI is projected to be pivotal in fostering economic growth and job creation, particularly in emerging industries such as AI research and development, data analytics, and digital transformation. According to Talmage-Rostron (2023) from McKinsey Global Institute, AI can deliver additional global economic activity of around $13 trillion by 2030, which is about 16% higher cumulative GDP than today. As businesses continue to leverage AI for process automation, predictive analytics, and customer personalisation, new opportunities for innovation and entrepreneurship are expected to emerge, creating high-skilled, high-paying jobs in various sectors. Additionally, AI-driven technologies are anticipated to enhance productivity, efficiency, and competitiveness across industries, contributing to overall economic prosperity and development.

However, alongside these opportunities, there are also challenges and risks associated with the widespread adoption of AI. Job displacement from automation and AI-driven technologies will likely continue, particularly in sectors reliant on manual labour. As AI becomes more integrated into everyday life, there is a pressing need to address the widening skills gap and ensure equitable access to education and training opportunities to prepare the workforce for the jobs of the future. Moreover, concerns about privacy, data security, and algorithmic bias are expected to grow, necessitating robust regulatory frameworks and ethical guidelines to safeguard against potential harms and ensure responsible AI development and deployment.

On the social-ecological value concept, AI has the potential to foster greater inclusivity, diversity, and accessibility, particularly in areas such as healthcare, education, and social services. AI-driven innovations in telemedicine, personalised learning, and assistive technologies are expected to improve access to quality healthcare and education, particularly in underserved communities. Additionally, AI-powered platforms for social networking, content moderation, and community engagement have the potential to foster greater connectivity, collaboration, and social cohesion in an increasingly digital world. By addressing the challenges and risks associated with AI and harnessing its transformative potential responsibly, we can create a future where AI contributes to a more equitable, resilient, and sustainable society for generations to come.

CONCLUSION AND RECOMMENDATIONS

In summary, the role of AI in shaping social-ecological value creation is multifaceted, with both opportunities and challenges arising from its widespread adoption. While AI has tremendous potential to enhance environmental monitoring, conservation efforts, economic growth, and social value creation, it poses risks such as job displacement, income inequality, and ecological degradation. Therefore, to maximise the benefits of AI while mitigating its negative impacts, users should consider;

1. Adopting a holistic approach prioritising ethical considerations, regulatory frameworks, and sustainability principles.
2. Investment in education, training, and workforce development is essential to ensure individuals have the skills and knowledge to thrive in an AI-driven world.
3. Moreover, collaboration between governments, businesses, civil society organisations, and academia is essential to address emerging challenges and promote responsible AI development and deployment.
4. By embracing innovation while safeguarding human welfare and environmental integrity, we can create a future in which AI positively creates social-ecological value and sustainable development.

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