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Artificial Intelligence and Sustainability:
Innovations in Business and Managerial Practices

Zurich, 2025

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We are delighted to present this research monograph titled Artificial Intelligence and Sustainability: Innovations in Business and Managerial Practices, a timely contribution to the evolving discourse at the intersection of technology and sustainability. In an era where artificial intelligence continues to redefine business landscapes and sustainability becomes a pressing global priority, this monograph offers a platform to foster critical discussions and innovative ideas. We are grateful to the contributing researchers and scholars whose rigorous work and diverse perspectives have enriched this publication. Our sincere appreciation also goes to the editorial team and institutional partners at SBS Swiss Business School for their unwavering support in bringing this vision to life. It is our hope that this monograph serves as a catalyst for further exploration and meaningful dialogue in this vital field.

PREFACE

Prof. Dr. Bert Wolfs
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1. Introduction

Artificial Intelligence (AI) has transformed contemporary business practices, facilitating efficiency, innovation, and decision-making advancements. Beyond these traditional applications, AI is increasingly recognized as a critical enabler of sustainability, driving organizations to adopt practices that align economic goals with environmental and social responsibilities. This paper/chapter explores how AI innovations are leveraged to advance sustainability within business and managerial practices, focusing on their implications, benefits, and challenges.

2. The Role of AI in Promoting Sustainability

AI technologies offer numerous opportunities to address global sustainability challenges. From optimizing resource usage to enhancing supply chain transparency, AI is a critical tool for businesses aiming to reduce their environmental footprint while maintaining profitability.

1. **AI for Energy Efficiency** Energy consumption is a major contributor to climate change, and businesses are increasingly using AI to monitor and optimize energy usage. For instance, Google's DeepMind AI reduced the energy consumption of its data centers by 15% by optimizing cooling systems (Evans, 2019). Similarly, smart grids powered by AI can predict energy demand, adjust supply accordingly, and integrate renewable energy sources efficiently (Zhou et al., 2020).

2. **Sustainable Supply Chain Management** AI-powered tools improve supply chain efficiency and sustainability by offering real-time monitoring, predictive analytics, and automation. These tools enable businesses to identify inefficiencies, reduce waste, and ensure ethical sourcing. For example, blockchain integrated with AI has been used to track the origin of raw materials, ensuring compliance with environmental and social standards (Saberi et al., 2019).

3. **Waste Management and Recycling** AI also plays a significant role in waste management. Machine learning algorithms can sort recyclable materials more accurately, reducing contamination in recycling streams. Additionally, predictive analytics helps municipalities and companies forecast waste generation patterns and develop more efficient collection strategies (Song et al., 2021).

3. AI-Driven Innovations in Managerial Practices

AI's influence extends beyond operational processes to managerial decision-making, fostering a culture of sustainability across organizations.

1. **Sustainable Decision-Making** AI-powered decision support systems provide managers with insights that prioritize sustainability alongside financial performance. These systems utilize data from various sources, including IoT sensors, market trends, and environmental indicators, to recommend actions that minimize environmental impact. For instance, AI tools can identify energy-intensive processes and suggest more sustainable alternatives (Jabbour et al., 2020).

2. **Employee Engagement and Training** AI is also used to enhance employee engagement in sustainability initiatives. Gamification platforms driven by AI can encourage employees to adopt eco-friendly practices by offering incentives and personalized recommendations. Additionally, AI-powered training modules provide customized learning experiences, equipping employees with the skills to implement sustainable practices effectively (Bennett & Lemoine, 2021).

4. Case Studies of AI-driven Sustainability

Several organizations exemplify the successful integration of AI and sustainability in their business and managerial practices.

- **Siemens and Energy Efficiency** Siemens has adopted AI-driven solutions to enhance energy efficiency across its manufacturing facilities. By deploying digital twins—virtual replicas of physical assets powered by AI—Siemens has significantly reduced energy consumption and maintenance costs (Schmidt et al., 2022).

- **Unilever and Supply Chain Transparency** Unilever utilizes AI to monitor its supply chain to ensure compliance with sustainability standards. By integrating AI with satellite imagery and blockchain, the company ensures that raw materials such as palm oil are sourced responsibly, minimizing environmental degradation and promoting fair labor practices (Sustainable Brands, 2021).

- **Waste Management and Smart Cities** in Copenhagen have implemented AI-driven waste management systems to optimize collection routes and reduce fuel consumption. These systems use machine learning algorithms to analyze waste generation patterns and predict optimal collection schedules, contributing to the city's goal of becoming carbon neutral by 2025 (European Commission, 2020).

5. Challenges and Ethical Considerations

Despite its potential, integrating AI into sustainability practices presents several challenges and ethical considerations.

- **Data Privacy and Security** The implementation of AI relies heavily on data collection and analysis. However, concerns regarding data privacy and security can hinder its adoption. Businesses must ensure compliance with regulations such as the General Data Protection Regulation (GDPR) to protect sensitive information (Voigt & Von dem Bussche, 2017).

- **Bias in AI Algorithms** AI algorithms can perpetuate biases if not designed and trained responsibly. For instance, biased algorithms may prioritize cost savings over environmental benefits, undermining sustainability goals. Developers must adopt ethical AI frameworks to ensure fairness and transparency (Floridi et al., 2018).

- **High Initial Costs** Adopting AI technologies often requires significant initial investments, which can be a barrier for small and medium-sized enterprises (SMEs). Governments and financial institutions can address this challenge by providing subsidies and incentives for sustainable innovation (Kamble et al., 2021).

6. Future Directions and Recommendations

To maximize the potential of AI in advancing sustainability, businesses and policymakers should consider the following strategies:

- **Fostering Collaboration:** Collaboration among stakeholders, including businesses, governments, and academia, is essential for scaling AI-driven sustainability initiatives. Public-private partnerships can facilitate the development of shared platforms and standards, promoting interoperability and innovation (OECD, 2019).

- **Investing in Research and Development:** Continuous investment in AI research and development is crucial for overcoming technical and ethical challenges. Areas such as explainable AI (XAI) and green AI—AI designed to minimize energy consumption—hold significant promise for advancing sustainability goals (Schwartz et al., 2020).

- **Promoting Education and Awareness:** Educational initiatives highlighting AI's role in sustainability can drive broader adoption. Business schools and professional training programs should integrate sustainability-focused AI modules into their curricula to prepare future leaders for future challenges (Bocken et al., 2020).

7. Conclusion

AI represents a transformative force in advancing sustainability within business and managerial practices. By optimizing energy efficiency, enhancing supply chain transparency, and supporting sustainable decision-making, AI enables organizations to align profitability with environmental and social responsibilities. However, realizing its full potential requires addressing challenges related to data privacy, algorithmic bias, and high initial costs. Through collaboration, investment in research, and education, businesses can harness AI to drive sustainable innovation and contribute to a more equitable and resilient future.

8. References

Bennett, N., & Lemoine, G. J. (2021). What VUCA means for you. *Harvard Business Review*, 99(1), 27-33.

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2020). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65, 42-56. https://doi.org/10.1016/j.jclepro.2013.11.039

Evans, D. (2019). AI and energy efficiency: How artificial intelligence can save power. *Nature Climate Change*, 9(4), 250–252. https://doi.org/10.1038/s41558-019-0438-7

Floridi, L., Cowls, J., Beltrametti, M., Chatila, R., Chazerand, P., Dignum, V., & Vayena, E. (2018). AI4People—An ethical framework for a good AI society: Opportunities, risks, principles, and recommendations. *Minds and Machines*, 28(4), 689-707. https://doi.org/10.1007/s11023-018-9482-5

Jabbour, C. J. C., Sarkis, J., de Sousa Jabbour, A. B. L., Renwick, D. W. S., Singh, S. K., Grebinevych, O., & Teixeira, A. A. (2020). Who is in charge now? The frontiers of environmental and social responsibility. *Sustainable Development*, 28(3), 359–372. https://doi.org/10.1002/sd.2041

Kamble, S. S., Gunasekaran, A., & Sharma, R. (2021). Sustainable industry 4.0 framework: A systematic literature review identifying the current trends and future perspectives. *Process Safety and Environmental Protection*, 149, 282-295. https://doi.org/10.1016/j.psep.2021.02.025

Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. *International Journal of Production Research*, 57(7), 2117-2135. https://doi.org/10.1080/00207543.2018.1533261

Schmidt, J., Kolbe, L. M., & Yoo, Y. (2022). Digital twins and the future of manufacturing: A strategic perspective. *Journal of Business Research*, 150, 165-175. https://doi.org/10.1016/j.jbusres.2022.01.015

Schwartz, R., Dodge, J., Smith, N. A., & Etzioni, O. (2020). Green AI. *Communications of the ACM*, 63(12), 54–63. https://doi.org/10.1145/3381831

Song, M., Wang, S., & Jiang, L. (2021). Waste management and smart cities: A big data perspective. *Journal of Cleaner Production*, 312, 127869. https://doi.org/10.1016/j.jclepro.2021.127869

Sustainable Brands. (2021). How Unilever is advancing sustainable business through AI. Retrieved from https://www.sustainablebrands.com

Voigt, P., & Von dem Bussche, A. (2017). The EU General Data Protection Regulation (GDPR): A practical guide. *Springer International Publishing*. https://doi.org/10.1007/978-3-319-57959-7

TABLE OF CONTENTS

SBS Research Monograph
Chapter 1: Harnessing Artificial Intelligence for Sustainable Finance: Innovations, Challenges, and Opportunities
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Chapter 1 - Harnessing Artificial Intelligence for Sustainable Finance: Innovations, Challenges, and Opportunities

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Abstract

This Artificial Intelligence (AI) is increasingly transforming the landscape of sustainable finance, offering innovative solutions for Environmental, Social, and Governance (ESG) investments, financial risk assessment, and responsible decision-making. This chapter presents a qualitative analysis of 56 recent scientific articles from the EBSCO host database, examining the intersection of AI and sustainable finance through an automated coding approach using Iramuteq. The analysis identifies five thematic categories: Innovation, AI Models, Learning, Environment, and Relationship, forming the IRAML Model (Innovation-Relationship-AI Model-Learning). The results highlight that Innovation is the primary driver of AI adoption, particularly in digital finance and ESG applications. The Relationship category acts as a critical bridge, linking AI models and learning to financial sustainability outcomes. However, the study also reveals that AI models and financial learning remain largely independent, suggesting a gap in integrating AI-driven financial decision-making with broader sustainability goals. This chapter proposes strategic recommendations to enhance AI's transparency, foster human-AI collaboration, and strengthen regulatory frameworks in sustainable finance. The findings contribute to ongoing discussions on AI-driven financial innovation, emphasizing the need for relationship-based frameworks to align AI applications with sustainable investment strategies.

Keywords: *Artificial Intelligence, Sustainable Finance, ESG Investments, AI Models, Financial Innovation, Machine Learning, Responsible Investing, Relationship-Based Finance, AI Governance, IRAML Model;*

1.1 Introduction

In recent years, the financial industry has witnessed a paradigm shift towards sustainability, driven by increasing awareness of environmental, social, and governance (ESG) issues. This transition is not only a response to global challenges such as climate change but also a strategic move to mitigate risks and capitalize on new opportunities. Concurrently, Artificial Intelligence (AI) has emerged as a transformative force across various sectors, including finance. AI's ability to process vast amounts of data and uncover complex patterns offers unprecedented potential to enhance sustainable finance practices. By integrating AI into financial decision-making, institutions can more effectively assess ESG factors, manage risks, and identify sustainable investment opportunities (Briere et al., 2022).

The convergence of AI and sustainable finance presents a unique opportunity to address the limitations of traditional financial analysis. Traditional methods often struggle with the complexity and volume of ESG data, leading to challenges in accurately assessing sustainability performance. AI technologies, such as machine learning and natural language processing, can analyze unstructured data from diverse sources, providing deeper insights into companies' ESG practices. This capability is particularly relevant in detecting greenwashing and ensuring the credibility of sustainability claims (Briere et al., 2022). Moreover, AI can enhance predictive analytics, enabling investors to anticipate and respond to sustainability-related risks and opportunities more effectively (Giudici & Wu, 2025).

Despite the promising applications of AI in sustainable finance, existing research primarily focuses on technological capabilities, with limited exploration of the practical integration of AI into financial decision-making processes. Studies have highlighted AI's potential in ESG data analysis and risk assessment (Brière et al., 2022; Giudici & Wu, 2025), yet there is a paucity of research examining how financial institutions can systematically implement AI-driven tools to enhance sustainability outcomes. Additionally, concerns regarding data quality, algorithmic transparency, and ethical implications of AI applications in finance remain underexplored (Pavlidis, 2025). Addressing these gaps is essential to harness AI's full potential in promoting sustainable finance.

This study aims to investigate the integration of AI into sustainable finance, focusing on how AI-driven tools can enhance ESG assessment and investment decision-making. The primary research questions are:

1) How can AI technologies improve the accuracy and efficiency of ESG data analysis?

2) What are the challenges and ethical considerations associated with implementing AI in sustainable finance?

By addressing these questions, the study seeks to contribute to both theoretical understanding and practical applications, offering insights for financial institutions aiming to adopt AI for sustainability purposes.

This research employs a qualitative approach, conducting a systematic review of peer-reviewed literature published in 2025. The study analyzes existing findings on AI applications in sustainable finance, emphasizing ESG data analysis, risk assessment, and ethical considerations. Additionally, the research examines case studies of financial institutions that have successfully integrated AI into their sustainability practices, providing practical insights and identifying best practices.

The paper is structured as follows: Section 2: Explores the role of AI in enhancing ESG data analysis and investment decision-making. Section 3: Discusses the challenges and ethical considerations of implementing AI in sustainable finance. Section 4: Presents case studies of AI integration in financial institutions, highlighting best practices and lessons learned. Section 5: Provides recommendations for policymakers and practitioners on effectively leveraging AI for sustainable finance. Section 6: Concludes with a summary of findings and suggestions for future research directions.

1.2 Literature Review

1.2.1 Introduction to Harnessing Artificial Intelligence for Sustainable Finance

The integration of Artificial Intelligence (AI) into sustainable finance represents a transformative shift in how financial institutions approach investment and risk management. This topic is increasingly relevant in the context of global challenges such as climate change, resource depletion, and social inequality (Fandella et al., 2023). Historically, the financial sector has often prioritized short-term gains over long-term sustainability. However, the advent of AI technologies in the 2010s has enabled a paradigm shift toward more responsible investment strategies that consider environmental, social, and governance (ESG) factors (Thanyawatpornkul, 2024).

AI encompasses a range of technologies, including machine learning, natural language processing, and predictive analytics, which can analyze vast datasets to uncover patterns and insights that human analysts might overlook (Anser et al., 2021). This capability is particularly valuable in sustainable finance, where the complexity and volume of data related to ESG factors can be overwhelming. For instance, AI can be employed to assess the environmental impact of potential investments, evaluate corporate sustainability practices, and identify emerging trends in consumer behavior related to sustainability (Ramzani et al., 2024).

The importance of this research topic cannot be overstated. As investors increasingly seek to align their portfolios with sustainability goals, understanding how AI can facilitate this alignment is critical. This literature review will explore key themes, including the role of AI in enhancing green investments, the challenges of data quality and algorithmic transparency, and the potential for AI to improve climate risk modeling. By synthesizing existing research, this review aims to provide a comprehensive overview of the current state of knowledge in this dynamic field, highlighting both the innovations and challenges that characterize the intersection of AI and sustainable finance.

1.2.2 Innovations and Challenges in AI-Driven Sustainable Finance

The application of AI in sustainable finance can be dissected into several focused themes: environmental risk assessment, green investment analysis, and climate change modeling. Each of these areas presents unique innovations and challenges that warrant detailed examination.

Environmental Risk Assessment

AI technologies enable financial institutions to evaluate the environmental risks associated

with their investments more effectively. Machine learning algorithms can analyze historical data on environmental impacts, regulatory changes, and market trends to predict future risks. For example, AI can assess the potential impact of climate change on asset valuations, allowing investors to make more informed decisions (Taleb & Kadhum, 2024). But, the reliance on algorithmic decision-making raises concerns about transparency and accountability. The "black-box" nature of many AI models can obscure the rationale behind specific investment recommendations, leading to skepticism among stakeholders regarding the reliability of these assessments (Petković, 2023a).

Green Investment Analysis

AI can significantly enhance the identification and evaluation of green investment opportunities. By analyzing vast datasets, AI can uncover hidden patterns that indicate the sustainability of various projects or companies. This capability allows investors to identify high-potential green investments that align with their sustainability goals (Petković, 2023b). Moreover, challenges persist, particularly regarding the quality and consistency of ESG data. Many organizations report their sustainability metrics, but the lack of standardization can lead to discrepancies in how these metrics are interpreted (Song et al., 2025). Furthermore, the effectiveness of AI in this area is often contingent on the availability of high-quality data, which may not be uniformly accessible across different markets.

Climate Change Modeling

AI's predictive capabilities are also being harnessed to model the potential impacts of climate change on financial markets. By simulating various climate scenarios, AI can help financial institutions understand the potential risks and opportunities associated with climate change. This modeling can inform investment strategies and risk management practices, enabling institutions to adapt to a rapidly changing environment (Jabeen et al., 2019). However, the methodologies used in climate modeling can vary significantly, leading to inconsistencies in findings across studies (Thanyawatpornkul, 2024). This section will delve deeper into these themes, comparing various studies and highlighting the inconsistencies and underexplored areas within the existing body of research.

1.2.3 Limitations and Future Directions in AI and Sustainable Finance Research

Despite the promising advancements in AI applications for sustainable finance, several limitations persist in the current literature. One of the primary challenges is the conflicting findings regarding the effectiveness of AI methodologies. Some studies suggest that AI can significantly enhance investment decision-making processes, while others raise concerns about the reliability of AI-driven insights (Umer Nadeem & Da Chen, 2024). This inconsistency highlights the need for more rigorous evaluation of AI applications in diverse contexts.

Moreover, many studies have focused primarily on developed economies, leaving significant gaps in understanding how AI can be harnessed in developing regions. The unique challenges faced by these markets, such as infrastructural limitations and regulatory hurdles, warrant further investigation. For instance, while AI has the potential to drive sustainable finance in emerging markets, the lack of technological infrastructure may hinder its adoption (Patoucha & Gareiou, 2024)worldwide. Artificial Intelligence (AI.

This review critically evaluates the methodologies employed in previous studies, noting that many rely on traditional statistical approaches that may not adequately capture the complexities of AI-driven solutions. Addressing these gaps, this research aims to propose a novel framework that integrates AI with sustainable finance practices, emphasizing the importance of transparency and accountability in AI models. By doing so, it seeks to contribute to the field by providing insights into how AI can be effectively utilized to achieve sustainable development goals.

In conclusion, the literature on harnessing AI for sustainable finance is rich with potential yet fraught with challenges. Continued research is necessary to explore the limitations and opportunities presented by AI in this domain, ensuring that financial institutions can leverage these technologies responsibly and effectively.

1.3 Research Methodology

This study employs a qualitative research approach to analyze the role of Artificial Intelligence (AI) in sustainable finance, focusing on ESG investment strategies, environmental risk assessment, and climate change modeling. The research methodology is structured into two key sub-sections: qualitative analysis through textual content analysis and the use of Iramuteq qualitative software for data processing and thematic extraction.

1.3.1 Qualitative Analysis by Textual Content Analysis

A textual content analysis was conducted to examine how AI-driven technologies influence sustainable finance decision-making. Textual analysis is a well-established qualitative research method that enables researchers to extract meaningful patterns, themes, and trends from unstructured textual data (Krippendorff, 2019). This approach is particularly relevant for this study, as it allows for an in-depth interpretation of narratives, concepts, and discourses related to AI and sustainable finance, drawn from academic literature.

1.3.2 Data Collection, Processing and Coding

The dataset for this research comprises 56 peer-reviewed scientific articles obtained from the EBSCOhost database, covering studies published between January and March 2025. The selection criteria included:

- Publications related to “Artificial Intelligence” and “Sustainable Finance”.
- Studies focusing on AI applications in ESG analysis, climate risk modeling, and ethical AI frameworks.
- Research published in high-impact peer-reviewed journals to ensure reliability and academic rigor.

To systematically analyze the data, an automated coding approach was implemented. This involved:

- Identifying frequently occurring key terms related to AI and sustainable finance (e.g., “machine learning,” “green investment,” “ESG analytics”).
- Grouping terms into thematic clusters based on conceptual relevance.
- Performing contextual analysis to examine how AI is discussed in the context of sustainable finance.

In the context of this study, Iramuteq was utilized to identify key thematic categories and analyze the relationships between AI, sustainable finance, and ESG performance metrics. Iramuteq (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires) is an open-source textual analysis software that facilitates lexical and statistical processing of qualitative data.

1.4 Findings

This study analyzed a corpus of 56 scientific articles retrieved from the EBSCO host database since January 1, 2025. The research focused on the intersection of artificial intelligence (AI) and sustainable finance, employing an automated coding approach to extract meaningful themes and relationships. The analysis identified five key thematic categories, each representing a critical aspect of AI-driven sustainable finance.

1.4.1 Categorization of Themes

The results from Iramuteq revealed five distinct clusters, as shown in Table 1, each associated with a specific percentage of the analyzed forms:

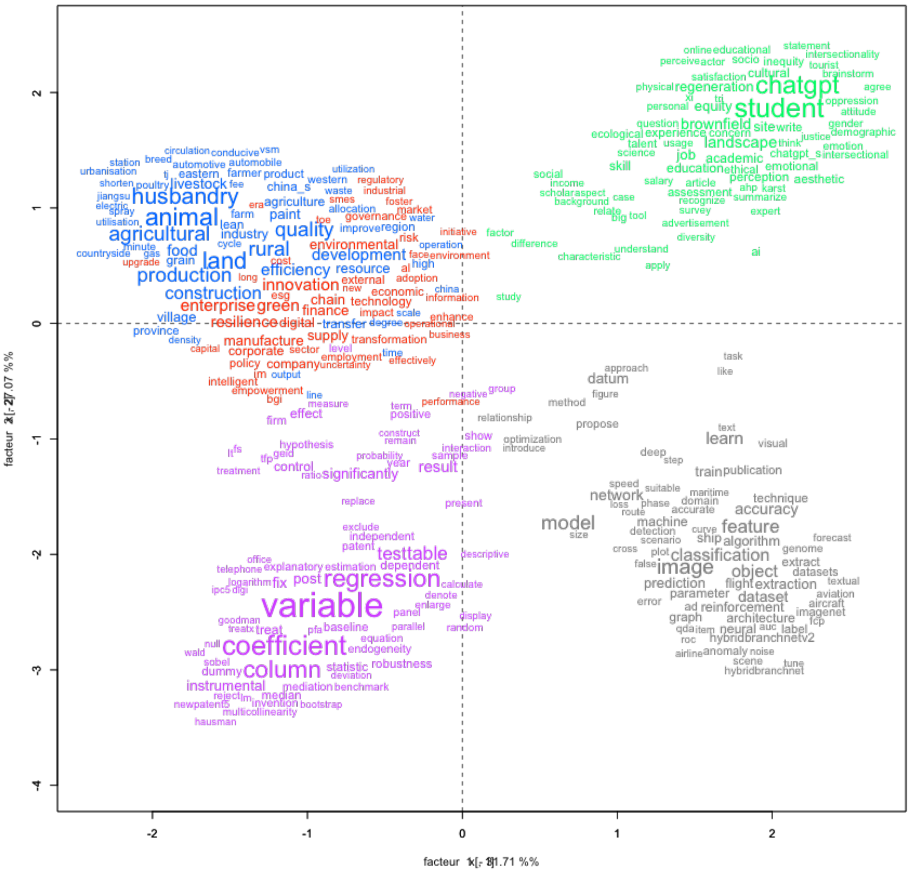

Figure 1: Factorial analysis

The factorial analysis results, as visualized in Figure 1, indicate a noteworthy connection between Innovation (Category 1) and Environment (Category 4). This suggests that advancements in AI-driven sustainable finance are closely tied to environmental considerations, where innovative AI solutions are increasingly deployed to tackle sustainability challenges.

Conversely, the remaining three categories—AI Model (Category 2), Learning (Category 3), and Relationship (Category 5)—are shown to be independent and separate from each other. This finding implies that while AI modeling and learning initiatives are critical to sustainable finance, they function in distinct capacities rather than forming an interconnected system.

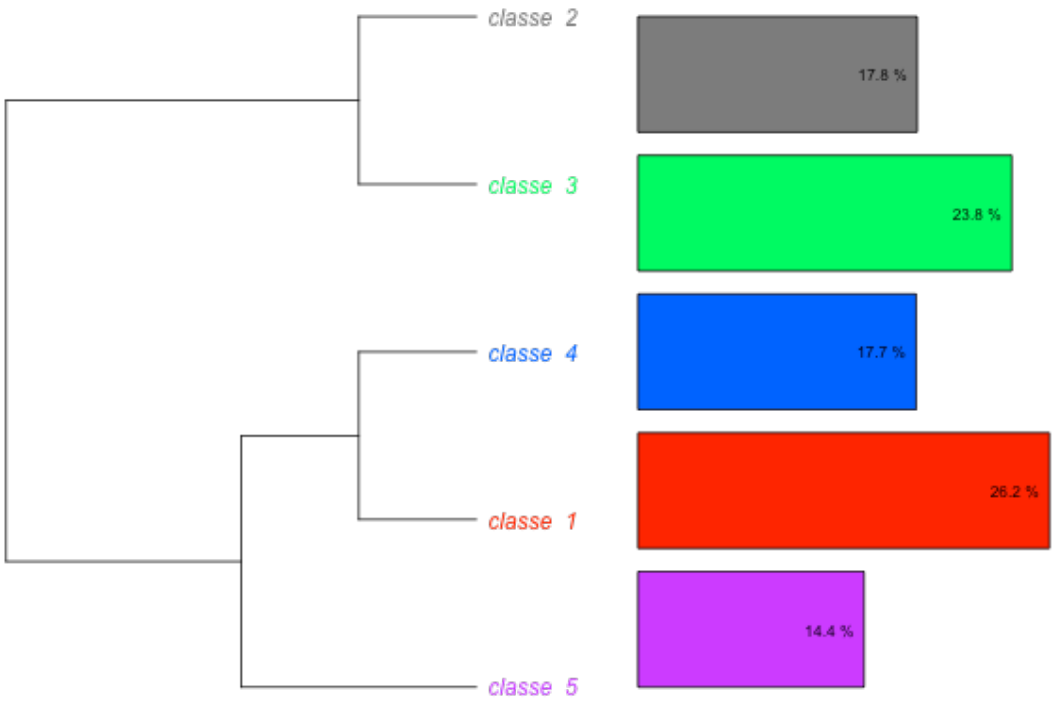

Figure 2: Dendrogram

Table 1: Categories explanation

Category	Color Code	Name	% of Forms Analyzed
Category 1	Red	Innovation	26.23%
Category 2	Gray	AI Model	17.8%
Category 3	Green	Learning	23.83%
Category 4	Blue	Environment	17.73%
Category 5	Pink	Relationship	14.41%

Each category encapsulates key terms and concepts extracted from the articles:

- Category 1 (Innovation - 26.23%): Associated with terms such as *digital, finance, chain, technology, transformation, impact*, indicating AI's role in driving technological advancements in sustainable finance.

- Category 2 (AI Model - 17.8%): Includes terms like *algorithm, object, dataset, classification, prediction, train, machine*, highlighting the core technical aspects of AI-driven financial modeling.

- Category 3 (Learning - 23.83%): Encompasses *education, upskilling, skills, experience, ethical, talents, science*, pointing to the necessity for AI literacy, ethical training, and workforce adaptation.

- Category 4 (Environment - 17.73%): Features terms such as *land, agricultural, development, quality, food, air, resource, product*, reinforcing AI's applications in sustainable resource management.

- Category 5 (Relationship - 14.41%): Includes *correlation, link, instrumental, connection, strength, effect, control, dependence*, signifying the importance of AI's impact on financial and environmental linkages.

1.4.2 Implications of Findings

These findings present several key takeaways for AI's role in sustainable finance:

1. Innovation is the Driving Force: The largest cluster (26.23%) suggests that AI is primarily viewed as a tool for transformation, emphasizing digitalization and fintech integration in sustainable finance.

2. AI Models Are Technically Isolated: Despite the increasing adoption of AI in finance, the analysis indicates that AI models operate separately from direct environmental impact or learning frameworks.

3. Education and Skill Development are Essential: The presence of "Learning" as a significant category (23.83%) reinforces the need for upskilling in AI ethics, data literacy, and sustainable finance practices.

4. AI's Environmental Role is Expanding: The overlap between Innovation and Environment suggests that AI innovations are shaping green finance, carbon footprint tracking, and climate risk management.

5. Understanding Relationships is Underexplored: The relatively smaller size of the "Relationship" category (14.41%) indicates that while AI is recognized for its analytical capabilities, its ability to establish clear financial-sustainability linkages remains underdeveloped.

1.4.3 IRAML Model: Innovation-Relationship-AI Model-Learning

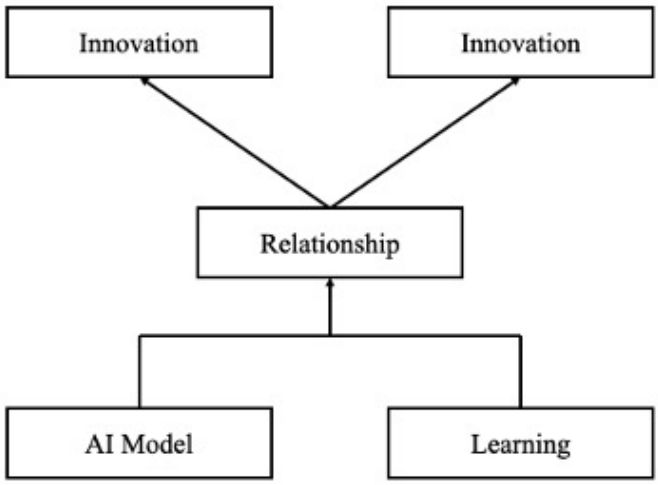

Figure 3: IRAML Model: Innovation-Relationship-AI Model-Learning

The acronym IRAML reflects the interconnected nature of AI-driven sustainable finance, emphasizing:

- Innovation as the starting point.
- Relationships as the structural link.
- AI models as the technical foundation.
- Learning as the essential human factor.

The model consists of five key components:

1. Innovation (Top-Level, Appears Twice)
    - Innovation appears at the top level twice, indicating that technological advancements drive AI adoption in sustainable finance.
    - This suggests two distinct types of innovations influencing financial sustainability:
        - Technological Innovation (e.g., AI-driven ESG scoring, predictive analytics).
        - Strategic Innovation (e.g., new financial models, AI-based green investment strategies).

2. Relationship (Middle-Level, Central Node)
    - The core of the model is "Relationship", which acts as a bridge between innovation and AI applications.
    - This suggests that AI's role in sustainable finance depends on how innovation connects with AI models and learning processes.
    - AI does not operate in isolation—it needs interconnected relationships across financial and environmental domains.

3. AI Model (Bottom-Left)
    - Represents the technical foundation of AI in finance.
    - Includes machine learning algorithms, data models, and automation used to optimize sustainable investments.
    - This component is structurally independent from innovation but is connected through relationships.

4. Learning (Bottom-Right)
    - Represents AI's role in skill development, education, and knowledge transfer in finance.
    - Includes upskilling professionals, AI ethics, and training for AI-driven ESG assessment.
    - Learning is separate from AI models but remains crucial for AI's broader adoption.

The IRAML Model (Innovation-Relationship-AI Model-Learning) provides a structured framework for understanding how Artificial Intelligence (AI) contributes to sustainable finance, particularly in ESG (Environmental, Social, and Governance) investment analysis, climate risk assessment, and financial decision-making. Below is a detailed explanation of how the model can be used in practice:

1. Application in Financial Institutions and Investment Decision-Making

The IRAML Model can be used by financial institutions, asset managers, and investors to optimize sustainable finance strategies.

- Innovation: AI-driven ESG analytics, green investment screening, and automated risk assessment allow financial institutions to innovate their portfolio management strategies by integrating sustainability considerations into traditional investment models.
- Relationship: AI enhances the relationship between financial markets and sustainability goals by bridging the gap between traditional finance metrics and ESG performance indicators. AI-powered tools provide a more precise understanding of the links between corporate sustainability actions and long-term financial performance.
- AI Model: Machine learning models help investors process and analyze unstructured ESG data, improving the accuracy and efficiency of sustainability assessments. AI also enhances predictive analytics, allowing investors to foresee sustainability risks and opportunities.
- Learning: Continuous AI-driven learning ensures that financial institutions keep up with evolving ESG regulations and sustainability trends. AI-driven insights adapt over time, refining investment strategies based on emerging environmental risks and regulatory changes.

2. Use in ESG Compliance and Regulatory Frameworks

Regulators and policymakers can use the IRAML Model to enhance ESG compliance, improve reporting accuracy, and develop AI-driven policy frameworks.

- Innovation: AI models help governments and regulatory agencies innovate regulatory mechanisms by using real-time sustainability data to track corporate compliance with ESG policies.
- Relationship: AI strengthens the relationship between corporate sustainability reports and regulatory requirements, ensuring that ESG disclosures are transparent, standardized, and fraud-resistant.
- AI Model: AI can detect greenwashing (false ESG claims) by analyzing company disclosures and comparing them with real-world environmental impact indicators (e.g., satellite data, carbon footprint reports).
- Learning: AI systems continuously learn from ESG regulatory updates, allowing companies to adjust their strategies and ensure ongoing compliance with evolving sustainability laws.

3. Application in Sustainable Banking and Fintech

Banks and fintech companies can use the IRAML Model to develop AI-powered green financial products, such as sustainable loans, carbon credit trading platforms, and climate risk-adjusted investment portfolios.

- Innovation: AI-powered digital banking platforms introduce sustainability-linked financial products that assess loan applicants based on climate risk exposure and ESG performance.
- Relationship: AI improves the connection between customers and financial institutions by promoting sustainability-focused lending models that reward businesses committed to ESG goals (e.g., lower interest rates for sustainable projects).
- AI Model: Advanced machine learning models allow banks to assess credit risks based on ESG performance metrics, ensuring more responsible lending practices.
- Learning: AI-powered banking solutions continuously update ESG risk parameters, allowing lenders to adapt their green finance strategies in real time.

4. Use in Corporate Sustainability and Risk Management

Corporations can adopt the IRAML Model to develop AI-driven sustainability strategies, ensuring better ESG performance and long-term financial resilience.

- Innovation: Companies can integrate AI-powered tools to track carbon emissions, optimize resource consumption, and improve supply chain sustainability.
- Relationship: AI enhances corporate ESG reporting transparency, strengthening relationships with stakeholders, investors, and regulators by providing data-driven sustainability insights.
- AI Model: AI helps companies identify financial risks associated with climate change, regulatory penalties, and ESG non-compliance, allowing proactive risk mitigation.
- Learning: AI-driven sustainability management platforms learn from real-time environmental and social impact data, helping corporations refine their ESG strategies over time.

5. Application in AI-Driven Sustainable Development Policies

Governments and international organizations can leverage the IRAML Model to design AI-powered sustainability policies, supporting the transition to a climate-resilient global economy.

- Innovation: AI enables data-driven policy recommendations, helping governments develop carbon tax frameworks, climate adaptation strategies, and sustainable development goals (SDGs).
- Relationship: AI-powered models enhance collaboration between governments, corporations, and financial institutions by promoting data-sharing initiatives for ESG monitoring.
- AI Model: Predictive AI models simulate long-term climate risks and financial stability scenarios, allowing policymakers to implement evidence-based sustainability strategies.
- Learning: AI continuously learns from environmental data, economic trends, and policy outcomes, refining sustainability regulations to adapt to changing global conditions.

1.5 Conclusion

This study explored the role of Artificial Intelligence (AI) in sustainable finance, with a particular focus on ESG investment analysis, environmental risk assessment, and climate change modeling. Using the IRAML Model (Innovation-Relationship-AI Model-Learning), the research demonstrated how AI-driven technologies contribute to enhancing financial decision-making, improving ESG compliance, and mitigating sustainability risks. The findings highlight that AI plays a transformative role in optimizing investment strategies, detecting greenwashing, and automating sustainability reporting. However, challenges such as algorithmic bias, data transparency issues, and regulatory gaps remain significant barriers to AI's full-scale implementation in sustainable finance. This study contributes to understanding how AI-powered innovations enhance financial sustainability, while also recognizing the need for stronger regulatory frameworks and ethical guidelines to ensure responsible AI deployment.

The research advances knowledge in the field of AI and sustainable finance by introducing the IRAML Model, which provides a structured framework for understanding AI's role in financial decision-making and ESG compliance. Unlike previous studies that primarily focused on technical capabilities of AI, this research bridges the gap by emphasizing the interrelationship between AI innovation, sustainability practices, and human learning. By demonstrating how AI facilitates dynamic ESG investment strategies, the findings extend existing theories on financial sustainability and AI-driven decision-making. Additionally, the study contributes to ongoing debates on the ethical challenges of AI in finance, offering insights into the importance of transparency, accountability, and fairness in AI applications.

The findings have significant implications for financial institutions, investment managers, policymakers, and corporate sustainability officers. AI-driven models can be applied in portfolio optimization, credit risk assessment, and sustainability-linked financial products, enabling financial professionals to enhance risk-adjusted returns while promoting ESG goals. Policymakers can use AI to automate ESG compliance, monitor corporate sustainability performance, and enforce regulatory frameworks more effectively. Additionally, fintech companies and sustainable banks can integrate AI to develop real-time ESG analytics platforms, improving transparency and investor confidence in sustainability-linked financial markets. By

leveraging AI-powered insights, businesses can align financial performance with sustainability objectives, ensuring a more resilient and responsible financial ecosystem.

Despite its contributions, this study has several limitations. First, the research primarily relied on qualitative analysis and automated textual data processing, which may not fully capture the quantitative impact of AI on financial performance. Second, the study focused on a limited dataset of recent peer-reviewed articles, which may introduce selection bias in the literature review findings. Third, AI applications in sustainable finance are rapidly evolving, and the study may not fully reflect the latest technological advancements or emerging regulatory policies. Finally, challenges related to AI ethics, algorithmic fairness, and energy consumption require further exploration, as they present long-term sustainability concerns that were beyond the scope of this study.

To build upon this study's findings, future research should explore quantitative assessments of AI's financial impact on ESG investment performance, utilizing machine learning models and real-time financial data. Additionally, studies should examine how AI can enhance financial literacy and ESG education, ensuring that AI-driven tools are accessible and beneficial to a wider range of investors and policymakers. Further research should also investigate regulatory alignment, focusing on how global financial institutions can harmonize AI-driven ESG policies across different markets. Lastly, interdisciplinary research involving computer scientists, economists, and sustainability experts should be encouraged to develop ethical AI governance frameworks, addressing concerns related to bias, fairness, and energy efficiency in AI-powered sustainable finance applications.

1.6 References

Anser, M. K., Ahmad, M., Khan, M. A., Zaman, K., Nassani, A. A., Askar, S. E., Abro, M. M. Q., & Kabbani, A. (2021). The role of information and communication technologies in mitigating carbon emissions: Evidence from panel quantile regression. *Environmental Science and Pollution Research*, *28*(17), 21065–21084. https://doi.org/10.1007/s11356-020-12114-y

Briere, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4252329

Fandella, P., Sergi, B. S., & Sironi, E. (2023). Corporate social responsibility performance and the cost of capital in BRICS countries. The problem of selectivity using environmental, social and governance scores. *Corporate Social Responsibility and Environmental Management*, *30*(4), 1712–1722. https://doi.org/10.1002/csr.2447

Giudici, P., & Wu, L. (2025). Sustainable artificial intelligence in finance: Impact of ESG factors. *Frontiers in Artificial Intelligence*, *8*. https://doi.org/10.3389/frai.2025.1566197

Jabeen, G., Yan, Q., Ahmad, M., Fatima, N., & Qamar, S. (2019). Consumers' intention-based influence factors of renewable power generation technology utilization: A structural equation modeling approach. *Journal of Cleaner Production*, *237*, 117737. https://doi.org/10.1016/j.jclepro.2019.117737

Patoucha, A., & Gareiou, Z. (2024). The role of artificial intelligence in environmental sustainability. *E3S Web of Conferences*, *585*, 11011. https://doi.org/10.1051/

e3sconf/202458511011

Pavlidis, G. (2025). Empowering sustainable finance with artificial intelligence: A framework for responsible implementation. In J. Lee & A. Darbellay (Eds.), *A Research Agenda for Financial Law and Regulation* (pp. 23–38). Edward Elgar Publishing. https://doi.org/10.4337/9781803929996.00009

Petković, M. (2023a). How Does Artificial Intelligence Influence on Company's Green Intellectual Capital? *Ecologica*, *30*(112), 541–548. https://doi.org/10.18485/ecologica.2023.30.112.5

Petković, M. (2023b). What are the Drivers of Competitive Advantage Coming from Green Intellectual Capital During 2022 Global Economic Crisis? *Ecologica*, *30*(109), 81–88. https://doi.org/10.18485/ecologica.2023.30.109.12

Ravan Ramzani, S., Konhaeusner, P., Olaniregun, O. A., Abu-Alkheil, A., & Alsharari, N. (2024). Integrating AI-Driven Green Finance Strategies for Sustainable Development: A Comparative Analysis of Renewable Energy Investments in Germany and Denmark. *European Journal of Business and Management Research*, *9*(2), 43–55. https://doi.org/10.24018/ejbmr.2024.9.2.2277

Song, Y., Zhang, Y., Zhang, Z., & Sahut, J.-M. (2025). Artificial intelligence, digital finance, and green innovation. *Global Finance Journal*, *64*, 101072. https://doi.org/10.1016/j.gfj.2024.101072

Taleb, M., & Kadhum, H. J. (2024). The Role of Artificial Intelligence in Promoting the Environmental, Social and Governance (ESG) Practices. In A. Alnoor, M. Camilleri, H. A. Al-Abrrow, M. Valeri, G. E. Bayram, & Y. R. Muhsen (Eds.), *Explainable Artificial Intelligence in the Digital Sustainability Administration* (Vol. 1033, pp. 256–279). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-63717-9_17

Thanyawatpornkul, R. (2024). Harnessing artificial intelligence for sustainable development in emerging markets: Exploring opportunities and challenges in Thailand. *European Journal of Sustainable Development Research*, *8*(4), em0273. https://doi.org/10.29333/ejosdr/15435

Umer Nadeem, & Da Chen, Y. (2024). *AI and Big Data in Finance: Enhancing Enterprise Intelligent Finance through Sustainable Machine Learning and Predictive Analytics*. Unpublished. https://doi.org/10.13140/RG.2.2.33600.55040

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Chapter 2 - The Potential of AI in HRM: Boosting Employee Wellbeing and Engagement in Today's Hybrid Work Environments

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Abstract

The Human Resource Management (HRM) is in need to effectively design workplace dynamics where employees feel they are well equipped to perform their daily tasks, whilst protecting their mental and physical wellbeing. This need is accentuated when employees are full or part-time remote. A sense of being connected with the organization, an organization which provides for useful resources to succeed at work may incentivize a desire to reciprocate the employer through higher engagement and better performance. The deployment of AI-powered HRM solutions has the potential to provide for a personalized employee experience that each remote worker can tailor to their daily needs. While working from home (WFH) offers benefits like increased autonomy and work-life balance, it also presents challenges such as work-life spillover and social isolation. This article posits that AI-assisted HRM solutions can significantly improve teleworkers' engagement through increased wellbeing at work. Through the exploitation of AI, HRM practitioners can design and create a more supportive and personalized remote work environment. This article reviews AI in HRM, highlighting uses like personalized support, predictive analytics, automated tasks, enhanced learning, and real-time feedback. It suggests that combining AI with human efforts can improve employee satisfaction and organizational performance by creating a more inclusive, supportive, and engaging work environment. AI tools such as chatbots, virtual assistants, and predictive analytics can provide real-time support, personalized wellbeing programs, and data-driven insights. These can be brought to the front of the organization's environment, fostering a more engaged and satisfied workforce.

The article reviews AI in HRM, highlighting uses like personalized support, predictive analytics, automated tasks, enhanced learning, and real-time feedback. It suggests that combining AI with

human efforts can improve employee satisfaction and organizational performance by creating a more inclusive, supportive, and engaging work environment. Key applications of AI in HRM include automated resume screening, performance evaluation, and employee engagement. Research on AI's impact on employee engagement is limited, but existing studies highlight AI's dual role in enhancing efficiency and reducing bias, while also raising concerns about job security, fairness, and privacy. The findings derived from this study suggest AI-assisted HRM solutions may offer significant opportunities to enhance employee engagement and wellbeing, especially for remote or hybrid workers. The overall success of such implementations will depend on surpassing AIs major threats, that is risk of bias, privacy concerns, potential inconsistent feedback, or an over reliance on technology, versus human-to-human interactions. AI-assisted HRM solutions thus must be carefully managed to maximize their benefits.

Keywords: *Key words: Employee engagement; employee wellbeing; AI-based HRM tools; AI-based employee support; HR analytics.*

2.1 Introduction

HRM practice currently demands new ideas to enhance the employee's overall wellbeing while working from home (WFH). WFH is known to bring many benefits to employees, like increased autonomy, schedule flexibility, increased work-life balance, or giving time back from reduced commuting, to name a few (Gajendran & Harrison, 2007). These benefits often lead to increased job satisfaction as well as increased willingness to continue WFH (Labrado Antolín et al., 2024). But the benefits of WFH do not come without drawbacks, like work-life spillover, perceived job insecurity, social and professional isolation or increased working hours (Gajendran et al., 2022). In the advent of hybrid forms of work, where spatiotemporal boundaries vary across the workweek (Bloom, 2023), it seems appropriate to explore if and in which ways can AI tools can help unleash the potential benefits of WFH while reducing the setbacks.

The present study is based on the assumption that AI-assisted HRM solutions can significantly improve remote workers engagement through increased well-being, exploiting the potential of technology to serve a human purpose and to create a more supportive and personalized work environment. The main thesis is that AI tools, such as chatbots, virtual assistants, and predictive analytics, can be foundational to provide employees with real-time support, personalized well-being programs, and data-driven insights, thereby fostering a less strained and more engaged and satisfied workforce. Additionally, the speed of implementation and the agility to enhance and improve the solutions once tested can be a good incentive for HRM practitioners to step into the AI-assisted HRM solutions.

Research on AI's impact on employee engagement remains limited (Ayu Gusti et al., 2024). Existing studies highlight AI's dual role in enhancing efficiency and reducing bias, while also raising concerns about job security, fairness, and privacy (Sadeghi, 2024). Former studies have relied on self-regulation or Resource-Based view (RBV) theories to research the topic. Self-regulation refers to the way individuals control their emotions and behaviors to achieve their goals (Bandura & Cervone, 1983). The adoption of self-regulation lens has resulted in new insights about how the employees interact with the tools. For example, for some the use of AI can enhance employee's productivity and getting things done; on the other hand, some

employees can experience job insecurity or fear of being replaced by technology. The use of RBV in HRM studies borrows from the strategy management literature. RBV stresses the importance of internal resources in the company to develop and sustain a competitive advantage (Barney et al., 2011). In the context of HRM, RBV provides a lens through which analyze the opportunities to effectively leverage the internal resources of the organization (e.g., AI technology) to enhance HR functions. Employee engagement or organizational commitment, among others, represent valuable sources of competitive advantage for enterprises. Under the RBV framework, organizations need to not only identify the valuable assets but also ensure they are not easily copied or lost to the competition. By placing a focus on employee wellbeing, as an antecedent of employee engagement, AI-assisted HRM solutions can represent a source of competitive advantage for nowadays firms.

Malik (2024) found that AI tools can boost perceived job security, enhancing job performance. AI, as a unique resource, can increase productivity, mediated by employee engagement. This article explores new theoretical perspectives on AI-based HRM solutions, aiming to deepen understanding of their potential in firms.

2.2 Literature review

The key themes of this study are employee wellbeing, the final aim; employee engagement, which it is hoped to have a mediating effect on wellbeing; and AI-based HRM solutions, potential enablers of such engagement. To build on previous knowledge and research strategies applied by HRM scholars, this study relies on two alternative grounding theories: Cognitive Load Theory (CLT) and Maslow's Hierarchy of Needs. These theories provide for an innovative theoretical approach to the study of challenges and opportunities in the field. The remainer of this section will synthesize the extant body of knowledge about (2.1) employee engagement, wellbeing and AI-powered HRM solutions, as well as (2.2) present the proposed grounding theories.

2.2.1 About Employee Engagement, Wellbeing and AI-Based HRM Solutions

Employee engagement raised interest in the scientific community before the turn of the century. The concept has been evolving without reaching a universal definition. Kahn (1990) identified a physical, cognitive and affective nature of employee engagement. Davis & Van Der Heijden (2023) propose a dynamic framework to manage employee engagement. The pair of researchers suggest the adoption of a holistic approach to employee engagement management. Their dynamic framework comprises five dimensions of analysis: (1) external context, including all macro and micro external factors like the loss of jobs during coronavirus, geopolitical tensions,…; (2) internal context factors affecting engagement, such as organizational, HR or operational strategies; (3) individual traits that influence how each employee interprets the environment, thus influencing engagement; (4) individual contexts that influence how valuable is work for each employee, affecting the status, self-esteem, career,…; (5) psychological state of mind that occurs before and during work engagement. Overall, literature on employee engagement recommends the promotion of an authentic corporate culture, setting clear expectations for employees, as well as interesting learning opportunities to attract and retain engaged employees (Bailey et al., 2017).

Employee engagement is a relatively stable state of positive energy towards work. HRM practitioners need to take seriously the impact of flexible forms of work (e.g., location,

time, schedule…) in job engagement. The level of engagement of an employee is correlated with the behavioral attitudes towards work. When facing the risk of employees not performing to the best self, employee engagement has the ability to reduce the appearance of withdrawal behaviors such as day dreaming, absenteeism, or turnover intent, among others (Liao et al., 2022). An engaged workforce is marked by vigor, dedication, and absorption. Driven by intrinsic motivation, engaged employees are known for enjoying increased energy levels, at physical, cognitive and emotional levels (Fachrunnisa & Palupi, 2024). Additionally, HRM scholars agree on the correlation between employee engagement and organizational commitment (Lan et al., 2020). Thus, employee engagement becomes crucial for organizational success. This is becoming of vital importance in a VUCA world (volatile, uncertain, complex and ambiguous).

Although recipes to create an engagement workplace seem available, most employees do not feel engaged with their jobs. According to Gallup's 2024 State of the Global Workplace report organizations today face critical challenges to foster employee engagement. Overall, global engagement remains low at 23%, with 62% of employees not engaged and 15% actively disengaged (Gallup, 2024). Thus, it can be said that most employees are disengaged; this disengagement is costly for firms, leading to an estimated $8.8 trillion in lost productivity worldwide. The report also notes the adverse effect of negative emotions at work. Stress, anxiety, and other negative emotions have reached their highest levels since Gallup began tracking them. This mental health crisis is exacerbated by poor management practices and lack of support for employee wellbeing. Although numerous studies in the literature explore the relationship between employee engagement, wellbeing and performance, they have not clearly defined or operationalized compelling strategies within this context (Fan et al., 2020). This gap has prompted calls for further research on the topic.

According to International Labour Organization (2024), employee wellbeing can be defined as every aspect of working life, including the quality and safety of the physical environment, workers' feelings about their jobs, their working conditions, the workplace atmosphere, and the organization of work. More and more, organizations are aware of the strategic importance of employee wellbeing for their success. Fostering the wellbeing of a firm's workforce benefits both the individuals and the firm. On one side, employees can benefit from reduced stress, illness, improved mental health, increased levels of energy or increased motivation, to name a few. But employee wellbeing impacts not only individuals but also the firm's productivity, creativity, community relations, and organizational reputation, among others. Thus, employee wellbeing is a strategic priority that should be on the corporate agenda, aligning with concepts like corporate social responsibility and legitimate obligations.

Traditionally, workplace health and safety practices have focused on avoiding and managing risk of injuries and illness. However, the strategic value of employee wellbeing relies on the armed lever to achieve organizational objectives. Despite the obvious connections, this strategic view of employee wellbeing remains yet underexplored in the literature (Halliday et al., 2024). There is limited evidence in the literature connecting employee wellbeing to strategic goals. Despite its importance, employee wellbeing often remains separate from organizational strategy, which tends to focus more on operational performance and productivity. The fact that the strategic value of employee wellbeing remains yet untapped in the literature reinforces the importance of the present study. There is a need to explore, from an HRM practice perspective, how organizational tools and wellbeing dynamics can be strategically integrated to optimize organizational outcomes, beyond the traditional risk management approach. To close this subsection, the following paragraphs delve into the current knowledge of AI-based

HRM solutions applied to workplace environment design. The adoption of AI-assisted

HRM solutions varies by industry. Traditionally, technology, finance, or e-commerce sectors are natural early adopters of new technologies. These sectors have identified key areas where AI could be put to serve the management of their workforce. This is the case for talent acquisition, employee engagement, or predictive analytics. Other sectors, such as healthcare, manufacturing, and education are seen as laggards in the adoption of AI, often due to regulatory or data privacy concerns. Overall, there is an increasing interest in the benefits AI could bring to the way a company supports its workforce. More and more the practitioners acknowledge the benefits and are exploring its integration into HR practices (Ganatra & Pandya, 2023). Thus, automated resume screening, applicant tracking, or candidate ranking in recruitment are recurrent use cases for AI-assisted HRM solutions. Additionally, exploiting the ability to analyze large datasets to identify performance, engagement, or turnover trends is an area of interest. The potential lies in the efficiency gains. Additionally, AI-assisted HRM tools can offer hyper-personalization of the employee experience. Features such as providing real-time feedback or facilitating support during employee self-service tasks through chatbots and virtual assistants are examples of how it could be made real.

Transparency in AI systems is crucial for building trust and positive employee attitudes. The implementation of enterprise-wide AI-powered solutions poses risks to job security, fairness, and privacy (Sadeghi, 2024). Results from Malik (2024) highlight the importance of the acceptance of AI solutions. In his study with over 300 employees of a multinational corporation Malik found a statistically significant correlation between perceived AI performance and job engagement. The study also found that higher perceived AI performance increases job security, which in turn increases job engagement and performance. The findings from this study demonstrate the interrelationships between effective AI adoption, employee engagement and performance.

Practitioners should note AI-based wellbeing solutions affect employee perceptions, behaviors, and outcomes of work. When considering their adoption, practitioners need to account for effective organizational strategies to motivate and upskill the employees for successful implementations. As it occurs with any change management program in the organization, clear communication plans, AI upskilling programs, and employee involvement need to be taken into consideration. The buying in and involvement of the whole workforce in the implementation of enterprise-wide AI-assisted HRM solutions is essential to mitigate negative impacts, hence benefiting from the expected outcomes. In sum, successful AI integration in HR requires a balanced approach where employee wellbeing is prioritized, human-AI collaboration is sensitively promoted, all within a robust ethical framework.

2.2.2 Foundational Theories: Cognitive Load and Maslow's Hierarchy of Needs

The research question of this article aims to explore how do AI tools like chatbots, virtual assistants, and predictive analytics impact real-time support, personalized well-being programs, and data-driven insights to foster a more engaged and satisfied workforce. To answer this question two foundational theories are employed: Cognitive Load Theory (CLT) and Maslow's Hierarchy of Needs. Cognitive Load Theory suggests that reducing unnecessary cognitive load can enhance learning and performance (Setiyani et al., 2019). In the context of HRM, AI can automate routine tasks, provide instant access to information, and streamline processes, thereby reducing cognitive load and allowing employees to focus on more meaningful and engaging work. According to CLT, these functionalities can boost focus and productivity, leading to better workplace results, like increased job satisfaction and engagement (Bilderback, 2024).

Maslow's Hierarchy of Needs, on the other hand, provides a framework for understanding human motivation and well-being. (Maslow, 1943) posited that needs, whether psychological or physiological, can influence attitudes and behaviours, such as job satisfaction, stability, recognition, and compensation. By addressing employees' basic needs (such as safety and physiological needs) and higher-level needs (such as belonging, esteem, and self-actualization), AI can create a more holistic approach to employee well-being. For instance, AI-driven wellness programs can offer personalized health recommendations, mental health support, and career development opportunities, ensuring that employees feel valued and supported at all levels of the hierarchy.

2.3 Designing AI-Powered HRM Solutions for Increased Wellbeing and Engagement

Following CLT and Maslow's hierarchy of needs lenses, the next paragraphs suggest a range of different AI-based HRM solutions designed to foster employee wellbeing and driving engagement, in the context of today's hybrid work environment.

2.3.1 Personalized Employee Support

AI-based HRM solutions can be leveraged to enhance the experience of employees at work, especially those working remotely. By offering personalized support tailored to individual needs, AI chatbots or virtual assistants can play a crucial role in enhancing the daily experience of those working from home, the coworking space or simply on the move. Some of the demanded features are the provision of instant assistance during the onboarding of a new hire, support troubleshooting technical issues, or offering mental health resources, among others.

CLT suggests that reducing unnecessary mental effort allows employees to focus on essential tasks, enhancing productivity and job satisfaction. AI tools streamline routine processes, such as troubleshooting technical issues or managing schedules, thereby minimizing extraneous cognitive load. This reduction in mental effort frees up cognitive resources, enabling employees to concentrate on more meaningful and complex work, ultimately boosting engagement and performance. These AI-driven tools not only improve employee well-being but also streamline HR processes, as demonstrated by IBM's successful implementation of Watson, which has significantly reduced costs and saved valuable time for managers (IBM, 2023).

AI chatbots and virtual assistants can significantly enhance the remote work experience by providing personalized employee support across various scenarios. For instance, during the onboarding process, new remote employees can receive instant answers to common questions, guidance through necessary paperwork, and tips for integrating into the team. When technical issues arise, such as connectivity problems or software malfunctions, AI virtual assistants can troubleshoot common problems, provide step-by-step solutions, and escalate more complex issues to IT support. For employees experiencing stress or anxiety due to isolation or workload, AI chatbots can offer mental health resources, suggest relaxation techniques, and provide access to virtual counseling services. Additionally, AI virtual assistants can recommend personalized wellness activities, such as exercise routines, healthy eating tips, and mindfulness practices, based on individual preferences and goals.

In terms of scheduling and time management, AI chatbots can assist employees by managing their calendars, suggesting optimal meeting times, and reminding them of upcoming deadlines and appointments. When employees have questions about company policies, benefits, or leave entitlements, AI virtual assistants can provide detailed information, answer specific queries, and guide them through the process of applying for benefits or leave. The multinational company IBM has successfully implemented AI-agents in their own organization, using proprietary technology (Watson). IBM Watson's AI agents have significantly improved HR processes by handling 94% of employee queries, saving over USD 5 million annually and 50,000 hours per year for managers (IBM, 2023). These AI-driven solutions enhance employee satisfaction and streamline talent acquisition and onboarding.

AI chatbots can additionally deliver real-time feedback based on performance metrics, suggest development resources, and schedule follow-up meetings with managers. Employees seeking professional development opportunities can benefit from AI virtual assistants recommending relevant training programs, courses, and certifications, and tracking their progress. AI chatbots can also facilitate team collaboration by enhancing communication, sharing project updates, and organizing virtual meetings. To help employees maintain a healthy work-life balance, AI virtual assistants can suggest strategies such as setting boundaries, taking regular breaks, and engaging in leisure activities.

From the perspective of Maslow's hierarchy of needs, personalized employee support solutions cater to various levels of employee needs. At the physiological and safety levels, AI ensures a stable and efficient work environment by providing timely assistance and reducing stress related to technical problems. For social needs, AI facilitates better communication and integration, especially for remote workers, fostering a sense of belonging. At the esteem level, personalized support and recognition from AI tools enhance employees' confidence and self-worth. Finally, by addressing these foundational needs, AI enables employees to reach self-actualization, where they can achieve their full potential and find greater fulfillment in their work. This holistic approach significantly enhances overall well-being and engagement.

By addressing these diverse scenarios, AI chatbots and virtual assistants ensure that remote employees feel supported, engaged, and well-equipped to handle their responsibilities, ultimately enhancing their overall work experience.

2.3.2 Predictive Analytics for Engagement

Predictive analytics for engagement can significantly enhance HRM by analyzing employee data to predict engagement levels, identify at-risk employees, and suggest proactive interventions. AI can analyze employee data to predict engagement levels, identify at-risk employees, and suggest proactive interventions. For instance, predictive analytics can monitor data points such as attendance, meeting participation, and email response times to identify early signs of disengagement. If an employee shows a sudden drop in these activities, the system can flag them for personalized support or engagement activities. Additionally, predictive models can analyze historical turnover data to identify patterns and factors contributing to employee departures, such as frequent job changes or low engagement scores. This allows HR to implement retention strategies like career development programs or recognition initiatives. From the Cognitive Load perspective, predictive analytics can anticipate potential issues, such as workload imbalances or burnout risks, enabling proactive interventions that reduce cognitive strain. By identifying patterns and trends, these tools help streamline workflows and optimize task allocation, minimizing extraneous cognitive load and allowing employees to concentrate on more meaningful work.

From the perspective of Maslow's hierarchy of needs, predictive analytics address various levels of employee needs. At the physiological and safety levels, these tools ensure a stable and supportive work environment by predicting and mitigating stressors, thus enhancing job security and reducing anxiety. For social needs, predictive analytics can identify opportunities for team collaboration and support, fostering a sense of belonging and community. At the esteem level, the insights provided by predictive analytics can help recognize and reward employee achievements, boosting confidence and self-worth. Ultimately, by addressing these foundational needs, predictive analytics enable employees to reach self-actualization, where they can achieve their full potential and find greater fulfillment in their work

If high stress levels or burnout risks are detected, the system can recommend wellness programs, flexible work arrangements, or mental health resources. Furthermore, by analyzing team performance data, predictive analytics can identify teams struggling with collaboration or communication issues and suggest team-building activities, training sessions, or changes in team composition.

Several vendors offer robust predictive HR analytics solutions that help organizations enhance decision-making, improve employee retention, and optimize HR strategies through data-driven insights. Microsoft Workplace Analytics, Tableau, Qlik, SAP SuccessFactors or Workday are industry leading software solutions allowing users to explore and analyze workforce data to uncover patterns and trends. These vendors, among others, are at the forefront of leveraging predictive analytics to transform HR practices and enhance organizational performance (AllHRSoftware, 2024).

Lumen Technologies, formerly known as CenturyLink, implemented Microsoft Workplace Analytics to enhance their sales operations. By providing real-time insights to sales leadership, they were able to uncover and replicate best practices, improve manager coaching, and drive productivity and well-being among their sales teams (Microsoft, 2020).

2.3.3 Automation: Employee Self-Service Portals

Employee self-service (ESS) portals are digital platforms that empower employees to manage various HR-related tasks independently. These portals streamline administrative processes, reduce the workload on HR departments, and significantly enhance employee engagement and wellbeing (Zhai et al., 2024). Examples of administrative tasks automated by ESS portals include personal information management, where employees can update their personal details, such as contact information, emergency contacts, and bank details, without needing to go through HR. This ensures that records are always up-to-date and reduces administrative delays. Leave and attendance management is another task, as ESS portals allow employees to apply for leave, check leave balances, and track attendance. Automated approval workflows ensure that leave requests are processed quickly, providing employees with timely responses and reducing uncertainty.

Payroll and benefits administration is also streamlined, with employees able to access their pay slips, tax documents, and benefits information through the portal. They can make changes to their benefits selections during open enrollment periods, ensuring they have the coverage that best suits their needs. Training and development are facilitated by ESS portals, which often include access to training modules and development resources. Employees can enroll in courses, track their progress, and receive certifications, fostering continuous learning and career growth. Performance management is another area where ESS portals excel, allowing employees to set goals, receive feedback, and track their performance reviews. This

transparency in performance management helps employees understand their progress and areas for improvement.

By automating these administrative tasks, ESS portals free up employees' time, allowing them to focus on more meaningful and productive work. This autonomy in managing their own HR-related tasks fosters a sense of control and empowerment, which is crucial for employee engagement. Moreover, the transparency and accessibility provided by ESS portals reduce stress and uncertainty. Employees have immediate access to important information and can resolve issues quickly, contributing to a more positive work environment. EES portals may be specifically convenient for remote and mobile workers who have limited opportunities for human interaction at the office. The ease of accessing training and development resources also supports career growth, enhancing job satisfaction and overall wellbeing. In summary, ESS portals not only streamline administrative processes but also play a vital role in enhancing employee engagement and wellbeing by promoting autonomy, reducing stress, and supporting continuous development.

Under Cognitive Load Theory, reducing unnecessary cognitive load allows employees to focus on more meaningful tasks. Employee self-service (ESS) portals automate routine administrative tasks, minimizing extraneous cognitive load and freeing mental resources for complex, value-added activities. This reduction in cognitive burden enhances productivity and job satisfaction.

Maslow's Hierarchy of Needs emphasizes fulfilling basic needs to achieve higher levels of motivation and self-actualization. ESS portals address several of these needs: they provide a sense of security by ensuring accurate and timely access to payroll and benefits information (safety needs), foster a sense of belonging through transparent communication and feedback mechanisms (social needs), and support personal growth by offering access to training and development resources (esteem and self-actualization needs). By meeting these needs, ESS portals enhance overall wellbeing and drive higher engagement, as employees feel more supported and empowered in their roles.

The adoption of EES portals does not come without words of caution. Employee self-service portals can reduce face-to-face interactions, even for employees who work permanently from the office, potentially leading to feelings of isolation and decreased personal support. They may also increase the cognitive load on employees who struggle with technology, causing frustration and stress. Additionally, the lack of immediate assistance for complex issues, such as understanding benefits, can lead to confusion and dissatisfaction (Rohuelo, 2024). These factors can negatively impact overall employee wellbeing and engagement.

2.3.4 Real-Time Feedback and Recognition

The new ways of working place a challenge on professional development and career progression. The lack of visibility of one's work, professional isolation or unclear information about how to navigate the company's decision ladder are part of today's threats for remote workers. AI tools can facilitate real-time feedback and recognition, helping to build a culture of appreciation and continuous improvement. AI tools can significantly enhance the visibility of employees' contributions by providing platforms for real-time feedback. For instance, AI-driven performance management systems can analyze work patterns, project contributions, and peer reviews to offer timely and objective feedback. This continuous feedback loop not only helps employees understand their strengths and areas for improvement but also ensures that their efforts are recognized promptly. Such systems can also identify high performers and potential leaders, aiding in career progression and professional development.

One practical application of AI in HRM is the use of AI to facilitate regular check-ins and pulse surveys, gathering real-time data on employee sentiment and engagement. For example, Work leap's Office vibe uses natural language processing (NLP) to analyze employee feedback and workplace trends, providing actionable insights to managers (McFarland, 2024). This helps in addressing issues promptly and recognizing employees' efforts, thereby enhancing their engagement and satisfaction.

Another example is the AI-driven recognition platforms that automate the process of acknowledging employees' achievements. These platforms can track milestones, project completions, and other significant contributions, sending automated recognition messages or rewards. This not only saves time for managers but also ensures that no effort goes unnoticed. Companies like Work human have successfully implemented such AI-based recognition systems, leading to improved employee morale and retention (Engagedly, 2024).

To complement real time feedback and recognition functions, AI tools can proactively suggest employees learning and development initiatives, aligning them with actual needs and interests, individual career goals and organizational needs. By analyzing employees' skills, performance data, and career aspirations, AI can recommend tailored training programs and development opportunities. This personalized approach ensures that employees receive relevant and timely support for their professional growth. For instance, IBM's Watson Talent uses AI to match employees with suitable career paths and development programs, enhancing their career progression and engagement (Engagedly, 2024).

From the perspective of Cognitive Load Theory, these AI tools reduce the mental strain associated with traditional feedback processes. By automating feedback and recognition, AI minimizes extraneous cognitive load, allowing employees to focus on their primary tasks and creative problem-solving. For example, AI-driven performance management systems offer immediate feedback, eliminating the need for employees to wait for periodic reviews. This continuous feedback loop helps employees adjust their efforts promptly, reducing uncertainty and cognitive overload.

Moreover, AI tools align with Maslow's Hierarchy of Needs by fulfilling various levels of employee needs. At the basic level, AI ensures job security and stability through predictive analytics that aid in workforce planning and risk management. Moving up the hierarchy, AI enhances the need for belonging and esteem by facilitating continuous recognition and appreciation. AI-powered platforms like Work human automate the recognition process, ensuring that employees' contributions are consistently acknowledged. This fosters a sense of belonging and boosts self-esteem, as employees feel valued and respected.

At the higher levels of Maslow's hierarchy, AI supports self-actualization by personalizing learning and development opportunities. AI tools like IBM's Watson Talent analyze individual skills and career aspirations, recommending tailored development programs. This personalized approach empowers employees to achieve their full potential, aligning their personal growth with organizational goals. By addressing these higher-order needs, AI not only enhances engagement but also promotes a culture of continuous improvement and innovation.

While AI-based personal feedback and recognition systems offer numerous benefits, they also come with potential risks that can negatively impact employee wellbeing and engagement. One major concern is bias and fairness (European Parliament, 2020). AI systems can inadvertently perpetuate existing biases present in the data they are trained on, potentially favoring certain groups of employees over others and leading to feelings of injustice and demotivation. Additionally, many AI models operate as "black boxes," making it difficult to understand how decisions are made. This lack of transparency can lead to mistrust among employees, who may feel that the feedback and recognition they receive is arbitrary or

unjustified.

Privacy concerns are another significant issue (Rohuelo, 2024). AI systems often require extensive data collection to function effectively, which can make employees uncomfortable with the level of surveillance and data monitoring involved. Such concerns can lead to stress and a decrease in overall wellbeing. Furthermore, over-reliance on automation can reduce the human element in workplace interactions. Employees may feel undervalued if they perceive that their achievements are only recognized by machines rather than their managers or peers.

Inconsistent feedback is also a risk. AI systems may not always provide consistent or contextually appropriate feedback, leading to confusion and frustration among employees who may struggle to understand or act on the feedback they receive. Additionally, the implementation of AI in HR processes can create anxiety about job security. Employees may fear that increased automation could lead to job displacement or reduced opportunities for career advancement.
To mitigate these risks, organizations should ensure that AI systems are designed and implemented with fairness, transparency, and privacy in mind. Maintaining a balance between automated and human-driven feedback and recognition can help preserve the human touch that is crucial for employee engagement and wellbeing

In conclusion, applying AI to provide real-time feedback and support in HRM offers significant benefits but also comes with notable risks. On the positive side, AI tools can enhance employee wellbeing and engagement by reducing cognitive load, ensuring timely recognition, and personalizing development opportunities. These tools help create a culture of continuous improvement and appreciation, aligning with both Cognitive Load Theory and Maslow's Hierarchy of Needs. However, there are risks considering. Bias and fairness issues, lack of transparency, privacy concerns, over-reliance on automation, inconsistent feedback, and job security anxieties can negatively impact employee wellbeing and engagement. To mitigate these risks, organizations must design AI systems with fairness, transparency, and privacy in mind, and maintain a balance between automated and human-driven feedback.

2.4 Challenges and Opportunities for Workers

The shift to a hybrid work model, where employees divide their time between the office and remote work, presents both opportunities and challenges for successful employee experiences. Companies play a vital role in addressing these challenges and promoting their employees' well-being (Ravinder, 2024). It is becoming clear that the integration of AI-based solutions in HRM has the potential to significantly enhance employee engagement and wellbeing, particularly for remote or hybrid workers. However, these technologies also present several challenges that need to be addressed to maximize their benefits.

2.4.1 Key Opportunities

The following represent a set of potential areas of application of AI-powered tools to better serve remote workers:

1. AI-powered chatbots and virtual assistants can provide immediate support and information to employees, reducing the time spent on administrative tasks and allowing HR professionals to focus on more strategic activities. These tools can answer common queries, assist with onboarding, and provide guidance on company policies. For remote

workers, this instant access to information can reduce feelings of isolation and increase their sense of connection to the organization (Parasa, 2023).

2. AI-driven performance management systems can offer real-time feedback and recognition, which is crucial for maintaining engagement and motivation among remote employees. These systems can analyze work patterns and contributions to provide timely and objective feedback, helping employees understand their strengths and areas for improvement. This continuous feedback loop fosters a remote culture of appreciation and continuous improvement, which is essential for the wellbeing of remote workers (Manfrino, 2024).

3. AI-enhanced self-service portals empower employees to manage their own HR-related tasks, such as updating personal information, accessing pay slips, and enrolling in benefits programs. This autonomy can lead to increased job satisfaction and engagement, as employees feel more in control of their work environment. For remote workers, these portals provide a convenient way to handle HR tasks without needing to visit the office (Bhargava, 2024).

2.4.2 Challenges

One of the significant challenges of AI-based HRM solutions is the potential for bias in algorithms. If the data used to train these systems is biased, the AI can perpetuate and even amplify these biases, leading to unfair treatment of certain employee groups. This can negatively impact employee morale and trust in the system (European Parliament, 2020)

AI systems often require extensive data collection to function effectively, raising concerns about employee privacy. Employees may feel uncomfortable with the level of surveillance and data monitoring involved, which can lead to stress and decreased wellbeing. Ensuring data privacy and transparency in how data is used is crucial to mitigate these concerns (Parasa, 2023)

While AI can streamline many HR processes, over-reliance on technology can reduce the human element in workplace interactions. Employees may feel undervalued if their achievements are recognized solely by machines rather than by their managers or peers. This lack of personal touch can diminish the sense of belonging and engagement (Engagedly, 2024).

AI systems may not always provide consistent or contextually appropriate feedback. This can lead to confusion and frustration among employees, who may struggle to understand or act on the feedback they receive. Ensuring that AI systems are regularly updated and monitored for accuracy is essential to provide reliable feedback (Setiyani et al., 2019).

2.5 Conclusions and Recommendations

As presented in this article, AI-based solutions may offer significant opportunities to enhance employee engagement and wellbeing, especially for remote or hybrid workers. HRM practitioners need to carefully design and implement the use of these tools within the remote or hybrid workforce. For example, chatbots and virtual assistants, real-time feedback and recognition systems, and employee self-service portals can be designed to improve efficiency,

autonomy, and connection to the organization. However, challenges such as bias, privacy concerns, over-reliance on technology, and inconsistent feedback must be carefully managed. By addressing these challenges, organizations can exploit AI functionalities to create a more supportive and engaging remote work environment for all employees. The inspiring idea behind this article relies on the expectation that remote workers, when offered AI-powered HRM solutions as described in this article, will perceive those as a valuable resource their employer is providing as a sign of commitment to the employee wellbeing. Remote workers may, in return, feel more engaged with their job, committed to the organizational goals and, overall, perform better.

To effectively design AI-based HRM solutions that support employee wellbeing and engagement, organizations should consider the following strategies:

a) Clear communication: Ensure that employees understand how AI tools are used and how they can benefit from them. Transparency in AI systems fosters trust and positive attitudes towards technology.

b) Personalization: Tailor AI-driven programs to meet individual employee needs. Personalized well-being programs and career development plans can enhance employee satisfaction and engagement.

c) Employee involvement: Involve employees in the implementation and continuous improvement of AI tools. This participatory approach ensures that AI solutions are aligned with employees' needs and preferences.

d) Ethical concerns: Address ethical concerns related to AI, such as data privacy and fairness. Implementing ethical AI practices ensures that employees' rights are protected and fosters a positive organizational culture.

e) Continuous Monitoring and Feedback: Regularly assess the effectiveness of AI tools and make necessary adjustments based on employee feedback and performance data. This iterative process ensures that AI solutions remain relevant and effective.

In conclusion, the integration of AI in HRM presents a transformative opportunity to enhance employee engagement through increased well-being, particularly in remote and hybrid work environments. By leveraging AI tools for personalized support, predictive analytics, and real-time feedback, organizations can create a more inclusive and supportive workplace. However, it is crucial to address challenges such as bias, privacy concerns, and over-reliance on technology to fully realize the benefits of AI. As we move forward, a balanced approach that combines AI's capabilities with human empathy and oversight will be essential in fostering a positive and productive work culture.

2.6 References

AllHRSoftware. (2024). 10 Best Predictive Analytics Tools for HR 2024. *HR List Software*. https://allhrsoftware.com/blog/10-best-predictive-analytics-tools-for-hr-2024/

Ayu Gusti, M., Satrianto, A., Candrianto, Juniardi, E., & Fitra, H. (2024). Artificial intelligence for employee engagement and productivity. *Problems and Perspectives in Management*, *22*(3), 174–184. https://doi.org/10.21511/ppm.22(3).2024.14

Bailey, C., Madden, A., Alfes, K., & Fletcher, L. (2017). The Meaning, Antecedents and Outcomes of Employee Engagement: A Narrative Synthesis. *International Journal of Management Reviews*, *19*(1), 31–53. https://doi.org/10.1111/ijmr.12077

Bandura, A., & Cervone, D. (1983). Self-Evaluative and Self-Efficacy Mechanisms Governing the Motivational Effects of Goal Systems. *Journal of Personality and SocialPsychology*, *45*(5), 1017–1028.

Barney, J. B., Ketchen, D. J., & Wright, M. (2011). The Future of Resource-Based Theory: Revitalization or Decline? *Journal of Management*, *37*(5), 1299–1315. https://doi.org/10.1177/0149206310391805

Bhargava, V. (2024). Artifical intelligence and employee engagement: A futuristic approach [Leena AI]. *HR Employee Engagement*. https://leena.ai/blog/artificial-intelligence-employee-engagement/

Bilderback, S. (2024). I will see you in the summer: Assessing the cognitive impact of social media on employee engagement. *Strategic HR Review*, *23*(6), 206–210. https://doi.org/10.1108/SHR-05-2024-0033

Bloom, N. (2023, December 23). Year in Review (A Special Report): The Changed Workplace—The Biggest Winners and Losers From the Work-From-Home Revolution: Remote or hybrid work has become the new normal for millions of people whose jobs can accommodate it. We are only just starting to see the impact. *Wall Street Journal, Eastern Edition*. https://www.wsj.com/lifestyle/workplace/work-from-home-impact-revolution-2aa72e0f?msockid=352042d07231603828a85789731a61da

Briere, M., Keip, M., & Le Berthe, T. (2022). Artificial Intelligence for Sustainable Finance: Why it May Help. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4252329

Davis, A. S., & Van Der Heijden, B. I. J. M. (2023). Launching the dynamic employee engagement framework: Towards a better understanding of the phenomenon. *Employee Relations: The International Journal*, *45*(2), 421–436. https://doi.org/10.1108/ER-08-2021-0338

Engagedly. (2024). *Leveraging Artificial Intelligence in Human Resource Management*. Engagedly. https://engagedly.com/leveraging-artificial-intelligence-in-human-resource-management/

European Parliament. (2020). *Artificial Intelligence: Threats and opportunities* (Topics European Parliament). European Parliament. https://www.europarl.europa.eu/topics/en/article/20200918STO87404/artificial-intelligence-threats-and-opportunities

Fachrunnisa, O., & Palupi, I. (2024). Affective Engagement and Cognitive Engagement: Two Different Dimensions to Strengthen Employee Work Ethic. *Organizational Cultures: An International Journal*, *24*(2), 61–85. https://doi.org/10.18848/2327-8013/CGP/v24i02/61-85

Fan, D., Zhu, C. J., Timming, A. R., Su, Y., Huang, X., & Lu, Y. (2020). Using the past to map out the future of occupational health and safety research: Where do we go from here? *The International Journal of Human Resource Management*, *31*(1), 90–127. https://doi.

org/10.1080/09585192.2019.1657167

Gajendran, R. S., & Harrison, D. A. (2007). The good, the bad, and the unknown about telecommuting: Meta-analysis of psychological mediators and individual consequences. *Journal of Applied Psychology*, *92*(6), 1524–1541. https://doi.org/10.1037/0021-9010.92.6.1524

Gajendran, R. S., Ponnapalli, A. R., Wang, C., & Javalagi, A. A. (2022). A dual pathway model of remote work intensity: A meta□analysis of its simultaneous positive and negative effects. *Personnel Psychology*. https://doi.org/10.1111/peps.12641

Gallup. (2024). *State of the global workplace*. https://www.gallup.com/workplace/349484/state-of-the-global-workplace.aspx

Ganatra, N. J., & Pandya, J. D. (2023). The transformative impact of artificial intelligence on hr practices and employee experience: A review. *Journal of Management Research and Analysis*, *10*(2), 106–111. https://doi.org/10.18231/j.jmra.2023.018

Halliday, B., Van Der Laan, L., & Raineri, A. (2024). Prioritizing Work Health, Safety, and Wellbeing in Corporate Strategies: An Indicative Framework. *Safety*, *10*(1), 18. https://doi.org/10.3390/safety10010018

IBM. (2023). A new set of enterprise AI agents are now available. *IBM Community*. https://community.ibm.com/community/user/watsonx/blogs/nickolus-plowden/2024/11/15/a-new-set-of-enterprise-hr-agents-are-now-availabl

International Labour Organization. (2024). *Worker wellbeing*. www.ilo.org

Kahn, W. A. (1990). PSYCHOLOGICAL CONDITIONS OF PERSONAL ENGAGEMENT AND DISENGAGEMENT AT WORK. *Academy of Management Journal*, *33*(4), 692–724. https://doi.org/10.2307/256287

Labrado Antolín, M., Rodríguez-Ruiz, Ó., & Fernández Menéndez, J. (2024). A time after time effect in telework: An explanation of willingness to telework and self-reported productivity. *International Journal of Manpower*, *45*(1), 200–214. https://doi.org/10.1108/IJM-05-2022-0238

Lan, T., Chen, M., Zeng, X., & Liu, T. (2020). The Influence of Job and Individual Resources on Work Engagement Among Chinese Police Officers: A Moderated Mediation Model. *Frontiers in Psychology*, *11*, 497. https://doi.org/10.3389/fpsyg.2020.00497

Liao, G., Li, M., Yin, J., & Wang, Q. (2022). Electronic communication during nonwork time and withdrawal behavior: An analysis of employee cognition-emotion-behavior framework from Chinese cultural context. *Frontiers in Psychology*, *13*, 1010197. https://doi.org/10.3389/fpsyg.2022.1010197

Malik, A. (2024). A Study on the Relationship of Artificial Intelligence Applications in HR Processes for Assessing Employee Engagement, Performance, and Job Security. *International Review of Management and Marketing*, *14*(5), 216–221. https://doi.org/10.32479/irmm.16838

Manfrino, M. (2024). AI and Employee Wellbeing: Navigating Human-centric Integration, Interactive Coaching, and Turnover Mitigation. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4821351

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, *50*(4), 370–396. https://doi.org/10.1037/h0054346

McFarland, A. (2024, October 2). 10 Best Employee Engagement Software Platforms. *Best Of*. https://www.unite.ai/best-employee-engagement-software-platforms/

Microsoft. (2020). Insights from Microsoft Workplace Analytics help Lumen drive ‘anything is possible’ mentality. *Customer Stories*. https://www.microsoft.com/en/customers/story/847172-lumen-telecommunications-workplace-analytics

Parasa, S. K. (2023). Impact of AI in Employee Wellness and Well-being Programs. *European Journal of Advances in Engineering and Technology*, *10*(15), 98–100.

Ravinder, T. (2024). Why mental health issues are on the rise and how to support your employees in a hybrid work environment. *Training Journal (Online)*.

Rohuelo, R. (2024). *How to build confidence in AI: ensuring privacy with proper design*. Ernst & Young. https://www.ey.com/en_fi/insights/consulting/mitigating-ai-privacy-risks-strategies-for-trust-and-compliance

Sadeghi, S. (2024). *Employee Well-being in the Age of AI: Perceptions, Concerns, Behaviors, and Outcomes*.

Setiyani, A., Djumarno, D., Riyanto, S., & Nawangsari, L. Ch. (2019). THE EFFECT OF WORK ENVIRONMENT ON FLEXIBLE WORKING HOURS, EMPLOYEE ENGAGEMENT AND EMPLOYEE MOTIVATION. *International Review of Management and Marketing*, *9*(3), 112–116. https://doi.org/10.32479/irmm.8114

Zhai, Y., Zhang, L., & Yu, M. (2024). AI in Human Resource Management: Literature Review and Research Implications. *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-023-01631-z

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Chapter 3 - Artificial Intelligence and Sustainability: Innovations in Business and managerial Practices

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Abstract

Artificial Intelligence (AI) will, more than ever, play a critical role in every aspect of organizational progression and influence decisions across the board. Human, talent, and overall workforce management is no exception to this influence and impact; AI's influence will be through organizational leadership via guiding decision-making, team management, and innovation processes. As its potential is explored, it becomes clear that leaders must adapt to leverage innovation effectively and address the new ethical and cultural issues they raise. Organizations, leadership, cultures, and pillars of organizational structures and systems must do this while remaining ethical, mindful, and aware of not affecting creativity (INSEAD, 2024). The leadership of any organization must lead with AI while keeping people, mindfulness, ethics, and values, as well as creativity and the human touch at the heart of everything that they do and each AI strategy (AON, 2024). AI has the potential to unleash creativity, foster human connections, imagine new ways of learning, enable the automation of existing tasks, and promote new adaptive tasks that require human ingenuity and empathy. That is quite a list, which raises equal challenges and opportunities (INSEAD, 2024). What is clear is that leaders will remain indispensable in helping their teams and firms negotiate this brave new world. To do so successfully, it is vital that they adopt a dual mindset, while helping to maintain and create moments of deep, thoughtful human interactions. Four challenges may arise from AI's influence and leverage: 1) HR's operational complexities, 2) data's readiness, accuracy, and availability, 3) legalities that may arise and conform to compliant approaches, and 4) Manpower's reactions and behavior against and towards algorithmic based decisions (Jobylon, 2024).

Keywords: *Diversity, Inclusion, Creativity, Human and Machines, Artificial Intelligence, Human Resources, and Human Touch;*

3.1 Introduction

"AI" is algorithm, software, enabling task mastery of specific operational needs to optimize performance, alleviate pressures, and enable focus on other strategic areas. If used properly and in the right context, it should enable streamlining operations and empower leaders to rid of administrative tasks while focusing on the most important and strategic initiatives, helping move their organizational strategies, short and long term, effectively forward.

Data analytics is easier to implement in operations, where the relevant questions have more clarity, such as a car's battery's failure likelihood? Identifying early signs of failures and alerting users has been proven (LinkedIn, 2024).

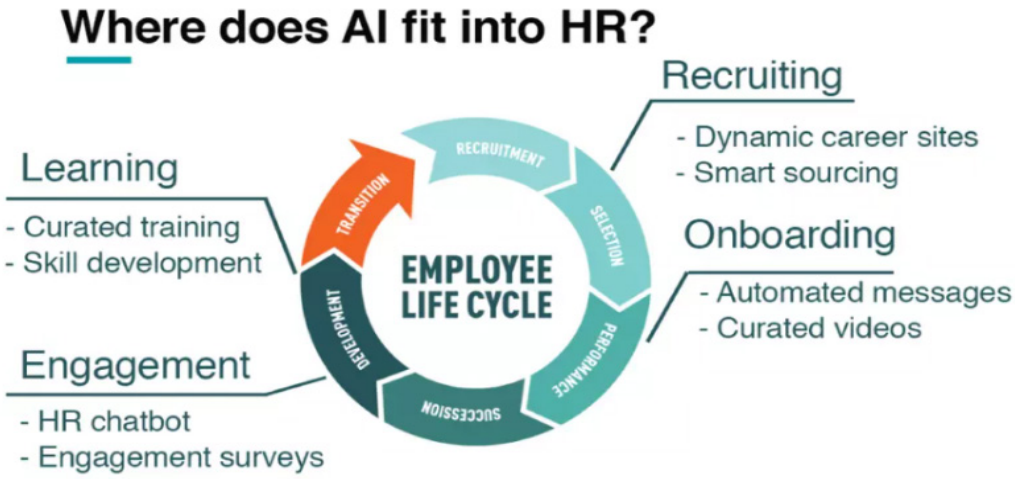

Figure 1. AI's fit into HR, LinkedIn 2024

The definition of a "performing employee" encompasses various dimensions that align with different criteria. Key performance indicators, a common business metric used within organizations to drive the right business outcomes while objectively and numerically guiding the reviews and quarterly touch points, has come under scrutiny, and has led employers to reconsider their application (van ESCH P, 2021). Problems exist between performance systems and a clear link between individual, team, and organizational performances. Therefore, algorithms related to performance are disadvantageous (LinkedIn, 2024).

Decision-making processes are sophisticated when releasing employees, AI falls short despite data's presence. This must be human lead (AON, 2024).

Hiring and firing cannot also be simulated via algorithms as it is sophisticated body language must be read, attitudes must be understood, and overall cultural frameworks of the criteria to hire employees are difficult to simulate through artificial intelligence (IBMI, 2024). Company vehicle's milage misreporting, or company credit card misuse, may be simulated with algorithms; however, simulating responses of potential hires is difficult.

The challenges of HR's tasks are categorized as follows: Operations, Data Input, Machine Learning, and Data Output (van ESCH P, 2021). Ideas from computer science and statis-

tics are introduced into the HR context and presented in managerial and HR partners' languages.

3.2 Literature Review

3.2.1 HR Operations through an Algorithmic Lense

"**Operations**" are of interest as hiring makes up 75%, or higher, of what HR partners do within an organization (Jobylon, 2024). The below table summarizes common activities of the "Human Resources Cycle," operational tasks:

Table 1: HR Operations, created by the author.

HR operation	**Prediction task**
Recruiting – candidates' applications; streamlining and vetting	Right candidate for the right job
Selection – Candidates' suitability to scope of work	Fit for purpose job offers
On-boarding – streamlining the hiring process and automating it	Practicality
Training	Relevance to job, career, and performance
Performance management – identifying good and deficient performance	Performance Improvements
Advancement – Promotion guidelines, indicators, and triggers	Performance based decisions
Retention	Prediction of high-risk employees
Employee benefits	Determination of the benefits' relevance to enable competitiveness and employee attractions; benefits' alignments with organizational financial performance.

The relationship between a senior executive leader, a leader, a manager, and a supervisor with their direct and indirect employees respectively is genuine human interaction. Most elite organizations in the world value people as the most important "asset" of their business. Albeit I do not agree with the word "asset," as humans are far more superior than that, but just to highlight the importance in general corporate terms.

Elite organizations put talent, talent management, employees, and employee's development, talent growth and retention, and overall high-performing population, at the heart of everything that they do; millions of dollars are spent yearly to evolve, develop, train, prepare, solidify, challenge, attract, and retain top talent and culture respectively.

The human element, the connection, the "one on one" private, tailored, and strategically focused meetings that happen between senior leaders and their employees, especially the high-performing ones, are so critical and essential to the continuity of business, establishment of an elite culture, and for 'positive word of mouth" for top talent to continue attracting external top talent into the organization ; for employees to feel the sense of belonging; for the culture of loyalty to be enriched; healthy competitiveness to be fostered; trust through constructive feedback and dialogue to be the currency dealt with; "open-door" policies to be instilled, and to bridge gaps that are not necessarily attainable through any other means, especially through algorithms, but through the human touch (HBR, 2023).

Please, let's reflect on the difficulties in making meaningful human connections and relationships, these days; bombardment of technological distractions, sending a message, which is readily available through many "at your fingertip solutions" versus securing "in person" meaningful conversations, and the fact that time's unavailability, passes by so quickly, effort it takes to get into one's vehicle to go see someone, or spend the time to connect with someone one to one personally, all make it quite difficult and quite easy to make excuses not to meet and not to connect in person. Regardless of the software we have in place, the sophistication and advancements of the algorithms used, and the overall buffers placed within it to eliminate errors; algorithms and AI will always fall short of replicating the human connection, will not accomplish as much in its stead.

Having had the privilege to have worked with several international organizations, the breadth of the organizations spread over the globe's entirety; having had the privilege to interact and work with several cultures across the world; having had the career bandwidth and successes to lead several cultures, take it a step further, several and almost all nationalities throughout my career, I value the human touch more than any other means for establishing meaningful, impactful, and lasting relationships and connection. There is an essence, an indescribable energy, about sitting down across the table and aligning against what is important, discussing what matters, allocating the time to resolve an issue, and setting the stage for collaborative, "win-win," outcomes for years to come.

It meant the world to me when one of my previous employers' senior executive leadership team took and made time to connect with me "one-on-one". I felt like I was the only employee in that organization, it made me feel ultra special, and it created a sense of belonging, as well as a sense of loyalty, that nothing else could replicate. It felt really special the fact that this very senior executive and individual in that organization, having global and overall corporate responsibilities, and the fact that they had tens of thousands of employees under their supervision and watch, took some time out of their busy schedule, putting aside a lot of responsibilities, just to be able to connect with me individually. These are memorable moments that are not forgotten, will stay with me for the rest of my humble career; these are instances that-at a moment of a weakness-come into play, occupy your mind and help you and guide you to do the right thing. Memorable opportunities and snapshots of time that will resonate

with you throughout your entire career in that company, and throughout your entire career holistically. You will always remember that conversation, the setting, where you two met, as far as remembering what you had for food and how engaging the conversation was. The best part is when you were given accolades for the great work that you do consistently, you were assured that at the very helm of the organization someone cared, is aware of what is happening despite all that is on their plate, and cares about what's going on in your world is so special and unforgettable. Leaders that invest actual time and energy to inform you that you are worthy of their time, they could be of help to evolve your professional career, are counting on your continued exceptional performance to help you help them, and to collectively continue to grow the company while evolving to the next incredible leader.

Opportunities such as these cannot be replicated through any algorithm and cannot be computerized or replaced; these are moments that must be governed, lead, and absolutely embodied by the human touch and its genuine connection. It is absolutely prudent that we use "fit for purpose" means wherever applicable; the fact that a senior leader took the time to individually connect and share lessons learned and invest in my development and growth is something that is tailored to my career growth, my accomplishments, as well as my progress progression and my specific professional path within the organization; the same senior leader will probably have a different discussion with someone else in the organization that is tailored to their specific needs and aspirations and focused on their fit within the organization and the respective organizational needs of them to best establish the 'win-win" outcomes. Algorithms, software, programs, and any kind of computer language, simple or complex, will fall tremendously short of coming close to simulating, emulating, and replicating such experiences in any way, shape, or form (AON, 2024).

There is just something magical about the human touch, the human connection that builds loyalty; emotional intelligence that reads the body language and allows adjustments on the fly in the approach and the conversation's positioning; social intelligence that allows us to navigate the way and learn about various cultures, and especially to those that we are working with and talking to, and showcasing how we have learned and adapted to their culture, out of respect, courtesy, and sense of belonging as humans. No software, algorithms, or augmented intelligence can pave the way to having these types of connections, such adaptable approaches, and readiness for adjusting the approaches, on the fly, as conversations evolve and mature (LinkedIn, 2024).

Human resource operations are quite critical, often to be frank, underestimated for the impact they have on organizational performance, cultural health, and the ability to enable all the right elements and ingredients that would help evolve healthy cultures that would advance agile strategies and important corporate initiatives forward.

If we master the art of human resources through genuine and integral, as well as authentic human touch and behaviors, we will often see attrition at the lowest rates and loyalty at the highest rates; longer term, you would actually save the company a lot of money because you wouldn't have to pay attrition bonuses, you would not have to worry about Labor laws and lawsuits, and no one would be doing anything but the best of the best to help the company be the best at what it's set to be. Such investments will take time, preparation, consistency, repetitiveness, and require a lot of authentic and from the heart approaches; such strategies require people to be at the heart and soul of everything that the organization does (HBR, 2023). However, such strategies in human operations will trump anything else the corporation tries to do to retain people; obviously we have to invest in everyone's training, betterment and involvement, and sometimes educational advancement, but those are investments that are secure returns and further advance the notions of loyalty, best behavior, and it becomes an

infectious leadership culture that continues to evolve and grow, and the leaders start grooming and growing leaders instead of followers, and the entire organizational health continues to thrive and excel (HBR, 2024).

As they say, there is a time in place for everything; the human touch is applicable in most applications and algorithms and software's are applicable in others. The best approach is to have a systematic body that embodies both approaches, a balanced approach to the holistic leadership and management of all HR requirements and operations (INSEAD, 2024); leverage AI and algorithmic machine learning based software to best advanced operational efficiencies, inclusive of HR operations, help streamline onboarding and training of employees, drive efficiencies in overall benefit's structuring, benchmarking, and salary studies, and set the stage to maximizing on efficiencies of hiring, vetting of candidates, and overall guided approaches of streamlining operational streams. On the other hand, the human touch and connection would be used to take on the most complex of tasks, those that require the human element, connection through emotional and social ties; psychological understanding of behaviors, proper understanding of body languages, and the overall vetting of communications through listening to listen skills, so that the best outcomes of the human connection yield the required results to continue advancing personal, professional, and corporate strategies forward while solidifying a positively driven culturally attractive organization.

There are numerous examples of how we can apply artificial intelligence into streamlining HR operations so that they are more effective, efficient, and a lot more aligned with overall corporate strategies and retaining talent. I will mention a few examples of these, but these should not come at the expense of the human touch and the fact that it is critical and crucial that we stay connected as professional societies and as human resource organizations with all the employees to secure that we are at the pulse of all their requirements while we continue to streamline operations to best serve the organization, the customer, and the overall employee-base. As previously stated above, based on experience and knowledge, it is wise to jointly use both approaches for success.

Artificial intelligence enables the hiring process through having algorithms that would enable applicants' vetting and grouping by filtering through their respective years of experience, scope of work alignments, and geographical suitability; grouping applicants based on their geographical expertise; bundling applicants in categories of core expertise; and another algorithmic enabler would be highlighting applicants time of job application to help hiring managers understand when various applicants, of different experiences and expertise, apply so that they understand how long they need to keep a job posted for. Most jobs, depending on the industry and background, yield hundreds of applications; some applications are meaningful and "fit for purpose" and certain applicants apply regardless of whether they are fit for the job, or not. The right algorithm here would help human resource operations, as well as a hiring managers, filter all the non-qualified applicants immediately and help with time management and efficiency so that the remaining resumes are the best of the applicants' pool and the hiring manager and their respective human resource partners can focus their time on trying to hire the best of the best from the qualified applications that have been sent through the right algorithms' filters and have been vetted and monitored throughout the months to secure trust in the decisions that the algorithm is making.

Reflecting on my years of leadership, I remember having to go through so many resumes and applications – a waste of time – that had nothing to do with the job posted, the expertise it required, and overall years of experience needed. Out of the two hundred applications that were put on my desk, I ended up highlighting three to five that were worthy of interviews during the first round. This is while leading a 500+ strong organization and having operations

across the entire region, and hundreds of millions in profit and loss responsibilities. I would have appreciated having an algorithm, at that time, which would have done all that work for me and saved me hours of meticulous reviews to highlight and select candidates that may be a fit, worthy of an interview.

Another great algorithm that would've helped streamline efficiency and maximize on the outcomes would have been cross checking what people put on their resumes against what they had posted in social media, professional platforms, or LinkedIn and comparing those against what the job's requirements inclusive of its location; several occasions, I had people show up to the interview where somebody else completely wrote their resume and said exactly what the job required them to say and needed of them, but when they showed up for the interview they had nothing to do with their resume and they knew nothing about the job?!

Another great example where AI and algorithms would've helped streamline hiring and expedite readiness would be in algorithms and machine learning securing that all applicants that have applied are willing to relocate for a position, or a country, that the job is required them to be located in; so many candidates would be completely surprised when they show up to their interview, we tell him/her that the job is based in "country X", and their immediate responses are "I did not know that, this may be a problem for me". The reason this is so ineffective and inefficient is most of the time these candidates end up being ideally fit for the role, but they are unwilling to relocate; therefore, we have just wasted organizational revenue and resources as well as the hiring managers' time.

These type of inefficiencies, as well as misalignments, are quite avoidable; the right algorithms in place will definitely secure such events not to be repeatable; most of the people looking after hiring are stretched in so many directions, hiring managers are wearing so many hats- having to do so many things all at the same time- details end up being missed, and as a result inefficiencies are realized and experiences are diluted.

The above are highlighted examples, some of many, that happen on a day-to-day basis in typical human resource operations amongst most organizations; these are specific to the act of hiring, which is one of many operational aspects of human resource organizations. Envision the impact AI and trusted algorithms can have on assigning the right training for the right employee filling the right and required gaps to attain the right professional growth and realize that required organizational potential; envisage streamlining the on boarding process and making it seamless, effective, and quite timely, with all the right resources allocated, at the right time and in the right place, and all the required trainings assigned, and all the introductions required made so that the onboarding processes of employees are seamless, done in record time, and the employees are as close as possible to readiness, on day one, to hitting the ground running and starting to realize personal and organizational growths from day one! How impactful, productive, and effective would it be using algorithms to set the travel schedules properly for employees, executives, leaders, and across the organizational org structures; looking at all the required safety and compliance check points, securing all the right approvals are in place automatically via vetted delegation of authority matrices that are all approved, vetted, and trusted so that the employees' travel plans, approvals and expenses' allocations are on all in place in a timely manner while securing cost competitiveness.

The above are real-life examples of some very simple and basic aspects of day-to-day operations in normal and massive organizations that must streamline operational efficiencies, make life a lot easier for everyone, and secure that the right resources are spent at the right and highest payoff activities; inefficiencies are avoided, frustrations are eliminated, and the right tasks are assigned and executed by the right algorithms. There is a time and a place for everything, and we need to have the right tools for the right jobs used for the right purposes to

yield the best results without taking away from the experiences, affecting outcomes, and living the moments.

However, algorithms and artificial intelligence cannot replace the human touch. They can enable better experiences through streamlining efficiencies and securing that all the administrative jobs can be looked after effectively and efficiently, so that leaders and human resource partners can focus on the human touch, enabling the best employee retention plans, hiring, onboarding, and growth and grooming.

Throughout my humble career and experiences, as a senior leader, I have had the privilege of leading a lot of team teams, and being able to build a lot of successful businesses centered around purposeful, enthusiastic, energetic, and laser focused teams and cultures. I was personally involved in every aspect of the business, I made sure that every employee to the best of my abilities taken care of, and I made sure that the top ten to fifteen percent of the organization had personal time and connection with me.

People leadership, leadership in general, is one of the most sophisticated aspects of running a business; if gone right, cultures thrive and results are realized-everybody wins; if gone wrong, cultures are toxic and results are not realized, and therefore everybody loses. Such an impeccable and impactful mission cannot be assigned to algorithms, no matter how sophisticated and encompassing the algorithm is, as it will never be able to simulate every single aspect of human interactions and the human touch.

Throughout my various leadership journeys, I have had the pleasure of mentoring and coaching team members, male and female, and from all aspects and places of the world, and that is one leadership trait that for sure cannot be simulated through any algorithm. Mentorship and coaching are very vital to creating loyalty, helping professionals move their careers forward and correctly paced, and it may sometimes end up morphing into being a personal consultation, navigating through a personal affair, which may result in saving lives and keeping families together.

These types of personal and tailored employee discussions require preparation, agility, adaptability, confidentiality, and most importantly trust and integrity that always govern the entire conversations. There is no room for errors, no room for absolute value responses, and no progression without the ability to read emotional reactions and understand body language. These are the type of conversations that can only be led by humans, understood by humans, and governed by the human touch that positions for best overall outcomes. Talking to a female supervisor leading a field job in Iraq is a completely different discussion then a female professional leading an entire team on an offshore rig in Algeria and is yet a completely different discussion then a mid-career female talent leading an entire business in North America or trying to make the next big organizational restructuring in Europe. Such discussions would also be quite different talking to a Hispanic male supervisor that is running a job offshore in the Gulf of America in comparison to a discussion with an African male professional running a drilling rig in the middle of the equator rainforest. Having a discussion with an employee that is excelling at their job to take a role based in Angola and convince them that it's the right next career move for them, looking forward two to three years down the road, is not a discussion you can have every single day and you have to prepare for that; no AI will help you have that discussion effectively, and no professional will accept that discussion, ready to make that decision, if the conversation was AI lead or algorithmically configured.

Globalization versus localization is also best leveraged and executed through experienced human interactions and intelligently guided personal discussions. Part of being a global company working in local markets is knowing exactly how to leverage the local talent and give back to the local communities, so that you are adding value and creating positive content

within the country the business is benefiting. Maturities of various local markets varies, having the experience of working in various local and global markets, one will find that the cultural and professional maturities, as well as cultural and professional readiness, vary from one country to the other, and vary within the same country itself based on specific in-country advancements. You must deal with cultural entitlement, and you must deal with various cultural gaps and classes within the same community to best tailor the message, go to market strategies, and operational initiative.

Another particularly important and critical area where algorithms and artificial intelligence fall short of replacing, or replicating, the human touch and connection is "communication." Clear, crisp, and concise communication is essential to any organizational success; it is imperative that the human touch remains quite involved in all kinds of critical communication to secure full alignments, clear understanding, and elimination of any gaps, or mistranslation of imperative objectives.

Messaging and understanding communication vary from one organization to the other, and within the organization it varies from one individual to another, from one country to the other, from one group of companies to another, and from one product company to another within the same organization. The governing factors that impede proper communication center around experience, age, communication, barriers, language barriers, connectivity barriers, and general other challenges, inclusive of, but not limited to, maturity and age.

Additionally, all strategies, initiatives, and overall intelligence must be communicated across all levels of the organization with the most effective means available, sometimes it is generic overall blanket communications. However, to drive the right understanding forward and to enable full alignment on all the goals and objectives to secure that everybody understands what's required in order to meet the overall corporate strategies' objectives, leaders would have to get involved personally; generally, setup mini town halls and group meetings in order to secure that everybody is aligned and has gotten the message's essence to the best of their abilities; you would find that many mini-announcements follow the big message to break it down, enable its intake, and to secure alignments and intelligence absorption.

3.2.2 Explainability

The possibilities of algorithmic based decisions' challenge are high, forcing leaders and managers to need for readiness to explain mechanisms of the algorithmic decisions, methodologies for the decisions, and results' explanation and articulation. There's something about meeting, face-to-face, and having group discussions; fire-side chats that clear the air and enable unity or huddling in a boardroom and discussing initiatives and strategies as teams that algorithms cannot replicate; the power of the human connection far surpasses any intelligence any algorithm can put together to decipher any human emotional code or deliver any human required message. As highlighted above in earlier and previous sections, every aspect of artificial intelligence and algorithms play a critical role in streamlining human operations, and securing that things are efficient and running smoothly; however, it will be quite difficult and challenging for any algorithm or artificial intelligence to replace the human touch and the human connection that far supersedes any other.

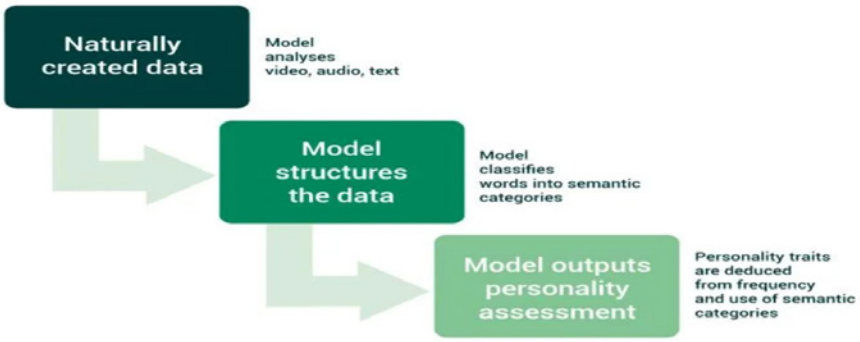

Figure 2: Factors Determining Organizations' Readiness for AI Implementations (INSEAD, 2024)

3.2.3 Back to Operations: Employee Reactions to Algorithmic Decisions

The above not only is a challenge of communication but also underpins the challenge that algorithm and artificial intelligence would have in taking on this initiative and securing clear and concise communication across the organization. Human touch is necessary, and it far outpaces and outperforms any algorithm set to secure clarity in communication happens across the board. The human touch has an impact, which is far more effective than algorithmic decisions (LinkedIn, 2024). The above facts do not negate the fact that sometimes as humans we respond more favorably to algorithmic based decisions than we do otherwise: no benefits' increase, or no raise, for example.

3.3 Discussions

This section addresses the AI challenges in HR management and offers practical recommendations. Table 1 summarizes recommendations, with the "Operations" column positioned at the end to address the changes brought about by algorithms. Recommendations are made to help streamline and address the potential challenges (IBM, 2024).

Table 2. Possible Pathways to Challenges of AI and The Human Touch, created by author.

Challenges	Responses			
	Information	Algorithm's Adaptability	Decision-Making	Operations
HR's Outcomes' Complexities	Employees' buy-in into the metric	Diversify of outputs through various algorithms' designs	Managers' discretion is based on the algorithm's predictions, experiments based	Timely checks and reviews
Data	diversified data use measure it against operational and financial performances; validate through third party vendors	Use vendor-trained models	Managers' guided involvement with algorithm's recommendations	practice and reverse design continuously
Accountabilities; conformance to labor laws	Evolving training modules	Errors' balances and checks	Diversify choices with probabilities algorithmic predictions	Specify a code of ethics for AI-related initiatives. Stand an AI Committee
Employees' Reactions	vetting	Attain employees' guidance	Double check decisions; benchmark	Attain employee feedback; monitor reactions and engagements

We all need help, these days; delegation of tasks is one of the many effective ways used by mature and effective leadership to try to grow and groom, talent, expose them to you and diversify initiatives, as well as enable their contribution to the team while being stretched on their assignments within their bandwidth. Delegation of tasks, based on certain outcomes, thresholds, and set indicators, can be automated via algorithms, and can be set as a tool through

software to best enable association of various tasks to specific team members, and it can help match those initiatives to the team's skill sets and expertise. The byproduct benefits of this are numerous as it allows for proper allocation of resources, maximizing on efficiency of manpower, and securing that the entire output of work is a shared success amongst the team where everybody contributed within their means, as well as learned, evolved, and matured during the process (AON, 2024).

I have spoken, above, about communication and its challenges as well as opportunities and enablement, and the fact that the art of communication remains one of the main challenges of all elite organizations. What a way to use algorithms and software, as well as artificial intelligence, to streamline workload, maximize on the resources in place, strengthen the team spirit, reduce overall costs while maximizing profits, and secure opening lines of communication that would not have been possible before. This is another standup effective example of how-to best leverage algorithms and artificial intelligence to best enable alignments on key performance indicators while securing that everyone is treated fairly, as everyone got assigned exactly what they are capable handling while complementing some of the gaps in skills they have (HBR, 2024).

Reputable organizations that are looking at maximizing their leaders efficiency while securing they optimize their time on effectively, communicating strategy, connecting with the overall manpower group, and securing that their high talent and top performers always have consistent communication and touch points with their senior executive leadership team will leverage Algorithms and artificial intelligence to enable streamlining efficient approaches to leading the business while making sure that is governed with compliance, checks and measures, and maximizing the chances for everyone's success (INEAD, 2024). This is critical for business continuity, not to mention maximizing the success of coaching, mentoring, and overall guided talent discussions whereas both the coach and coached need to invest energy, time, preparation, and effort to maximize the chances of talent preparation, growth, and grooming.

An example that comes to mind is the automated auditing of expenses, employee submissions of their spend on behalf of company, credit cards, and making sure that those spends are done according to the rules and guidelines of compliance, professional business conduct, and overall corporate guidelines for spending money on behalf of the organization to advance its business strategies. These automation and auditing tools will help streamline some of the administrative tasks that leaders have to embark on and complete while leading an organization, and that will help maximize their time allocation, securing that they invest as much of their rime as possible towards management of human resources' initiatives and overall operational excellence that drive the right outcomes and business results.

Great leaders know that for them to move onto their next career growth opportunity, they would have had to prepare their next few replacements and must be ready for the plug and play option to best secure business continuity. This does not happen if talent management is not well invested into, and if the right training and grooming initiatives are not fostered, applied, and advanced (HBR, 2024).

3.4 Conclusions

In an ever-changing and quite difficult to lead and complex business environments, where emerging industries are at the spotlight of all attention, progressing at impressive advancement rates and attracting talent and investors; where time management and availability are super critical and finding the right time allocation for all the required leadership initiatives and tasks,

taken on by managers and senior leaders, arts that not many are able to master and excel at; at times where most leaders are stretched, human resource departments are resource-thin, and strategic information and compelling intelligence are readily available at employees' fingertips, algorithm and artificial intelligence leverages and deployment becomes an inevitable initiative and business tool that is prudent to embrace (AON, 2024).

Hope must guide what we do; intentions must be at the highest of levels and forms, and experiences and expertise must be at the heart of the strategies organizations set and the heartbeat of the cultural pillars' teams are founded upon. No algorithm or artificial intelligence can replace the human touch and intelligent interactions, but they must coexist in manners that enable efficient approaches, collaborative spirits, and continuous improvement mindsets where these algorithms continue to improve and evolve as business challenges and team and talent management continue to get more complex, transition, and advance forward (INSEAD, 2024).

It is imperative to use algorithms and to embody AI correctly; a must for business continuity as well as for excelling in an ever-challenging environment, whereas fierce competition for top talent is at its highest peaks, emerging and more attractive industries are evolving quickly, and adaptability, as well as flexibility to remote work environments remains a controversy. Leveraging these tools, we have and partnering with technological solutions that will set organizations and teams apart are as smart and creative, as well as hopeful and well-intentioned, of business strategies to advance mastery of the art of business performance.

I have made bold statements above throughout this chapter, one of which is that talent, people, and high performance must be at the heart of everything elite organizations do. Leadership with soul must guide and transition business initiatives into better arenas and help realize better and more effective outcomes. Organizations without the right talent and people are like a plant without water; survival chances are minimized while continuity and survivability are dwarfed (LinkedIn, 2024).

Leadership through algorithm and artificial intelligence, must be assisted and enabled to lead the various business initiatives, align with administrative tasks to enable focus on the right talent, grooming, and growth, so that the strategies and focus areas of the business are realized. Yesterday's way of leading an organization will not survive or continue for tomorrow's business environment; what used to work in the past will not work in the future. Evolvement is necessary, aligning with the times is inevitable, and progressing with technological innovation and solutions, in all aspects of the business, are essential; especially when it comes to leading the right human resource initiatives. It is frightening and overall worrying to know that less than 25% of organizations have embodied any means, or form, of artificial intelligence; scary and worrying to learn that talent and generational progress is outpacing organizational agility, ability to contain and evolved at the same rates (INSEAD, 2024).

Causal reasoning is the first principle relevant to addressing these challenges across the stages of the AI Life Cycle as it helps with issues of fairness and explainability (IBM, 2024). Causal reasoning has both benefits and limitations. Employers must first accept the greater costs, and lower predictive power from their algorithms, and they must work to develop consensus about causal assumptions in advance of modeling. These challenges explain why the data science community is often skeptical about reasoning AI systems (HBR, 2023).

Randomization is a second principle that can help with algorithmic-based decisions, in part, recognizing that what constitutes "noise" in modeling is useful for improving algorithmic models. Our surprising conclusion is that fairness and explainability in HR decisions improve significantly by recognizing algorithm limitations and adding an element of randomness (van Esch P., 2021).

The art of communication remains to be one of the most challenging initiatives any

organization takes on; gaps in communication, misunderstanding of information across the various organizational levels, translation of objectives as it gets communicated down the organization, and overall professional experiences and maturities, affect the ability to translate the goals and objectives into actionable initiatives that yield the results they were intended for.

Implementing data analytics will enable the HR function to integrate more effectively with other business areas, especially finance and operations. HR leaders face the risk that if they do not actively engage with the potential of AI, another business function may assume control over it (INSEAD, 2024).

Leaders should adopt AI, organizations should train for its use, and employees should accept it. All actions should be guided by ethical principles, human considerations, and data integrity (Jobylon, 2024). Efficiency, technology, and balanced approaches do not necessarily always align. AI-management tools and HR need to align to best drive meaningful, impactful, reliable outcomes (van Esch P., 2021).

I call upon all leadership to put artificial intelligence to best use; embody its many ways and forms of advancements, and best position their organizations for today's and tomorrow's challenges, needs, progress, and successes. Organizations that are best leveraging artificial intelligence tools, the right algorithms that continue to evolve and improve, will be leading the charge in business growth and maturity, investors' attraction and trust, business lines' adaptability and improvement, as well as talent attraction, and retention. Such organizations will be able to do all of this while performing at the highest levels of profitability while instilling the most efficient cost structures (HBR, 2024).

3.5 References

AON. (2024). *How Artificial Intelligence is Transforming Human Resources and the Workforce*. https://www.aon.com/en/insights/articles/how-artificial-intelligence-is-transforming-human-resources-and-the-workforce

Black S., van Esch P. (2021). *AI-Enabled Recruiting in the War for Talent*. Business Horizons, 64(4), pp513-524. https://www.insead.edu/faculty-research/publications/journal-articles/ai-enabled-recruiting-war-talent

IBMI. (2024). *International Business Management Institute*. https://www.ibm-institute.com/

IBM. (2024). *Artificial Intelligence and a New Era of Human Resources. https://www.ibm.com/think/topics/ai-in-hr*

INSEAD. (2024). *How Businesses Can Survive the AI "Black Hole". https://knowledge.insead.edu/strategy/how-businesses-can-survive-ai-black-hole*

HBR. (2023). *4 Actions HR Leaders Can Take to Harness the Potential of AI.* https://hbr.org/sponsored/2023/11/4-actions-hr-leaders-can-take-to-harness-the-potential-of-ai

HBR. (2024). *Where AI Can — and Cannot — Help Talent Management. https://hbr.org/2022/10/where-ai-can-and-cant-help-talent-management*

Jobylon. (2024). https://www.jobylon.com/blog/ai-in-hr/

LinkedIn. (2024). *Artificial Intelligence (AI) Impact on Human Resources (HR)*. https://www.linkedin.com/pulse/artificial-intelligence-ai-impact-human-resourceshr-gummudu

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Chapter 4 - The Sustainability Paradox of Artificial Intelligence: How AI Both Saves and Challenges Resource Management Efforts

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Abstract

The net gain of AI and sustainable development remains a critical area of inquiry, as Artificial Intelligence (AI) offers opportunities and challenges in advancing sustainability. AI offers benefits like optimized energy use and improved resource efficiency, but its rapid adoption also results in high energy consumption, increased e-waste, and resource depletion. This contradiction is referred to as the Sustainability Paradox and calls for a structured evaluation of AI's impact. The Sustainable AI Impact Assessment Framework (SAIAF) serves as a tool to measure AI's role in sustainability while accounting for its unintended consequences. It assesses AI across three dimensions: environmental (carbon footprint, energy use), social (labor market changes, ethical issues), and economic (cost efficiency, long-term resilience). Case studies in precision agriculture and smart energy grids demonstrate how SAIAF aids policymakers and industries in minimizing negative impacts while enhancing the sustainability gains of AI. However, fragmented global policies complicate the effective implementation of AI for sustainability, leading to inconsistent regulations and misaligned objectives. This paper highlights the importance of cohesive AI governance and shared sustainability standards. By incorporating SAIAF into policies and industry practices, AI can shift from being resource-heavy to becoming a strategic sustainability ally. The study suggests further research on the sustainability of AI lifecycles, adaptive policies, and innovations in energy-efficient AI systems for a more balanced and responsible future.

Keywords: *Sustainable AI, AI and Environmental Sustainability, Energy-Efficient AI and Green Technology, Sustainable AI Impact Assessment, AI Policy and Global Sustainability;*

4.1 Introduction

Artificial intelligence would be key to achieving the UN Sustainable Development Goals (SDGs) across various sectors (Vinuesa et al., 2020). Its advanced capabilities enable organizations to monitor environmental changes, predict outcomes, and improve efficiency like never before (Weforum, 2024). For example, AI in precision agriculture uses satellite imagery, weather forecasts, and soil sensor data to optimize water, fertilizers, and pesticides, resulting in higher crop yields and reduced environmental impact (Winston, 2024). While AI offers significant benefits for sustainability initiatives, it may not be an absolute solution. The rapid growth of artificial intelligence (AI) offers both opportunities and significant challenges for sustainability. Complex AI models require a significant amount of energy. For instance, a single ChatGPT query uses nearly ten times the electricity of a standard Google search. AI applications could lead to a 160% increase in data center power demand by 2030 (Goldman Sachs). There are concerns about its high energy consumption, the resource-intensive production of AI hardware, and potential socio-economic disruptions due to automation and technological inequalities (Tabbakh et al., 2024; Patterson et al., 2021). For example, Vinuesa et al. (2020) found that AI could aid in achieving 134 Sustainable Development Goal (SDG) targets, but it could also hinder progress on 59 targets, highlighting its mixed impact.

Sustainability is a critical component of contemporary development initiatives, striving to harmonize environmental, economic, and social dimensions to address current needs without jeopardizing future generations (Brundtland, 1987). Nonetheless, well-intentioned sustainability efforts can occasionally yield unintended consequences, giving rise to what this chapter termed the Sustainability Paradox. The chapter defines Sustainability Paradox as the phenomenon of well-intentioned sustainability initiatives that inadvertently result in negative consequences.

In the early 2000s, biofuels were promoted as a sustainable alternative to fossil fuels to lower greenhouse gas emissions and decrease reliance on non-renewable energy. Governments encouraged using crops such as corn, sugarcane, and palm oil for biofuel production. However, this led to significant negative consequences: Deforestation in Southeast Asia and the Amazon has led to significant forest clearing for palm oil plantations, resulting in biodiversity loss and higher carbon emissions. This undermines the environmental benefits of biofuels (Oliveira et al., 2021; Gao, 2011). The movement of agricultural resources to biofuels has raised global food prices, making staple crops less affordable for vulnerable populations, particularly in low-income countries (Liu & Wang, 2022).

Electric vehicles (EVs) are marketed as a sustainable way to cut greenhouse gas emissions and air pollution. They do reduce emissions by decreasing reliance on fossil fuels, but their production and disposal can have substantial negative effects: Mining for rare-earth minerals used in EV batteries, such as lithium, cobalt, and nickel, leads to significant environmental damage. It results in deforestation, soil erosion, and water contamination. For example, lithium extraction in South America's "Lithium Triangle" can use up to 500,000 gallons of water per ton, causing severe water shortages (Ahmad, 2024). Furthermore, mining activities contribute to greenhouse gas emissions, potentially negating some of the carbon savings from electric vehicles (Dunn et al., 2012). In the Democratic Republic of Congo, where over 70% of the world's cobalt is mined, exploitative labor practices, such as child labor and unsafe working conditions, are widespread (Amnesty International, 2024).

Battery recycling faces significant challenges due to a lack of infrastructure for lithium-ion batteries, leading to increased electronic waste. Improper disposal can release harmful

chemicals into the environment (Forti et al., 2022).

Both examples demonstrate that sustainability initiatives can lead to unintended environmental and social challenges. It highlights the urgent need to assess the impacts of the Sustainability Paradox and develop strategies that align AI development with sustainability principles to maximize benefits and reduce risks. This chapter evaluates the lifecycle impacts of AI initiatives, focusing on addressing unintended consequences to protect resources for future generations. It explores the balance between AI innovation and sustainable resource management, emphasizing AI's crucial role in advancing sustainable development while promoting resilience and equity.

4.1.1 Definition of Scope and Terms of Chapter

The definitions provided below will help clarify the terminology utilized throughout the chapter and the scope of these terms.

- *Sustainability*: Sustainability is commonly viewed through an environmental lens (Bosselmann, 2010). However, this chapter takes Purvis and Robinson's (2019) multidimensional approach to incorporating environmental, economic, and social factors into its scope. It also refers to the Brundtland Report (1987), which defines sustainability as development that satisfies present needs without compromising future generations' ability to meet theirs.

- *Artificial Intelligence:* The advancement of machines equipped with human-like intelligence enables them to perform diverse tasks and make informed decisions that traditionally necessitate human cognitive abilities (Kok et al., 2009).

4.1.2 The Sustainability Paradox

Sustainability represents a fundamental focus in contemporary development, aimed at balancing environmental, economic, and social needs to secure the well-being of both present and future generations (Brundtland, 1987). At its essence, sustainability initiatives underscore the importance of efficient resource utilization, the adoption of renewable energy sources, and the development of sustainable supply chains (Brundtland, 1987; Wang, 2021). Nonetheless, despite these well-meaning endeavors, sustainability practices may occasionally yield unintended negative consequences, referred to in the chapter as the Sustainability Paradox. This paradox manifests when actions intended to improve sustainability inadvertently exacerbate environmental degradation or intensify social inequalities. For example, sustainability initiatives frequently expose deficiencies in conventional resource management practices, revealing underlying trade-offs that might lead to counterproductive results. These challenges underscore the necessity for proactive strategies that anticipate and mitigate potential drawbacks prior to their escalation.

4.1.3 The Sustainability Paradox in AI Applications

AI-driven sustainability solutions hold potential in various industries (Weforum, 2024), but they also create new environmental and social trade-offs toward the Sustainable Development Goals (SDGs) (Vinuesa et al., 2020).

AI in Precision Agriculture:

- Mitigation: AI-driven predictive analytics enhance the use of water, fertilizers, and pesticides, boosting crop yields while reducing resource waste (Winston, 2024).
- Contribution to the Paradox: The production of AI hardware for agriculture depends on rare-earth elements, leading to resource depletion (Oliveira et al., 2021).

AI in Smart Energy Grids:

- Mitigation: AI improves renewable energy integration and stabilizes the grid (Patterson et al., 2021).
- Contribution to the Paradox: AI-driven energy optimization demands high computational power, which can raise overall electricity consumption and may depend on fossil fuel-based grids (Bender et al., 2021).

Table 1 contrasts traditional sustainability efforts with those to prevent the Sustainability Paradox. While traditional sustainability strives to balance environmental, economic, and social factors, prevention of the Sustainability Paradox focuses on avoiding negative consequences from these efforts. The goal is to prevent depletion and deterioration due to overuse or mismanagement (Singh et al., 2023). Understanding both perspectives is necessary for building resilient and adaptive frameworks. Organizations and policymakers can better tackle sustainability challenges by implementing early intervention measures and strategic resource management. This approach helps ensure that well-meaning initiatives do not undermine long-term sustainability goals.

Table 1: *Traditional Sustainability and Sustainability Paradox Comparison*

ASPECT	Traditional Sustainability	Sustainability Paradox
DEFINITION	Emphasizes the need to balance environmental, economic, and social factors for sustainable resource availability and well-being (Brundtland, 1987).	Practices or initiatives that unintentionally harm the environment or exacerbate social inequalities, ultimately failing their sustainability goals.
PRYMARY OBJECTIVE	Uses resources in a way that fulfills current needs without jeopardizing the ability of future generations to meet theirs.	Identifies and addresses unintended negative effects of sustainability efforts to avoid harm.

FOCUS	Design systems that balance resource use, environmental preservation, and social equity (Sueyoshi & Goto, 2019).	Analyse and address the secondary or hidden impacts of sustainability practices.
APPROACH	Promotes renewable energy, waste reduction, and green technologies for ecological harmony (Wang, 2021).	Assess the lifecycle and broader impacts of "sustainable" initiatives to identify potential issues like resource depletion or inequity.
O U T C O M E RISKS	Focusing only on short-term goals can lead to overlooked long-term unintended effects (Sueyoshi & Goto, 2019).	Directly addresses long-term risks by re-evaluating sustainability practices to reduce harm.

Source: The Author (2025)

The intersection of Artificial Intelligence (AI) and sustainability also includes:

4.1.4 AI as a Tool to Promote Sustainability

Energy Optimization AI monitors and enhances energy consumption across diverse industries. Machine learning algorithms significantly improve the efficiency of renewable energy grids, facilitating more effective integration of wind and solar power (Wang, 2021). These advancements highlight AI's potential to conserve energy and reduce carbon emissions. Furthermore, AI-driven predictive analytics are instrumental in optimizing supply chain operations and recycling processes, contributing to waste minimization and the efficient use of materials. For example, these algorithms enhance the sorting of electronic waste and the extraction of rare-earth elements, thereby fostering sustainability in material reserves (Forti et al., 2022). Recent advances in AI, such as transfer and federated learning, reduce reliance on large, centralized datasets, helping preserve data resources. These methods enable the reuse of existing datasets while ensuring privacy and promoting diversity (Sun et al., 2022). AI-enabled platforms in education improve individuals' skills for success in AI-driven economies. Adaptive learning systems, which tailor content to individual needs, are incredibly effective (Nguyen et al., 2023).

4.1.5 AI as Contributor to Sustainability Paradox

Energy Reserves

Artificial intelligence and bottomless learning models consume much energy, producing high CO□ emissions. Patterson et al. (2021) indicate that training advanced models can require as much energy as a small town. This highlights the importance of AI's sustainability regarding non-renewable energy resources.

Material Reserves

Producing AI-related hardware like GPUs and TPUs requires rare-earth metals such as lithium, cobalt, and neodymium. Extracting and processing these materials can cause serious environmental harm and raise sustainability concerns (Oliveira et al., 2021). Additionally, the quick obsolescence of this hardware contributes to the increasing problem of electronic waste, making it harder to manage these crucial resources.

Data Reserves

AI relies on large datasets for training, but gathering this data can harm social and informational integrity. Dependence on user-generated data raises privacy issues and diminishes trust. Furthermore, biased data collection limits diversity in datasets, which weakens sustainable AI solutions (Bender et al., 2021).

Human Capacity Reserves

AI automation can displace workers and erode traditional skills, leading to socio-economic challenges that threaten social equity, which is crucial for societal stability and progress (Manyika et al., 2017).

4.2 Related Literature

Artificial intelligence offers immense potential for organizations. However, business leaders must recognize how AI could complicate their sustainability goals and find a way to balance these conflicting demands (Ganesan & Mosier, 2024). Research shows that data centers for AI servers contribute to electronic waste, heavily consume water resources, and depend on unsustainably mined critical minerals and rare elements (UNEP, 2024). These centers also use vast amounts of electricity, leading to greenhouse gas emissions (UNEP, 2024). A recent review by Hagendorf (2024) emphasizes the pressing need to address AI's environmental impact. Solutions include adopting renewable energy and using energy-efficient hardware for generative AI systems (Bender et al., 2021; Patterson et al., 2021). Generative AI models demand considerable energy, water for cooling, and specialized hardware that relies on rare metals (Bender et al., 2021; Gill & Kaur, 2023). Extracting these resources often contributes to further environmental damage (Shelby et al., 2023).

Global Challenge: Policy Fragmentation and AI Sustainability

Fragmented global policies, primarily shaped by Western perspectives, challenge aligning artificial intelligence (AI) innovations with sustainability goals (Frimpong, 2024). Different regulatory frameworks across regions hinder coordinated international efforts to address the environmental, social, and economic issues AI systems pose. Policy fragmentation results in inconsistent standards and uneven enforcement among countries (Gogsadze, 2022). Scholars argue that fragmented policies contribute to the Sustainability Paradox by allowing unsustainable practices to persist (Oliveira et al., 2021). This lack of cooperation impacts critical concerns like environmental sustainability and the fair deployment of AI. Without unified policies, countries prioritize their interests, causing duplication of efforts and inefficiencies

(European Commission, 2024). For instance, while the EU has implemented regulations like the AI Act and GDPR, many regions lack similar standards, creating discrepancies that slow international progress. This lack of a global framework for governing AI development and deployment hinders sustainability innovations.

Regulatory Disparities

There are notable regulatory differences regarding AI between developed and developing regions. Developed economies, especially in Europe, have implemented strict policies on ethical AI use, data protection, and sustainability. For example, the European AI Act aims to create a risk-based framework for AI governance that ensures transparency and accountability and considers environmental impacts (European Commission, 2024). Due to limited resources, developing economies often lack strong regulatory mechanisms and focus on economic development and poverty alleviation (Amnesty International, 2024). They typically implement lenient regulations to attract foreign investment, resulting in poor enforcement of labor and environmental laws. This leads to ecological damage and exploitative labor practices in resource extraction for AI hardware production (Oliveira et al., 2021).

The difference in regulatory standards creates an uneven playing field. Developed regions gain from high governance while shifting harmful practices to less-regulated areas. This gap underscores the need for international cooperation to establish consistent AI sustainability standards.

Resource Imbalances

The uneven distribution of resources complicates global policy alignment. Wealthy nations with advanced technology, like Japan and Germany, can invest in renewable energy and effective recycling systems to promote sustainable AI practices. For example, they have established efficient recycling programs for rare-earth materials essential for AI hardware (Oliveira et al., 2021). In contrast, developing countries that rely on resource extraction often struggle to address the environmental and social costs of mining. For instance, mining for lithium and cobalt in the Democratic Republic of Congo (DRC) causes significant environmental damage and deepens socio-economic inequalities (Amnesty International, 2024).

Universal Patterns

Existing research on AI and the Sustainability Paradox reveals significant insights highlighting patterns and contradictions in the relationship between AI technologies and global sustainability efforts.

Energy-Intensive AI Models as a Universal Concern

Training large AI models like GPT-4 and AlphaFold significantly contributes to global carbon emissions (Strubell et al., 2019; Patterson et al., 2021). This is especially problematic in regions where fossil fuels power data centers, such as parts of Asia and the Middle East.

In Europe and North America, data centers using renewable energy help reduce AI's negative energy impacts (Wang, 2021). However, these sustainable solutions are not evenly distributed, creating disparities in AI's energy efficiency across regions.

Material Resource Depletion

Extracting and recycling resources for AI hardware poses a significant global challenge. Mining rare-earth elements like lithium and cobalt predominantly occur in low-income countries such as the Democratic Republic of Congo and Bolivia, often resulting in environmental harm and socio-political issues (Oliveira et al., 2021; Amnesty International, 2024). Conversely, wealthier regions consume these resources at an unfair rate and lack proper recycling facilities. Developed economies like the EU and Japan are investing in material recycling innovations, but low-income regions, where mining has the most significant environmental impact, are lagging.

Data Exploitation and Privacy Concerns

AI relies heavily on large datasets, which raises concerns about data equity, privacy, and algorithm biases. Research by Bender et al. (2021) and Sun et al. (2022) indicates that the quality and diversity of these datasets are often inadequate, hindering AI's effectiveness in supporting equitable sustainability goals. Privacy and data ethics are prioritized in regions with strong data governance, like the EU under GDPR. Conversely, countries with weak data protection laws, such as some in Southeast Asia and Africa, face higher risks of data exploitation and loss of information security.

Social Impact and Workforce Inequities

The rise of AI-driven automation is resulting in significant job displacement on a global scale, particularly within low-skill sectors. As highlighted by Manyika et al. (2017), this trend raises important concerns regarding social inequities, which threaten the sustainability of the workforce. Advanced economies typically provide reskilling programs to address job losses, but such initiatives are rare in developing regions. This lack of resources increases inequalities, leaving workers in less developed areas more vulnerable to the impacts of automation.

Technological Progress vs. Sustainability Trade-offs

AI technologies offer efficiency and sustainability, but their environmental impact can negate these benefits. For instance, while AI-driven energy optimization, like smart grids, helps reduce emissions, the high carbon costs of AI model training can undermine these gains (Bolón-Canedo et al., 2024). Contradictions also exist in transportation, as autonomous vehicles lower local emissions but rely on resource-heavy global AI infrastructure.

Regional Disparities in Resource Management

Countries in the Global South, rich in resources, are experiencing environmental degradation due to mining activities. In contrast, nations in the Global North, which consume these resources, are reaping the benefits of technological advancements without addressing the underlying causes of resource depletion (Amnesty International, 2024). This situation highlights regional inequalities, as the environmental costs are disproportionately shouldered by developing regions, while the benefits primarily flow to developed economies.

Policy Gaps and Fragmentation

While some regions, such as the EU, have implemented strict AI and sustainability guidelines, others are falling behind in establishing policies to regulate AI's environmental and social impacts. This regulatory fragmentation leads to inconsistent global efforts to address the Sustainability Paradox.

Energy Sources and Infrastructure

Regions with abundant renewable energy resources, such as Scandinavia, have a competitive advantage in reducing artificial intelligence's (AI) carbon footprint. In contrast, developing countries that rely on coal or natural gas face more significant challenges in aligning AI deployment with energy sustainability goals (Wang, 2021).

Cultural and Ethical Variations

Privacy and data governance norms differ significantly across cultures. For instance, the European Union strongly emphasizes individual privacy, while countries like China use data more liberally for AI development. These cultural and regulatory differences affect how Sustainability Paradox issues related to data exploitation can arise (Sun et al., 2022).

Economic and Workforce Impacts

High-income regions invest heavily in reskilling programs to mitigate the disruptions caused by AI in the workforce. However, developing regions often lack the necessary infrastructure or funding to implement similar initiatives, exacerbating global inequalities (Manyika et al., 2017). There is no universally accepted framework for evaluating AI's impact on Sustainability Paradox. Research in this area is often fragmented, focusing on specific issues like energy consumption and electronic waste without adequately addressing their interconnections.

4.3 Key Gaps and Research Questions

The literature shows a complex relationship between AI's benefits and unintended consequences, shaped by patterns and regional differences. While AI can significantly enhance sustainability, it presents significant challenges in energy consumption, resource management, and social equity.

There is no established methodology to evaluate the Sustainability Paradox holistically, particularly in AI-driven sectors. Current literature focuses on isolated aspects of AI's unintended consequences, such as energy consumption, resource depletion, or social inequities. However, a comprehensive framework connecting these interdependent issues remains absent. For example, the relationship between AI-driven automation (social impact) and its reliance on energy-intensive computation (environmental impact) is inadequately explored.

AI's dual role as a contributor to and a mitigator of the Sustainability Paradox lacks nuanced analysis. For instance, how AI can simultaneously drive efficiency in renewable energy systems and exacerbate resource exploitation through hardware demands remains underexplored.

Significance of Research

Addressing the research gaps will enhance our understanding of AI's impact on global sustainability through the concept of the Sustainability Paradox. This work will create practical frameworks and metrics for policymakers, industries, and researchers. It will also support equitable AI deployment in resource-constrained regions and inform strategies that balance AI innovation with sustainability, ensuring long-term benefits and reducing unintended consequences.

4.4 Sustainable AI Impact Assessment Framework

To address the shortcomings in evaluating the sustainability impacts of artificial intelligence, this chapter presents the Sustainable AI Impact Assessment Framework (SAIAF) (see Figure 2). This framework encompasses holistic dimensions, lifecycle assessments, and dual role pathways, offering a comprehensive methodology to mitigate the Sustainability Paradox. The SAIAF emphasizes the interconnected effects of AI projects to ensure that sustainability solutions do not unintentionally exacerbate existing environmental and social issues. As illustrated in Figure 1, the framework assesses AI impacts through lifecycle analysis, dual role pathways, and consideration of regional contexts.

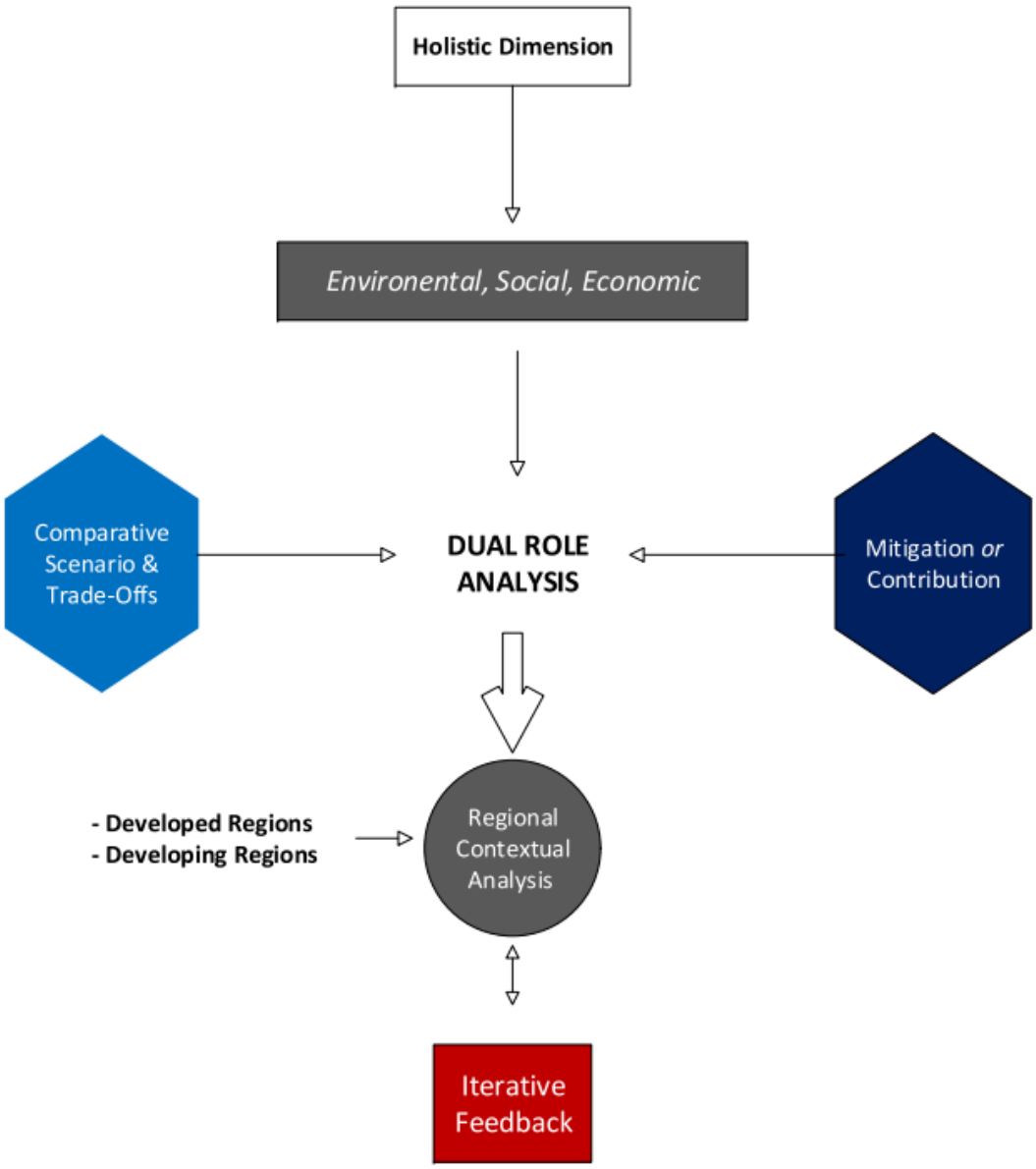

Figure 1: Sustainable AI Impact Assessment Framework
Source: The Author (2025)

4.5 How SAIAF Mitigates Unintended Consequences

Holistic Dimension Impact Evaluation
AI plays a dual role that affects all aspects of the SAIAF framework: environmental, social, and economic.

1) Environmental:
Mitigation: AI improves energy efficiency with smart grids and predictive analytics, lowering carbon emissions.
Contribution: Training large AI models uses much energy, similar to small towns, resulting in high carbon emissions.

2) Social:
Mitigation: AI tools help reskill workers and enhance education, promoting equity.
Contribution: AI-driven automation displaces low-skill workers, widening *socio-economic gaps.*

3) Economic:
Mitigation: Optimizing resource allocation and reducing waste leads to cost savings and enhances organizational resilience.
Contribution: The high costs of rapid hardware obsolescence and rare-earth resource extraction threaten long-term viability.

This interdependence analysis connects different dimensions to reveal systemic impacts.

Dual Role Analysis: Comparative Scenario and Trade-Offs

The dual role of AI must be evaluated throughout its lifecycle:

Upstream:
Mitigation: Sustainable hardware material sourcing minimizes environmental impact.
Contribution: Mining rare-earth metals for GPUs and TPUs depletes resources and harms the environment.

Midstream:
Mitigation: AI improves supply chains, lowering transportation emissions and material waste.
Contribution: High energy use in AI deployment increases carbon footprints.

Downstream:
Mitigation: AI-driven recycling programs extend product lifecycles and reduce e-waste.
Contribution: Poor recycling infrastructure for AI hardware leads to increased e-waste.

Dual Role Analysis: Mitigation Vs. Contribution

A dual-pathway analysis assesses both mitigation and contribution directly.

Comparative Scenario Analysis:
Baseline Scenario: Evaluate impacts without AI interventions.
Mitigation Scenario: Assess how AI solutions reduce emissions, optimize resources, and support workforce reskilling.
Contribution Scenario: Examine how energy-intensive computations and socio-economic disruptions worsen the Sustainability Paradox.

Weighted Trade-Off Analysis:
Quantify AI's positive impacts (energy savings, reduced waste) and negative impacts (emissions, resource depletion) to determine its net sustainability benefit.

Regional Contextual Analysis: Bridging Disparities
Tackle regional disparities using localized data on energy infrastructure, resource availability, and socio-economic conditions.

Developed Regions:
Mitigation: Renewable energy infrastructure uses AI to lower carbon footprints.
Contribution: Heavy reliance on imported rare-earth materials for AI hardware increases ecological debt to resource-rich developing regions.

Developing Regions:
Mitigation: AI boosts agricultural productivity and resource efficiency.
Contribution: Unregulated mining for AI hardware damages local resources and communities.

Iterative Feedback: Adapting to AI's Dual Role

Integrate iterative feedback loops into the framework to refine and adapt based on emerging data.

Real-Time Monitoring:
AI systems should continuously track sustainability metrics to pinpoint where benefits exceed drawbacks.

Stakeholder Collaboration:
Policymakers, researchers, and industries must work together to improve AI's role in mitigating and reducing its negative impacts.

4.6 SAIAF Framework Implementation

Winston (2024) emphasizes the inconsistency in AI's sustainability contributions, often undermined by its environmental impact, particularly in areas lacking access to renewable energy and effective recycling systems. To address these concerns, it is essential to prioritize the development of energy-efficient technologies and implement sustainable resource management practices within AI systems.

The Sustainable AI Impact Assessment Framework highlights AI's dual role in mitigating and contributing to environmental challenges, with one practical example from the agriculture sector.

Implementation Roadmap for Policymakers and Industries

A well-structured implementation roadmap enables policymakers and industries to integrate AI innovations effectively with sustainability objectives. This approach mitigates environmental impacts and promotes equitable progress across various sectors.

Step 1

Conduct Baseline Assessments

Objective: Evaluate the current sustainability status and identify gaps.

ACTION:

Conduct energy audits for AI infrastructure.

Map supply chain inefficiencies and sources of Unintended Sustainability .

Use SAIAF to measure environmental, social, and economic impacts.

Step 2

Deploy AI Solutions with Mitigation Strategies

Objective: Implement AI technologies to address identified gaps.

ACTION:

Optimize logistics and production processes with AI-driven analytics.

Use AI tools for workforce reskilling and education.

Promote renewable energy-powered data centers for AI operations.

Step 3

Adapt Solutions to Regional Needs

Objective:Customize AI deployments based on regional challenges and resources.

ACTION:

In developed regions, focus on integrating AI with advanced renewable energy systems.

In developing regions, provide technical and financial support to build sustainable AI infrastructure.

Step 4

Monitor and Adjust Through Feedback Loops

Objective: Continuously evaluate the impacts of AI interventions.

ACTION:

Use AI-driven dashboards to track sustainability metrics.

Adapt strategies based on performance data, ensuring net-positive outcomes.

Collaborate with stakeholders to refine interventions dynamically.

Step 5

Policy Integration

Objective: Embed SAIAF outcomes into global and regional policy frameworks.

ACTION:

Advocate for international standards on sustainable AI.

Incentivize adoption of best practices through subsidies or tax benefits.

Establish global partnerships to address cross-border sustainability challenges.

Figure 2: A Five-Step Practical Implementation Roadmap for Adopting SAIAF
Source: The Author (2025)

4.7 Addressing Policy Fragmentation

The absence of a global agreement on AI governance limits the ability of multilateral organizations to regulate and effectively manage AI risk. In order to address the current fragmentation of global AI policy, it is essential to establish unified frameworks and coordinated strategies (Nabil, 2024). The process of harmonization should begin:

1) Global Standards for AI Sustainability

Establish global standards to assess AI's lifecycle impacts on energy use, carbon emissions, and resource consumption. Create a certification system for sustainable AI technologies to ensure industry compliance. The United Nations, for example, should expand initiatives like the Sustainable Development Goals (SDGs) to include specific targets for artificial intelligence. It should also help developing economies build the infrastructure for sustainable AI adoption.

2) Collaborative Policy Frameworks

Form international partnerships to share best practices for AI sustainability. Create global agreements similar to the Paris Agreement that tackle AI's environmental impact and encourage countries to set specific sustainability goals. The World Economic Forum should facilitate discussions among governments, industries, and researchers to develop actionable frameworks for improving global AI sustainability.

3) Incentivizing Responsible Practices

Financial incentives should be used to promote the adoption of energy-efficient AI models and recycling initiatives. Organizations like the International Energy Agency should advocate for renewable energy integration in data centers and facilities used for AI training and establish penalties for corporations that fail to address their AI applications' environmental and social impacts.

4.8 Transitioning to Sustainability-Centric Business Models

A recent IBM report reveals that 50% of consumers are willing to pay more for sustainable products, and 44% identify as purpose-driven, choosing brands that align with their values (IBM, 2024). This highlights the need for managers to align corporate strategies with sustainability to fulfill their corporate social responsibility (CSR) and environmental, social, and governance (ESG) objectives. While AI has been integrated into citizen science for tasks like automated classification, the reverse—incorporating citizen science into AI—remains underdeveloped (Fraisl et al., 2024). AI and citizen science have great potential to tackle important sustainability challenges, including health and climate change.

The Triple Bottom Line (TBL) approach developed by John Elkington in 1994 emphasizes the importance of environmental, social, and economic factors. Elkington argued that businesses should consider three objectives equally: people, the planet, and profit, rather than focusing solely on profitability (Elkington, 1997; Miller, 2000). The shift reflects a growing recognition of the importance of sustainable practices for long-term business success). Using

tools for automation, data visibility, goal tracking, and value chain evaluation can simplify measuring the triple bottom line. (Jonker, 2023).

Improving Operational Efficiency Through AI

AI advancements improve operational efficiency by reducing waste, optimizing resource use, and lowering carbon emissions.

Inventory Management and Logistics Optimization

AI-driven predictive analytics enhance inventory management and transportation logistics, cutting waste and emissions (Wang, 2021). They enable businesses to forecast demand accurately, prevent overproduction, and optimize supply chain operations.

Recycling and Resource Recovery

Organizations leverage AI to enhance recycling and resource recovery, establishing closed-loop systems that cut waste and promote sustainability (Forti et al., 2022). These systems efficiently reuse resources, reducing environmental impact.

Energy Efficiency

Smart energy grids and AI-driven building management systems are essential for reducing energy use and operational costs. By automating energy optimization, these systems help businesses lower their carbon footprints and enhance cost efficiency (Patterson et al., 2021).

Tracking Sustainability Metrics

Managers utilize AI tools to monitor sustainability metrics such as carbon emissions and energy usage. These tools help align corporate practices with sustainability goals, promoting informed decision-making and accountability (Manyika et al., 2017).

Stakeholder Engagement

Active collaboration with stakeholders is essential for effective management. Managers can build trust and promote cooperation by working with employees, customers, and external partners to develop sustainability initiatives. This approach ensures that sustainability is integrated into the organization's core values and operations.

Workforce Reskilling

AI-driven programs equip employees with the skills for sustainable practices and new technologies. These initiatives prepare the workforce for the future and enhance the organization's sustainability efforts.

Incorporating sustainability into business operations represents a significant shift in modern strategies. Organizations can align their goals with environmental, social, and

economic sustainability by leveraging artificial intelligence and sound management practices. This approach ensures long-term viability, meets stakeholders' expectations, and addresses global sustainability challenges.

4.9 Conclusion

Integrating AI into sustainability efforts offers both significant opportunities and substantial risks. While AI can enhance resource efficiency, climate resilience, and circular economy practices, it raises concerns about energy use, environmental harm, and socio-economic disruptions. This Sustainability Paradox highlights the need for a clear, evidence-based framework to manage AI's role in sustainability. The Sustainable AI Impact Assessment Framework (SAIAF) offers a precise method for evaluating AI's environmental, social, and economic impacts. It includes real-time monitoring, lifecycle assessments, and policy-focused decision-making, helping governments, industries, and researchers effectively address AI's sustainability challenges. A key challenge to sustainable AI deployment is the fragmentation of policies, leading to conflicting regulations that hinder global coordination. SAIAF is a unifying tool, providing a universal assessment mechanism to align AI innovation with sustainability goals. By integrating SAIAF into corporate ESG frameworks and government AI policies, stakeholders can identify trade-offs, reduce unintended consequences, and promote responsible AI development. To align AI with sustainability in the long term, we must focus on cross-sector collaboration, enforce sustainability benchmarks, and enhance SAIAF's adaptability across various industries and regulations. AI should shift from being a technological disruptor to a driver of sustainable change, achievable through structured frameworks like SAIAF.

4.10 References

AllHRSoftware. (2024). 10 Best Predictive Analytics Tools for HR 2024. *HR List Software*. https://allhrsoftware.com/blog/10-best-predictive-analytics-tools-for-hr-2024/

Ahmad, S. (2024, December 11). Retrieved from https://hir.harvard.edu/lithium-triangle/

Amnesty International. (2024, December 23). Retrieved from https://www.amnesty.org/en/documents/afr62/3183/2016/en/

Bender, E. M., Gebru, T., McMillan-Major, A., & Shmitchell, S. . (2021). On the Dangers of Stochastic Parrots: Can Language Models Be Too Big? *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency*, (pp. 610–623. DOI: 10.1145/3442188.3445922).

Bosselmann, K. (2010). Losing the Forest for the Trees: Environmental Reductionism in the Law. *Sustainability, 2(8)*, 2424-2448. https://doi.org/10.3390/su2082424.

Brundtland, G. H. (1987). *Our Common Future.* United Nations.

Dunn, J. B., Gaines, L., Sullivan, J., & Wang, M. Q. (2012). Impact of Recycling on Cradle-to-Gate Energy Consumption and Greenhouse Gas Emissions of Automotive Lithium-Ion Batteries. *Environmental Science & Technology 46 (22)*, 12704-12710 DOI: 10.1021/es302420z.

Elkington, J. (1997). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business.* Oxford.

European Commission. (2024). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1689

Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2022). *The Global E-Waste Monitor 2020.* United Nations University. ISBN: 978-92-808-9114-0.

Fraisl, D., See, L., Fritz, S. et al. (2024). Leveraging the collaborative power of AI and citizen science for sustainable development. *Nat Sustain*, https://doi.org/10.1038/s41893-024-01489-2.

Frimpong, V. (2024). Cultural and Regional Influences on Global AI Apprehension. *Qeios*, doi:10.32388/YRDGEX.3.

Gao Y., Skutsch M., Masera O. & Pacheco P. (2011). *A global analysis of deforestation due to biofuel development.* Retrieved from https://www.cifor-icraf.org/publications/pdf_files/WPapers/WP-68Pacheco.pdf

Gill, S. S., & Kaur, R. (2023). ChatGPT: Vision and challenges. *Internet of Things and Cyber-Physical Systems, 3*, 262–271.

Gogsadze, N. (2022, October). *From fragmentation to policy coordination: Why does it matter?* Retrieved from https://ipcig.org/sites/default/files/pub/en/OP524_From_fragmentation_to_policy_coordination.pdf

Goldman Sachs. (2024, May 14). Retrieved from https://www.goldmansachs.com/insights/articles/AI-poised-to-drive-160-increase-in-power-demand

Gupta, S. (2015). Enhancing brand equity through sustainability: waste recycling. *Thunderbird International Business Review, 58(3)*, 213–223. https://doi.org/10.1002/tie.21730.

Gupta, S. (2015). Reverse marketing and sustainability: Impacts of recycling on brand equity. *Journal of Marketing Sustainability, 7(3)*, 19–34.

Hagendorf, T. (2024). Mapping the Ethics of Generative AI: A Comprehensive Scoping Review. *Minds and Machines 34(39)*, https://doi.org/10.1007/s11023-024-09694-w.

IBM. (2024, December 13). Retrieved from https://www.ibm.com/thought-leadership/institute-business-value/report/2022-consumer-study

Jonker, A. (2023, December 1). *IBM*. Retrieved from https://www.ibm.com/think/topics/triple-bottom-line

Kok JN, Boers EJ, Kosters WA, et al. (2009). Artificial intelligence: Definition, trends, techniques, and cases. *Artificial Intelligence 1*, 270–29.

Kumar, M., Raut, R., Jagtap, S., & Choubey, V. (2022). Circular economy adoption challenges in the food supply chain for sustainable development. *Business Strategy and the Environment, 32(4)*, 1334-1356. https://doi.org/10.1002/bse.3191.

Porter, M. and Kramer, R. (2011). Creating Shared Value. *Harvard Business Review, Vol. 89, No. 1*, 2-17.

Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., & Marrs, A. (2017). *Jobs Lost, Jobs Gained: Workforce Transitions in an Era of Automation.* McKinsey Global Institute.

Miller, K. (2000, December 8). *Harvard Business School Online.* Retrieved from https://online.hbs.edu/blog/post/what-is-the-triple-bottom-line

Nabil, R. (2024, February 2). *Yale*. Retrieved from https://www.yalejournal.org/publications/global-ai-governance-and-the-united-nations

Nguyen, T., & Le, H. . (2023). Adaptive AI in Education: Building Human Capacity for Sustainable Economies. *Journal of Educational Technology, 20(3)*, 45–60 DOI: 10.1007/s10956-021-09901-2.

Oliveira, M. E., Silva, R. D., & Cruz, J. P. . (2021). The Environmental Cost of Rare-Earth Element Extraction: A Review. *Environmental Research Letters, 16(4)*.

Patterson, D.A., Gonzalez, J., Le, Q., Liang, C., Munguía, L., Rothchild, D., So, D.R., Texier, M., & Dean, J. . (2021). Carbon Emissions and Large Neural Network Training: Assessing Energy Consumption Trends. *ArXiv*, abs/2104.10350.

Purvis, B., Mao, Y. & Robinson, D. . (2019). Three pillars of sustainability: in search of conceptual origins. *Sustain Sci 14.*, 681–695 https://doi.org/10.1007/s11625-018-0627-5.

Rajeshwari Ganesan, Jeff Mosier. (2024, April 02). *Infosys*. Retrieved from https://www.infosys.com/iki/perspectives/ais-growth-exponential.html

Salas-Navarro, K., Castro-García, L., Assan-Barrios, K., Vergara-Bujato, K., & Zamora-Musa, R. . (2024). Reverse Logistics and Sustainability: A Bibliometric Analysis. *Sustainability, 16(13)*, 5279 https://doi.org/10.3390/su16135279.

Shelby, R., Rismani, S., Henne, K., Moon, A., Rostamzadeh, N., Nicholas, P., Yilla-Akbari, N., Gallegos, et al. . (2023). Sociotechnical harms of algorithmic systems: Scoping a taxonomy for harm reduction. In S. D.-B. F. Rossi. ACM.

Singh, R., Gupta, P., & Arora, S. (2023). Reserve Sustainability: Conceptual Foundations and Implications. *Sustainability Science, 18(2)*, 123–137. DOI: 10.1007/s11625-022-01100-3.

Strubell, E., Ganesh, A., & McCallum, A. (2019). Energy and Policy Considerations for Deep Learning in NLP. *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics, 57*, (pp. 3645–3650. DOI: 10.18653/v1/P19-1355).

Sueyoshi, T., & Goto, M. . (2019). Corporate sustainability assessment: Measuring economic, environmental, and social efficiencies. *Journal of the Operational Research Society, 70(12)*, 2187-2203. DOI: 10.1080/01605682.2018.1537593.

Sun, C., Chen, H., & Luo, Z. (2022). Federated Learning for Data Sustainability: Balancing Efficiency and Privacy. *IEEE Transactions on Neural Networks and Learning Systems, 33(5)*, 2021–2032. DOI: 10.1109/TNNLS.2021.3083456.

Tabbakh, A., Al Amin, L., Islam, M. et al. . (2024). Towards sustainable AI: A comprehensive framework for Green AI. *Discov Sustain 5(408)* , https://doi.org/10.1007/s43621-024-00641-4.

UNEP. (2024, December 28). Retrieved from https://www.unep.org/news-and-stories/story/ai-has-environmental-problem-heres-what-world-can-do-about

United Nations General Assembly. (1987). *Report of the World Commission on Environment and Development: Our Common Future. Transmitted to the General Assembly as an Annex to document A/42/427 – Development and International Co-operation: Environment.* Retrieved from https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

Verónica Bolón-Canedo, Laura Morán-Fernández, Brais Cancela, Amparo Alonso-Betanzos. (2024). A review of green artificial intelligence: Towards a more sustainable future. *Neurocomputing, Volume 599*, https://doi.org/10.1016/j.neucom.2024.128096.

Vinuesa, R., Azizpour, H., Leite, I. et al. . (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. *Nat Commun 11(233)* , https://doi.org/10.1038/s41467-019-14108-y.

Wang, X., Jiang, P., Yang, L., Fan, Y.V., Klemeš, J.J. and Wang, Y. (2021). Extended Water-Energy Nexus Contribution to Environmentally-Related Sustainable Development Goals. *Renewable and Sustainable Energy Reviews, 150. Article 111485*, https://doi.org/10.1016/j.rser.2021.111485.

Weforum. (2024, December 23). Retrieved from https://www.weforum.org/stories/2024/09/ai-acceler-

ator-sustainability-silver-bullet-sdim/
Winston, A. (2024, July 11). *MITSLOAN*. Retrieved from https://sloanreview.mit.edu/article/will-ai-help-or-hurt-sustainability-yes/

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Chapter 5 - Sustainable HR Practices with AI

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Chapter Information

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Abstract

Artificial intelligence (AI) is crucial for productivity and efficiency. Employees' deteriorating commitment and resilience add to organizations' concerns on sustainability. An innovative culture facilitates organizations to benefit from AI, whilst leadership influences innovation, employees' commitment and resilience. The current study aims to examine the mediating effects of innovative culture on the positive relationships of transformational leadership with employees' affective organizational commitment and resilience and identify practical recommendations for employers, leaders and HR practitioners to drive innovation and sustainability. Data were collected from a random sample of 430 employees in Hong Kong via an online survey with validated scales. Structured equation modelling through SmartPLS (Version 4.1.0.9) was used to examine the linear relations and the mediating effects. Ten semi-structured interviews were conducted to validate how transformational leaders drive AI development and adoption, innovation and workforce sustainability in their organization. Transformational leadership was positively related to innovative culture ($p=0.000$), employees' affective organizational commitment ($p=0.000$) and resilience ($p=0.000$), whilst innovative culture was positively related to employees' affective organizational commitment ($p=0.000$) and resilience ($p=0.010$). Hence, innovative culture partially mediated the positive relationships between transformational leadership and employees' affective organizational commitment and resilience. The interviews showed that transformational leaders are role models who create psychological safety for their employees to take risk with accountability to enable experimentation, expose employees to stimulations for innovation and growth, establish trust and transparent communication with everyone to strengthen their affective organizational commitment and resilience to adversity. Leaders should demonstrate transformational leadership to drive employees' affective commitment and resilience, which are crucial for their organization's sustainability. Transformational leadership also helps leaders create an innovative culture to facilitate the development and implementation of AI. HR practitioners

should implement leadership development programs focused on transformational leadership.

Keywords: *leadership, innovation, commitment, resilience, artificial intelligence or AI, sustainability;*

5.1 Introduction

In today's volatility, uncertainty, complexity, and ambiguity (VUCA) world, artificial intelligence (AI) can enhance an organization's productivity and efficiency (Manimuthu et al., 2022). In its global survey 2023, McKinsey & Company found that organizations with a strong innovative culture are three times more likely to encourage experimentation and deliver growth and resilience through generative AI and other new technologies (Banholzer et al., 2023). Tech firms obviously are early adopters of innovation (Meyerson, 2016). Nowadays, even traditionally conservative industries are using AI to speed up their innovation. For example, pharmaceutical companies are using AI to expedite their drug discovery research and development as using AI is now seen as safe and responsible (Ghaffary, 2024).

Leadership and human resources management (HR) practices are two interlinked areas that drive sustainability and innovation. Both factors are crucial for AI development and implementation (Lafram & Bahji, 2024). Besides, leadership and innovativeness positively influence sustainability performance (Agbenyegah et al., 2024). In addition to the need for innovativeness to embrace AI and other new technologies, organizations are also faced by deteriorating employee commitment and organizational resilience that affect their sustainability. Behaviors like quiet quitting and conservation of effort are observed in employees. As a result, organizational performance is significantly affected (Arar & Yurdakul, 2024). Whilst organizations are increasing their investments in sustainability initiatives, business leaders also prioritize the sustainability of their workforce since they believe it helps increase employees' resilience and morale beyond meeting regulatory requirement (Caleb, 2024).

Researchers found that sustainable HR practices significantly enhance resilience individually and collectively (Elshaer et al., 2024). Many organizations adopt sustainable HR practices aiming to provide employees with the support that they need to be successful. At the same time, organizations try to ensure employees' commitment and resilience with intangible offerings like work-life balance, mental health, well-being, growth as well as tangible wages and benefits. Nonetheless, the perceived organizational fit of employees is equally important, since it influences employees' performance and the competitiveness of an organization (Bhatti, 2024). However, a crucial research gap remains unresolved.

Whilst there are studies on the impact of leadership and HR practices and their influences on innovation and other employee outcomes, limited research is found on the effects of innovative culture. Besides, there are cross-cultural variations in the effects of leadership, HR practices and organizational culture. Hong Kong has a unique culture with influences from both Confucian and Western cultures (Szeto, 2021). Therefore, the current study aims to address this unfilled research gap and answer the following research questions:

How does top management team's transformational leadership influence an organization's innovative culture?

How does top management team's transformational leadership influence employees' affective organizational commitment and resilience?

How does an organization's innovative culture influence the relationships between top

management team's transformational leadership and employees' affective organizational commitment and resilience?

In addition to the quantitative study that produced empirical data to answer the above research questions, ten semi-structured interviews were conducted with distinguished Hong Kong business leaders, tech firm founders and subject matter experts in the areas of innovation, employee commitment and resilience to generate practical advice for academics, industry leaders, and policymakers.

5.2 Literature Review

5.2.1 HR Practices and Sustainability

Human resources management (HR) practices shape an organization's culture and employees' behavior and influence an organization's sustainability efforts and results (Varshini et al., 2024). Whilst leaders' commitment strengthens the relationship between artificial intelligence and sustainability (Li et al., 2024), employees' commitment is equally important for an organization's sustainability, since it connects between HR practices and sustainability performance (Mohammed & Binti Ahmad, 2024). Besides, resilience is another crucial factor for sustainability (Pedol et al., 2021). HR practices can enhance employees' resilience through social exchange (Malik & Singh, 2024). In the immediate term, HR practices enhance sustainability by retaining high-quality employees, maintaining their well-being, and fostering organizational resilience (Syafri & Rasyid, 2025). In a longer run, HR practices drive an innovative culture that reinforces sustainability (Murtaza et al., 2024).

5.2.2 Artificial Intelligence

The advancements in artificial intelligence (AI) have brought radical changes to HR functions (Registre & Saba, 2024). The integration and diverse use of AI in various HR practices including talent acquisition, learning and development, performance management, rewards, compensation and benefits, employee engagement and well-being can enhance organizational outcomes and create a sustainable competitive advantage (Tairov et al., 2024). However, the successful adoption and implementation of AI depend on human and financial resources, necessary competences and an innovative culture (Chen et al., 2024). Therefore, leadership and employees' commitment are crucial factors for a successful AI ecosystem (Lafram & Bahji, 2024).

5.2.3 Transformational Leadership

There are strong links between leadership and HR practices. Leadership predicts human resources management competences, which in turn drive culture, change and technology (Motsoeneng et al., 2024). On the other hand, HR practices mediate the relationships between leadership and many employee outcomes (Siraj et al., 2022). Leadership and HR practices are often studied as two separate factors, but they interact with each other to shape organizational and individual outcomes. Therefore, these two areas should be investigated as an integrated factor (Zhao et al., 2023).

Leaders are responsible for coordinating and managing individuals to deliver team results (Antonakis, 2021). Hence, leadership is a crucial factor for organizational success (Longenecker & Insch, 2018), development, improvement (Everett, 2021), change, innovation (Day & Shea, 2020), trust (O'Brien, 2015; Kovac & Jesenko, 2010), resilience (Bulatova, 2015), competitiveness, diversity and sustainability (Stomski & Leisten, 2015). Leadership is also a crucial factor in new product development and decision making through adopting AI (Cooper & Brem, 2024). Leadership style is an important factor (Peterson, Abramson, & Stutman, 2020) for innovation (Nwagbara et al., 2024). However, this intangible element that makes leaders and their organization successful, competitive, and sustainable (Petrick et al., 1999) is usually missing (Kovac & Jesenko, 2010).

Transformational Leadership (TFL) has dominated the Western leadership theory developed by Burns and expanded by Bass (Bass, 2003; Burns, 1978, pp. 241-256; Brown et al., 2020). It influences the effectiveness of HR practices (Motsoeneng et al., 2024). It positively influences talent management, learning and development, employees' voluntary effort and job involvement (Sulistiasih et al., 2024). It also enhances employees' satisfaction, motivation and performance (Ali, 2023). Unlike transactional leaders who rely on their bureaucratic powers to influence employees, transformational leaders are employees' role models (Van Knippenberg & Sitkin, 2013). They create a vision to facilitate employees' identification with the organization (Koveshnikov & Ehrnrooth, 2018) and transform the organization (Hartog et al., 1997). In addition to having a positive impact on organizational performance, TFL has a strong influence on organizational change capability (Le & Le, 2021).

5.2.4 Innovative Culture

Culture is a collective phenomenon that distinguishes the characteristics of one group of individuals to the others (Hofstede, 2011). Organizational culture plays a crucial role in shaping the social and psychological environment of an organization and guiding decision making and employees' behavior (Haberberg & Rieple, 2008). According to Wallach (1983), organizational culture is employees' shared understanding about the expected standards of behavior, speech and performance. In other words, it defines how employees should do things in their organization. Wallach argues that there are no good or bad cultures, but one that reinforces the organization's mission, purposes and strategies would be effective. She categorizes organizational culture into three types: Bureaucratic, innovative, and supportive cultures, and suggests that innovative organizations are exciting, dynamic, driving, enterprising, challenging, stimulating, creative, results- oriented and risk-taking.

Organizational culture is a crucial factor that influences how creative and innovative an organization is when tackling its problems (Adler, 1980). Innovation involves both a top-down strategic decision making on change goals and bottom-up creative involvement that keeps employees enthusiastic and motivated (Si et al., 2023). An innovative culture (IC) promotes curiosity, creativity and encourages employees to take risks (Watson-Hemphill, 2024). It is an essential element for an organization to improve its innovation capability (Munoz-van den Eynde et al., 2015). It also facilitates the introduction of AI in an organization as it eases human-computer interaction (Xu et al., 2024) and creates a competitive advantage for organizations which embrace the use of AI (Banholzer et al., 2023).

5.2.5 Affective Organizational Commitment

Affective organizational commitment (AOC) refers to employees' emotional attachment to their organization through which they identify themselves with their organization and are strongly committed to its activities and goals (Allen & Meyer, 1990). It has a positive relationship with sustainability and makes significant contributions to process improvement and innovation for sustainable practices (Rae et al., 2015). It drives innovative work behavior and ownership (Mustafa et al., 2024). It also enhances employees' resilience by reducing role ambiguity and increasing work engagement (Orgambídez & Benítez, 2021).

5.2.6 Employee Resilience

Employee resilience (ER) is employees' capability to cope with pressure and crisis, which is crucial for the sustainability and sustainable development of an organization (Arvanitis et al., 2023). Factors like employee engagement, retention, diversity, well-being and performance are important for building and maintaining a sustainable work environment and a resilient workforce (Kaaria, 2024). Psychological well-being enhances employees' emotional engagement with their organization and performance in solving problem (Wulandari & Subiyanto, 2024). Retaining high-quality employees and keeping them motivated are important to resilience (Low, 2024). Resilience is integrated with sustainability, leadership and innovation to drive change, capability enhancement and business model transformation (Liang et al., 2024).

5.3 Hypothesis Development

Leadership style and organizational behavior influence an organization's creativity and innovation (Egide, 2024). TFL is positively related to many favorable individual and organizational outcomes (Sayyadi & Provitera, 2024). Transformational leaders show their inspirational motivation to encourage employees to voice out their thoughts (Jiang & Yang, 2016). They demonstrate their idealized influence and charisma (Podsakoff et al., 1990). They stimulate employees (Muchiri et al., 2020) and motivate them to innovate and adapt to the everchanging world (Afsar et al., 2019; Shafi et al., 2020; Schuesslbauer et al., 2018). Through intellectual stimulation, employees feel safe to challenge old assumptions (Bass, 1997). Therefore, TFL is expected to predict IC:

H1: TFL is positively related to IC

Transformational leaders focus on inspiration and motivation and facilitate employees to exceed their usual performance (Akotia et al., 2024; Weber, 2009). They also make employees feel that their work is meaningful through intellectual stimulation (Peng, et al., 2016). They provide employees with individualized consideration such that employees have trust with their leaders (Martinez-Corcoles et al., 2020) and higher affective commitment to their organization (Rafferty & Griffin, 2006; Gemasari et al., 2024). TFL also lowers employees' turnover intention (Ha et al., 2024; Jia & Li, 2024) and motivates employees to go beyond self-interest for higher purpose (Atoki et al., 2024). Therefore, TFL is expected to predict AOC:

H2: TFL is positively related to AOC

In addition to enhancing employees' productivity (Sayan & Surucu, 2024) and innovative work behavior (Akotia et al., 2024), TFL is also positively related to employees' resilience (Ha et al., 2024). It improves agility (Probojakti et al., 2024), learning and involvement (Sulistiasih et al., 2024). It also facilitates knowledge sharing and helping behavior amongst team members (Wong, 2024). It drives corporate social responsibility and organizational performance (Thapa et al., 2024), and helps employees achieve organizational goals (Boutamine & Benlaharche, 2024). It positively influences problem solving (Wulandari & Subiyanto, 2024), research and development (Bas & Aksoy, 2024), efficiency and sustainability (Atoki et al., 2024). Therefore, TFL is expected to predict ER:

H3: TFL is positively related to ER

IC drives the adoption of AI, which in turn improves employee experience and strengthens meaningful employee recognition and organizational culture (Tanner, 2024). It is positively related to employee engagement (Hooi & Chan, 2023). It enhances an organization's performance, profitability, competitiveness and sustainability ((Restrepo-Morales et al., 2024). Some researchers argue that employees' organizational commitment and organizational culture do not affect employees' innovative behaviour (Gemasari et al., 2024). Others suggest that IC has positive effect on employees' organizational commitment (Lok & Crawford, 2004).

Nonetheless, organizational culture is a mediator between leadership behavior and many employees' outcomes (Cravens et al., 2015). Innovativeness mediates the positive relationship between leadership and performance (Suifan, 2021). Besides, IC is positively related to employees' behavioral outcomes (Khan et al., 2018), mediates between organizational culture and performance (Imran et al., 2021) and moderates between AOC and employees' job satisfaction (Saha & Kumar, 2018). Therefore, IC is expected to have positive effects on AOC and ER, hence mediate the positive relationships of TFL with AOC and ER:

H4: IC mediates the positive relationship between TFL and AOC

H5: IC mediates the positive relationship between TFL and ER

Figure 1a and 1b depict the theoretical models of the current study.

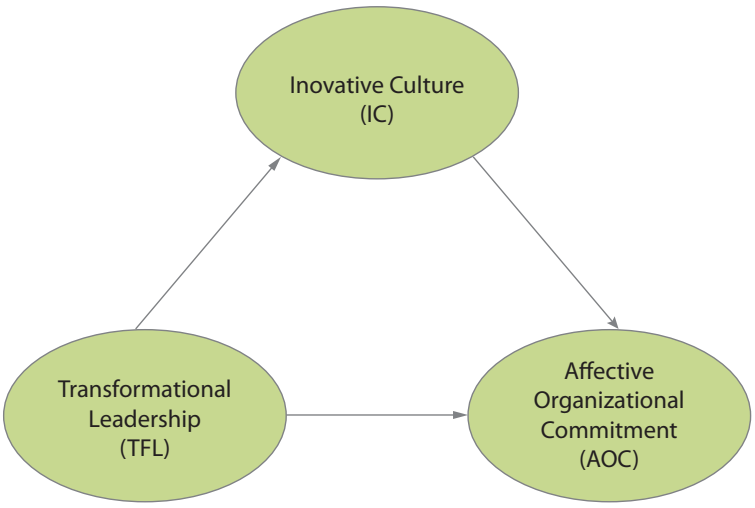


Figure 1a. Theoretical Model 1

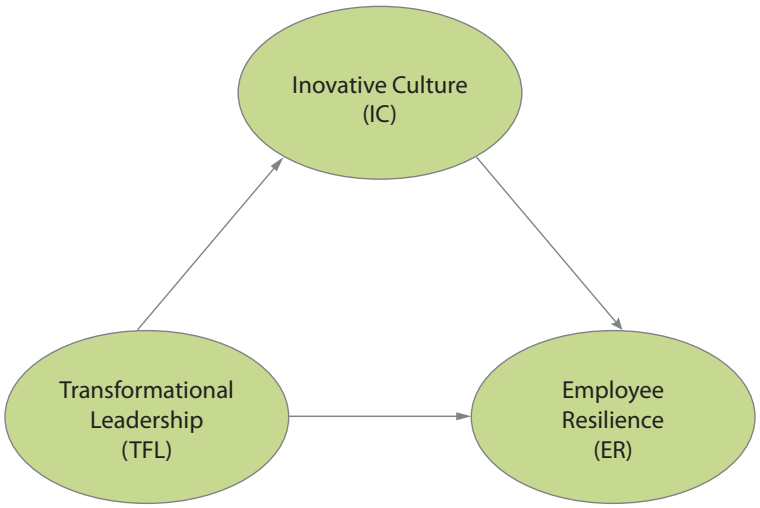


Figure 1b. Theoretical Model 2

5.4 Methods

To address the research questions, a quantitative and confirmatory approach was adopted to test the hypotheses with data collected through a self-administered online survey. A mediation analysis was conducted through the structural equation modelling (SEM) tool to analyze the structural relationships in the theoretical model.

5.4.1. Data Collection

Through random sampling, a cross-sectional survey questionnaire was used to collect Hong Kong employees' assessments on their top management team's TFL, their organization's IC, and employees' AOC and ER. Demographic data were also collected through the questionnaire. As all data came from survey respondents, the survey results were open to common-sourced–common-method bias, which was alleviated by data anonymity and confidentiality, the shortened versions of the scales, shuffled scale items, and dividing the questionnaire into separate pages such that respondents were not able to return to the previous pages upon completion of each page.

A total of 628 invitations were sent and 430 valid responses were collected between November and December 2024, achieving a response rate of 68 percent. A 7-point Likert scale was used, through which respondents provided ratings, from 1 - strongly disagree to 7 - strongly agree, on seven questions on TFL derived from the Multifactor Leadership Questionnaire by Bass (1985), four questions from the IC scale (Judge, 2021), six items from the AOC scale (Allen & Meyer, 1990), and nine items from the ER scale (Naswall et al., 2019).

5.4.2. Sample

Most respondents worked in Banking, Financial Services, Insurance Activities, etc. (18 percent), NGO, Non-Profit Activities, etc. (14 percent), Consulting, Professional Services, Scientific, Technical Activities, etc. (13 percent), Education (12 percent), and Import/Export,

Wholesale, Retail Trades, e-Commerce, etc. (11 percent). Most responses came from large organizations with 1,000 employees or more (39 percent), followed by organizations with 50-499 employees (32 percent) and small organizations with less than 50 employees (22 percent). Most respondents were at the job level of Assistant Manager, Manager, Senior Manager or Equivalent (45 percent) whilst close to a third of respondents were Senior Executives in a CXO, VP, General Manager, Director or Department Head capacity (34 percent). The distributions of respondents by industry, organizational size and job level are shown in Tables 1, 2 and 3 respectively.

Table 1. Respondents' industries.

Industry	Responses	%
01. Accommodation, Food Service Activities, etc.	16	4%
02. Arts, Entertainment, Recreation, etc.	5	1%
03. Banking, Financial Services, Insurance Activities, etc.	77	18%
04. Conglomerate, Multi-industry Organisation, etc.	10	2%
05. Construction	10	2%
06. Consulting, Professional Services, Scientific, Technical Activities, etc.	55	13%
07. Education	52	12%
08. Energy	4	1%
09. Government, Public Administration, etc.	18	4%
10. Healthcare	23	5%
11. Import/Export, Wholesale, Retail Trades, e-Commerce, etc.	46	11%
12. Information, Communications, etc.	17	4%
13. NGO, Non-Profit Activities, etc.	62	14%
14. Real Estate	12	3%
15. Transportation, Storage, Postal, Courier Services, etc.	22	5%
16. Water Supply, Sewerage, Waste Management, etc.	1	0.2%
Grand Total:	430	100%

Table 2. Respondents' organizational sizes.

Org Size	Responses	%
01. Below 50	94	22%
02. 50-499	137	32%
03. 500-999	33	8%
04. 1,000 and above	166	39%
Grand Total:	430	100%

Table 3. Respondents' job levels.

Job Level	Responses	%
01. General Staff or Non-Managerial Position	91	21%
02. Assistant Manager, Manager, Senior Manager or Equivalent	193	45%
03. Senior Executive (CXO, VP, General Manager, Director or Department Head)	146	34%
Grand Total:	430	100%

5.5 Results

SEM Partial Least Squares (PLS-SEM) was used to investigate the causal relationships of TFL with IC, AOC and ER in the theoretical models and to examine the mediating effect of IC via SmartPLS (Version 4.1.0.9). A significance level of 5 percent ($\alpha < 0.05$) was adopted.

5.5.1. Measurement Model

The reliability and validity of the two theoretical models were examined by assessing the composite reliability, the convergent validity, the average variance extracted (AVE), the discriminant validity and the cross-loadings (Hair et al., 2014). All constructs selected from shortened versions of well-established scales had at least four items (Marsh et al., 1998; Robinson, 2017). The Cronbach's alpha values of all constructs, TFL, IC, AOC and ER, in the two models were higher than 0.7 (Koran, 2020). The internal reliability and convergent validity were confirmed (Hair et al., 2011).

The discriminant validity was confirmed as all constructs had a rho_A value higher than 0.7, a composite reliability (CR) value higher than 0.7, and an AVE value above 0.5 (Kline, 2015, pp. 7-24). Besides, the square roots of AVE of all latent variables were higher than their correlations with the other constructs (Fornell & Larcker, 1981). All items had a cross-loading value higher than 0.5 (Gefen & Straub, 2005). All heterotrait–monotrait ratio of correlation (HTMT) values were lower than 0.9 (Henseler et al., 2015). See Table 4a and 4b for the Cronbach's alpha, CR, and AVE of the latent constructs, Table 5a and 5b for the square roots of AVE, Table 6a and 6b for the cross-loading analysis, and Table 7a and 7b for the HTMT values in the two theoretical models.

Table 4a. Internal reliability and convergent validity in Theoretical Model 1.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AOC	0.924	0.926	0.941	0.727
IC	0.907	0.910	0.935	0.782
TFL	0.911	0.918	0.930	0.655

Table 5a. Construct correlations – square roots of AVE in Theoretical Model 1.

Square Roots of AVE	AOC	IC	TFL
AOC	0.853		
IC	0.645	0.884	
TFL	0.715	0.775	0.809

Table 6a. Cross-loading analysis for Theoretical Model 1.

	AOC	IC	TFL
AOC1	0.865		

AOC2	0.883		
AOC3	0.871		
AOC4	0.877		
AOC5	0.888		
AOC6	0.719		
IC1		0.869	
IC2		0.903	
IC3		0.902	
IC4		0.862	
TFL1			0.812
TFL2			0.756
TFL3			0.662
TFL4			0.840
TFL5			0.889
TFL6			0.874
TFL7			0.810

Table 7a. HTMT values in Theoretical Model 1.

	AOC	IC	TFL
AOC			
IC	0.703		
TFL	0.779	0.849	

Table 4b. Internal reliability and convergent validity in Theoretical Model 2.

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
ER	0.910	0.917	0.927	0.586
IC	0.907	0.910	0.935	0.782
TFL	0.911	0.919	0.930	0.655

Table 5b. Construct correlations – square roots of AVE in Theoretical Model 2.

Square Roots of AVE	ER	IC	TFL
ER			
IC	0.659		
TFL	0.753	0.849	

Table 6b. Cross-loading analysis for Theoretical Model 2.

	ER	IC	TFL
ER1	0.774		

ER2	0.573		
ER3	0.793		
ER4	0.812		
ER5	0.840		
ER6	0.826		
ER7	0.733		
ER8	0.730		
ER9	0.775		
IC1		0.872	
IC2		0.901	
IC3		0.903	
IC4		0.861	
TFL1			0.808
TFL2			0.753
TFL3			0.664
TFL4			0.843
TFL5			0.890
TFL6			0.873
TFL7			0.813

Table 7b. HTMT values in Theoretical Model 2.

	ER	IC	TFL
ER			
IC	0.659		
TFL	0.753	0.849	

5.5.2 Structural Model

The SEM analysis was used to confirm the predictive ability of the theoretical model. All variance inflation factor values (VIF) were lower than 5.0. The reliability of the results from the inferential statistics was confirmed as collinearity was ruled out in both models (Huck, 2012, pp. 68-89; Hair et al., 2014). See Table 8a and 8b.

Table 8b. VIF values in Theoretical Model 1.

	AOC	IC	TFL
AOC			
IC	2.505		
TFL	2.505	1.000	

Table 8b. VIF values in Theoretical Model 2.

	ER	IC	TFL
ER			
IC	2.516		
TFL	2.516	1.000	

In Model 1, after a non-parametric bootstrapping for up to 5,000 times, the path coefficients between TFL and AOC, between TFL and IC, and between IC and AOC were 0.538, 0.775 and 0.228 respectively, showing positive correlations amongst all three constructs ($p < 0.05$). In Model 2, the path coefficients between TFL and ER, between TFL and IC, and between IC and ER were 0.550, 0.776 and 0.179 respectively, also showing positive correlations amongst all three constructs ($p < 0.05$). See Table 9a and 9b.

Table 9a. Path coefficients and statistical significance in Theoretical Model 1.

	Path Coefficient	Sample mean	Standard deviation	T statistics	p-values
IC -> AOC	0.228	0.228	0.055	4.143	0.000
TFL -> AOC	0.538	0.538	0.049	10.944	0.000
TFL -> IC	0.775	0.776	0.024	32.457	0.000

Table 9b. Path coefficients and statistical significance in Theoretical Model 2.

	Path Coefficient	Sample mean	Standard deviation	T statistics	p-values
IC -> ER	0.179	0.182	0.071	2.522	0.012
TFL -> ER	0.550	0.549	0.066	8.335	0.000
TFL -> IC	0.776	0.777	0.024	32.677	0.000

The coefficients of determination (R Square) showing the predictive accuracy of the structural models or the proportion of variance in IC, AOC and ER that TFL accounted for in Theoretical Model 1 and 2 are shown in Table 10a and 10b respectively.

Table 10a. Coefficients of determination in Theoretical Model 1.

TFL as Independent Variable	R Square	R Square Adjusted
AOC	0.532	0.529
IC	0.601	0.600

Table 10b. Coefficients of determination in Theoretical Model 2.

TFL as Independent Variable	R Square	R Square Adjusted
ER	0.487	0.485
IC	0.603	0.602

Figure 2a and 2b show the results of PLS-SEM analysis depicting the relationships

between the latent variables in Theoretical Model 1 and 2 respectively.

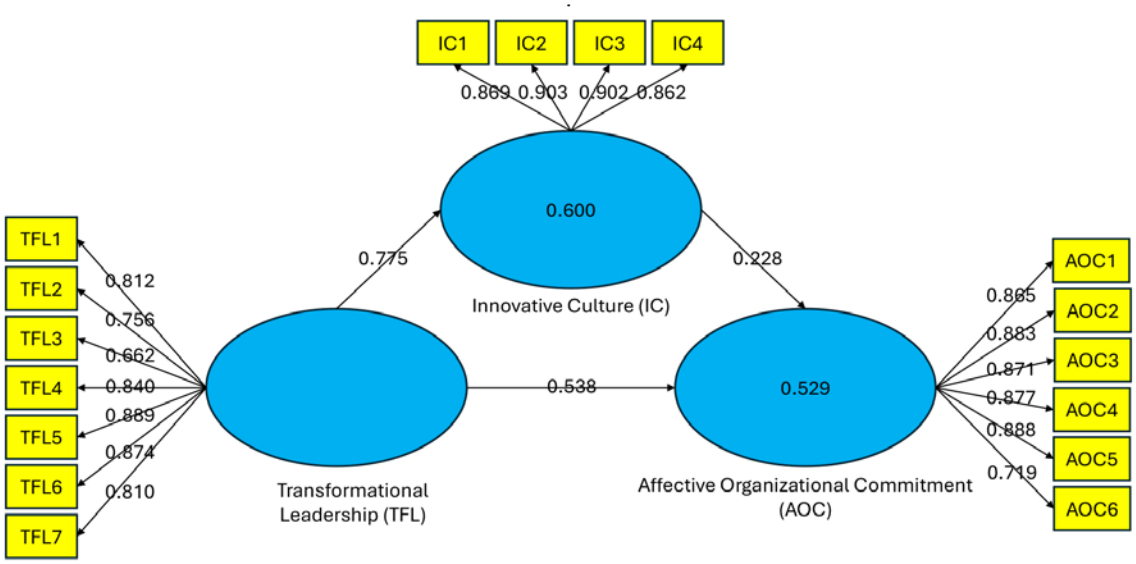


Figure 2a. Results of PLS-SEM analysis for Theoretical Model 1

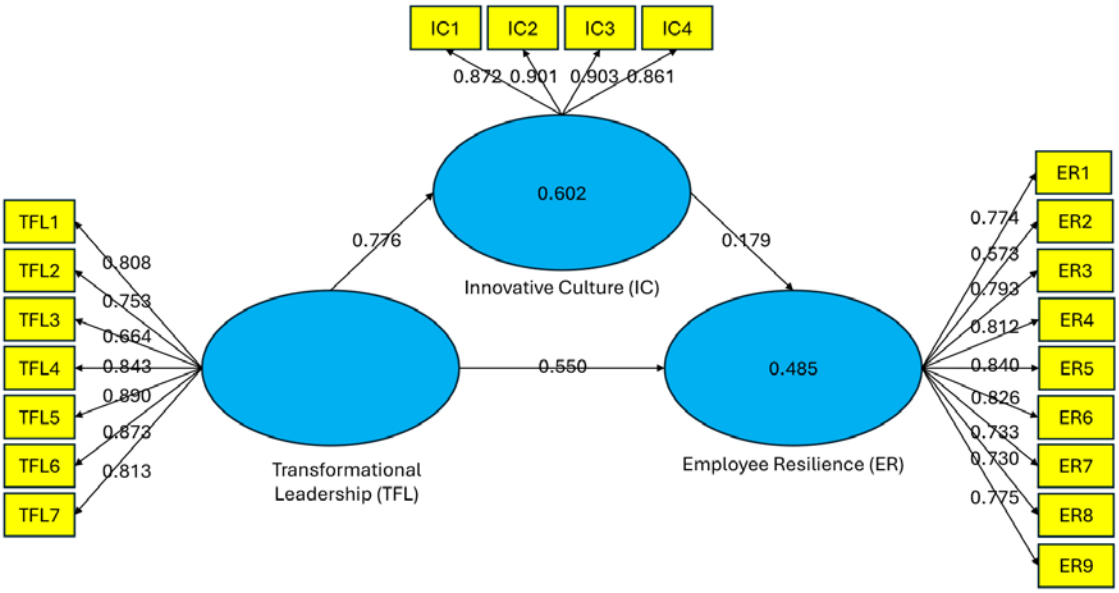


Figure 2b. Results of PLS-SEM analysis for Theoretical Model 2.

The positive relationships amongst TFL, IC and AOC in Theoretical Model 1 and amongst TFL, IC and ER in Theoretical Model 2 were all statistically significant ($p < 0.05$). The mediation analysis confirms that a mediating factor, IC, exists in both structural models, and the mediating effects were partial (Iacobucci, 2012). Table 11 shows the hypothesis testing results.

Table 11. Results of hypothesis testing.

No.	Hypothesis	Result
1	TFL is positively related to IC	Accepted
2	TFL is positively related to AOC	Accepted
3	TFL is positively related to ER	Accepted
4	IC mediates the positive relationship between TFL and AOC	Accepted
5	IC mediates the positive relationship between TFL and ER	Accepted

5.6 Semi-structured Interviews

In order to facilitate the transfer of the evidence-based quantitative research findings to practitioners and avoid academic knowledge losses before and in translation (Podgorodnichenko et al., 2022), ten semi-structured interviews were conducted with business leaders, founders of tech firms, and subject matter experts in employee commitment and resilience in Hong Kong to examine their behaviors in leading their organizations and understand the reasons behind their strategies and actions (Sekaran & Bougie, 2013, pp. 112-128). During these interviews, conversations and narratives were captured and analyzed (Myers, 2020, pp. 21-40). After interpreting these experts' narratives and examples in relation to TFL behaviors, practical insights were generated (Flick, 2019, pp. 11-22). The qualitative findings are organized under the four TFL dimensions – idealized influence, inspirational motivation, intellectual stimulation, and individualized consideration (Judge & Piccolo, 2004).

5.6.1 Idealized Influence

Employees regard their leaders as role models (Van Knippenberg & Sitkin, 2013). Employees' personal values, beliefs, and attitudes can be transformed by the idealized influence of their transformational leaders (Podsakoff et al., 1990; Toader & Howe, 2021). Idealized influence also facilitates employees' identification with their organization (Bass & Steidlmeier, 1999; Kark & Shamir, 2002; Koveshnikov & Ehrnrooth, 2018) and motivates employees to work toward leaders' vision (Hartog et al., 1997). Implementing AI to enhance sustainability is a major change to employees. Idealized influence, which is positively related to innovative behaviors and employees' problem-solving abilities (Chu & Lai, 2011), can help employees cope with the challenges brought by the change. For the current study, the following three leaders shared how they demonstrate their idealized influence as employees' role models.

"Leadership is like swimming; it's not just about keeping your head above water, but mastering the strokes that guide others through the waves while looking ahead, not backward." – Allan Zeman

Dr. Allan Zeman, Founder of Lan Kwai Fong Holdings, is a prominent entrepreneur and business leader, widely recognized for his pivotal role in the development of Hong Kong's entertainment and leisure industries. He has demonstrated a unique ability to blend creativity with

strategic business acumen. When Dr. Zeman shared his insights on leadership, particularly during challenging times, he emphasized that leaders must first leave their own comfort zones before guiding their teams to do the same. To foster a future-oriented mindset within teams, Dr. Zeman advised leaders to encourage their members to focus on what lies ahead rather than dwelling on the past. He suggested leaders to prompt their teams to observe the world around them and envision how current trends might evolve over the next one, five, or ten years.

"A true leader is a role model who stands firm in the face of adversity, showing up for their team when times are tough, demonstrating how to tackle challenges, and inspiring others by bouncing back stronger from setbacks." – Daniel Chan

Mr. Daniel Chan, a Hong Kong Paralympics medallist, founded his training consultancy, Kompass, after retiring from international competition. To promote para-sports, raise disability awareness, and foster a more inclusive world, he decided to hire a team of para-athletes to help them transition from their athletic journeys to the business realm. Mr. Chan is a strong believer in the power of role modelling; he feels that, as the founder of his company, he must demonstrate passion and a strong work ethic. He insists on being hands-on and making progress to inspire passion and confidence within his team. He encourages team members to experiment with new ideas. He takes small risks and accepts mistakes, emphasizing the importance of identifying root causes after any error and creating a two-way channel and a supportive environment for team members to experiment with new ideas to foster innovation.

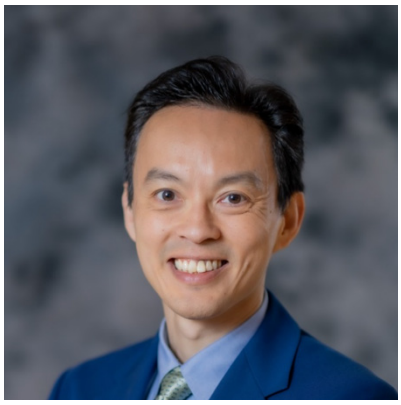
"Leaders must model the courage to admit mistakes, as this not only uncovers blind spots but also transforms errors into valuable learning opportunities, fostering a culture of growth and resilience." – Karen Chung

Ms. Karen Chung is the founder of Kossie, AI-assisted coaching platform that helps medium-scale companies get access to 1:1 professional coaching via an employee well-being program. As a leader in a tech start-up, Ms. Chung emphasizes the importance of fostering an innovative environment where team members feel safe to share new ideas without fear of judgment. She holds regular team meetings to uncover leadership blind spots and emphasizes the necessity of embracing mistakes as learning opportunities. This approach encourages her team to remain agile and focused on gaining experience, which is vital in the ever-evolving tech landscape. Transparent communication is another cornerstone of Ms. Chung's leadership philosophy. By modelling the behavior she expects from her team, she creates a culture of recognition and appreciation, ensuring that team members feel valued and motivated. She actively acknowledges contributions, reinforcing the idea that everyone plays a critical role in the organization's success.

5.6.2 Inspirational Motivation

Through inspirational motivation, transformational leaders stimulate employees to generate

and implement innovative idea (Muchiri et al., 2020) from diverse perspectives (Lauring & Jonasson, 2018). Employees can improve their adaptability (Schuesslbauer et al., 2018), creativity (Shafi et al., 2020), mutual support (Veshne & Munshi, 2020), decision-making quality and speed (Hsu & Chang, 2021), critical thinking and efficacy in voicing out their thoughts (Jiang & Yang, 2016). As inspirational motivation drives employees' innovative work behavior (Afsar et al., 2019), facilitates product and process innovation (Al-Husseini et al., 2013) and makes an organization more innovative (Knezovic & Drkic, 2021), it can enhance an organization's effectiveness in using AI to implement its innovation strategy (Chun et al., 2016). The following two leaders shared how they exemplify their inspirational motivation to their teams.



"Seeding projects and planned failures are essential for creating a safe space where teams can innovate, learn, and grow. Failures are acceptable, but we as a team take responsibility together, followed by actionable steps to improve and move forward."– Alan Cheung

Dr. Alan Cheung is the Chief Director, Artificial Intelligence and Trust Technologies of Hong Kong Applied Science and Technology Research Institute (ASTRI) which was established in 2000 to enhance Hong Kong's competitiveness through applied research and has successfully transferred over 1,500 technologies to industry, holding more than 1,100 patents globally. He asserted that a robust innovative culture is essential for survival in the rapidly evolving tech landscape. He leads a team that stays current with advancements in technologies, including but not limited to generative AI, while actively addressing industry challenges. He highlighted the importance of exploratory "seeding projects" and "planned failures," where potential risks and consequences are identified, allowing for effective risk management and client communication. He also emphasized that innovative teams are highly attuned to economic fluctuations, making them more resilient to environmental changes.

"Leaders must embody humility and curiosity, embracing the power of questions to drive innovation and improvement. Balancing risk-taking and prioritization is essential, but they must always remain anchored to the original purpose and mission." – Bonnie So

Ms. Bonnie So is the CEO and Secretary General of Hong Kong Red Cross. As the leader of a workforce comprising 400 staff members and 30,000 volunteers to provide humanitarian services, education, and fundraising, Ms. So emphasizes the importance of understanding the organization's purpose. She believes it is essential for the team to reconnect with their original mission of serving the community and the significance of their work. Leaders, in her view, must continuously learn and confront weaknesses rather than avoiding them. She believes leaders should view the world as boundless and embrace the notion that nothing is impossible. She encourages team members who may not regularly interact with service users to reach out and engage directly with them to understand how their roles contribute to humanitarian improvement. Ms. So

maintains direct dialogue with all team members and creates initiatives to support innovation, believing that an innovative culture must be established from the top down.

5.6.3 Intellectual Stimulation

Whilst other TFL dimensions focus on the affective aspects, intellectual stimulation emphasizes on the cognitive and intellectual leadership processes (Barling et al., 2000). Intellectual stimulation is associated with challenging the traditions and status quos under which employees generate new ideas and do things in new ways (Bass, 1997). It influences innovation and makes employees feel that their work is meaningful (Peng, Lin, et al., 2016). Intellectual stimulation makes employees more satisfied with and committed to their job (Anjali & Anand, 2015; Robinson & Boies, 2016). Leaders can use intellectual stimulation to empower employees to support their vision (Rao, 2014), help each other (Lorinkova & Perry, 2019) and fulfil their individual development needs (Starc, 2013) as they feel that they can learn and improve based on performance feedback (Yadav & Seth, 2021). Leaders with strong intellectual stimulation can tap into employees' specific competences (Hicks, 2018) to build a sustainable competitive edge (Farkas et al., 2020). The following two leaders explained how their intellectual stimulation helps enhance their teams' readiness for AI implementation, innovation and continuous improvement.

"The cream always rises to the top; leaders must continually present new challenges to their talent, fostering a culture of learning, agility, and excitement. This not only keeps them motivated but also equips them to drive innovation and tackle future challenges with confidence." – Krish Sundaresan

Mr. Krish Sundaresan is the General Manager of Pfizer Hong Kong and Macau. He emphasizes a paradigm shift from an inside-out to an outside-in perspective, encouraging his team to engage not only with healthcare professionals but also with patients and caregivers as well as other key stakeholders such as insurers and employers. By adopting a design thinking framework, he fosters a culture of empathy and understanding, enabling his team to grasp the true value of their innovations and how they can meaningfully improve lives. He implements three key talent management strategies: Instilling core values such as courage, joy, equity, and excellence, organizing patient forums that facilitate direct interactions between team members and patients, and fostering a sense of belonging through the celebration of both small and significant achievements. He also champions continuous learning and development by encouraging zig-zag job rotations, allowing team members to acquire diverse skills and experiences. This commitment to growth ensures that top talents emerge, ultimately contributing to a more innovative and resilient organizational culture.

"Leadership is about co-creating the future with balance and intention. We can draw from Buddhist and Confucian principles to apply the five aggregates of leadership – Form (色), Sensation (受), Perception (想), Action (行), and Consciousness (识) – as a guide to navigate complexity." – William Lee

Mr. William Lee is the Co-founder of YAS Microinsurance and N+ Ventures Studio. He stands out not just as a serial tech entrepreneur but as a modern-day philosopher of leadership. He has developed a unique leadership philosophy that integrates clarity of vision, adaptability, and purpose-driven action. Central to Mr. Lee's approach is the application of Buddhist and Confucian principles. His leadership embodies a harmonious blend of control and flexibility, creating a culture that thrives on both structure and fluidity. He emphasizes the importance of empowering individuals to take ownership of their decisions, embrace diverse roles, and think beyond traditional job titles. This parallel mindset cultivates a multi-dimensional and agile workforce. He views AI not merely as a tool for efficiency but as a means to augment human potential. By expanding the possibilities for creative problem-solving and enhancing individual capabilities, AI plays a crucial role in his vision of the future of work.

5.6.4 Individualized Consideration

Individualized consideration enhances employees' job performance, organizational citizenship behavior (Jong & Ford, 2020), learning (Loon et al., 2012) and affective commitment to their organization (Rafferty & Griffin, 2006). It also strengthens employees' self-awareness such that they can make better use of their strengths at work (Ding & Lin, 2021). Transformational leaders establish trust with employees through enhanced role clarity (Martinez-Corcoles et al., 2020) and transferring personal wisdom to employees (Zacher et al., 2014). Innovation and implementation of AI require diverse experiences and competences. Transformational leaders' individualized consideration can facilitate change management by considering employees' individual differences (Alqatawenh, 2018). The following three leaders elaborated how demonstrate their individualized consideration in driving sustainability through strengthening innovation, commitment and resiliency.

"The right people require little encouragement to innovate and deliver results; thus, understanding team members' values, strengths, and motivations is far more crucial than merely adhering to job descriptions." – Cintia Nunes

Ms. Cintia Nunes is the General Manager and Head of Asia of The Mills Fabrica. She fosters a culture of freedom and safety, where employees feel comfortable expressing themselves and asking questions. She promotes autonomy, empowers employees to take charge of their work, fosters transparency and recognition among team members and advocates for resource ownership, encouraging employees to propose new ideas without fear of resource constraints. Ms. Nunes asserted that it is crucial to makes sure employees feel that their ideas

are heard, though those ideas may not always be fully accepted. She conducts interim reviews to listen to employees' requests and wishes, ensuring they feel heard regardless of outcomes. Ms. Nunes encourages individuals to take ownership of their growth while providing regular, transparent feedback. She promotes a culture of continuous assessment and dialogue to align career progression with organizational needs.

"Leaders play a vital role in assessing their team's alignment with the company's core values, swiftly addressing workplace toxicity caused by misfits to cultivate a healthy, cohesive environment where everyone can thrive." – Amanda Pang

Ms. Amanda Pang is the Chief Operating Officer and Co-founder of Evercare, a premier health tech platform that connects over 30,000 healthcare professionals with more than 1 million patients across hospitals, elderly homes, and residential communities via its proprietary matching algorithm and caregiver app. She underscored the critical role of mutual trust in cultivating an innovative culture. She places a strong emphasis on authenticity within her organization, regularly assessing whether her team reflects the company's core values. She believes that thorough fact-finding is essential for effective problem-solving, particularly when it comes to enhancing team resilience or identifying misfits and underperformers to mitigate workplace toxicity. In the rapidly evolving innovation sector, she highlighted the significance of speed and progress tracking, asserting that timely recognition of achievements serves as a powerful motivator for teams.

"Leaders have a duty to prioritize the well-being and resilience of their workforce, remaining vigilant to individual behaviors to identify and address any self-harming tendencies, ensuring a supportive and thriving workplace." – Angie Chan

Ms. Angie Chan is the Executive Director of The Samaritan Befrienders Hong Kong dedicated to suicide prevention, ensuring that those inclined toward suicidal thoughts have a compassionate listener to help them articulate their inner pain and distress. Ms. Chan shared that among the 1,043 help seekers of working age (22-59) over the past year, 7.2% faced work-related challenges. These cases comprised 38% related to work stress, 30% concerning unemployment or job-seeking difficulties, 19% involving coworker relationships, and the remainder dealing with disputes with employers, work injuries, and concerns about unsatisfactory working environments. She explained that most help seekers struggle with a diminished sense of self-worth. For individuals who have developed suicidal thoughts or plans, intervention by mental health experts is crucial. However, leaders can foster resilience among employees by cultivating a respectful workplace culture where all individuals feel valued. Prioritizing employees' physical and mental health is essential, alongside promoting a healthy lifestyle and an environment conducive to open dialogue and mutual respect.

5.7 Discussion and Conclusions

Implementing AI is no longer an option. Organizations that embrace AI can create a sustainable competitive advantage with their enhanced productivity and efficiency (Manimuthu et al., 2022). To achieve that, a strong innovative culture is needed (Banholzer et al., 2023). The current study aims to examine the relationships amongst transformational leadership, innovative culture, affective organizational commitment and resilience to produce empirical evidence on how leaders can create an innovative culture, which in turn will enhance employees' affective commitment to the organization and build employee resilience. In addition to the quantitative findings, interviews with business leaders, tech firm founders and subject matter experts provide practical insights to leaders and HR practitioners and advise them what they can do to boost their sustainability through AI and innovation, and at the same time increase employees' commitment and resilience.

5.7.1. Theoretical Implications

The current study addresses the scarcity of research on the relationships between the innovative culture of an organization and its employees' commitment and resilience. As expected, transformational leadership had a direct impact on innovative culture, but the current study further discovered the mediating effects of innovative culture on the relationships between transformational leadership and employees' affective organizational commitment and resilience, highlighting the importance of transformational leadership that bring favorable individual and organizational outcomes, and an innovative culture's effects on other favorable employee outcomes apart from enhancing the organizational readiness in implementing AI and other new technologies.

5.7.2. Practical Implications

Through the semi-structured interviews, business leaders, tech firm founders and subject matter experts provided their practical advice on what employers, leaders and HR practitioners should do to build an innovative culture, enhance employees' affective organizational commitment and strengthen employee resilience. Leaders are advised to be role models of employees on leaving their comfort zones, being future-oriented, demonstrating passion and strong work ethic, and maintaining transparent communication. They should also create psychological safety and promote risk-taking with accountability to motivate employees to discover new ideas and experiment new ways of doing things. They should focus on attracting and retaining the right people with the right values, stimulate and expose them to challenges, and strike a balance between structure and fluidity to enable them to innovate and take charge of their growth. Nonetheless, diversity is important for an innovative culture. Leaders should establish trust and mutual understanding with every individual, celebrate progresses and learn from failures together to make their team feel valued.

5.7.3. Limitations and Future Studies

Innovation demands leaders and employees to have diverse competences and experiences. To maximize organizational and individual performance and growth, leaders are required to

match their leadership style to different situations and individuals' competences, development needs and personalities (McHugh, 2024). In the current study, effects of transformational leadership were examined. Whilst transformational leaders rely on their charismas to lead their team, transactional leaders use their bureaucratic powers. According to Bass (1985), transformational and transactional leadership augment each other. Both bring favorable individual and organizational outcomes (Weber, 2009). In addition, authenticity influences diversity, trust and transparency (Boekhorst, 2015). Therefore, authentic leadership may also bring positive influences on innovation. Both quantitative and qualitative data collected for the current study showed that certain behaviors under transactional leadership and authentic leadership have significant relationships with innovative culture and employees' affective organizational commitment and resilience. Therefore, future studies on transactional leadership and authentic leadership are recommended.

5.8 References

Adler, N. (1980). Cultural synergy: The management of cross-cultural organizations. In W. Burke, & L. Goodstein, Trends and Issues in OD: Current Theory and Practice (pp. 163-184). San Diego: University Associates.

Afsar, B., Masood, M., & Umrani, W. A. (2019). The Role of Job Crafting and Knowledge Sharing on the Effect of Transformational Leadership on Innovative Work Behavior. Personnel Review, Vol. 48 Issue 5, 1186-1208.

Agbenyegah, A. T., Boahen, P. A., & Ofosu-Appiah, S. (2024). The effect of green transformational leadership on the performance of manufacturing SMEs in Ghana: The moderating role of green creativity. African Journal of Business and Economic Research, 19(2), 527-547.

Akotia, M. W., Dzansi, D. Y., Rambe, P., & Sakyi, E. K. (2024). Transformational leadership, absorptive capacity and innovative work behaviour: Case study in the Ghanaian hospitality industry. International Journal of Management, Accounting and Economics, 11(9), 1153-1177.

Al-Husseini, S., Elbeltagi, I., & Dosa, T. (2013). The effect of transformational leadership on product and process innovation in higher education: An empirical study in Iraq. Proceedings of the International Conference on Intellectual Capital, Knowledge Management & Organisational Learning, 1-10.

Ali, B. (2023). What we know about transformational leadership in tourism and hospitality: A systematic review and future agenda. The Service Industries Journal, 1-43.

Allen, N. J., & Meyer, J. P. (1990). The measurement and antecedents of affective, continuance and normative commitment to the organization. Journal fo Occupational Psychology, 63, 1-18.

Alqatawenh, A. S. (2018). Transformational Leadership Style and its Relationship with Change Management. Business: Theory & Practice, Vol. 19, 17-24.

Anjali, K. T., & Anand, D. (2015). Intellectual Stimulation and Job Commitment: A Study of IT Professionals. IUP Journal of Organizational Behavior, Vol. 14 Issue 2, 28-41.

Antonakis, J. (2021). Leadership to Defeat COVID-19. Group Processes & Intergroup Relations, Vol. 24 Issue 2, 210-215.

Arar, T., & Yurdakul, G. (2024). Increasing danger in business after the pandemic: Adaptation of the quiet quitting scale to Turkish. Istanbul Business Research, 53(3), 279-298.

Arvanitis, K. A., Holenstein, M., & Schriber, L. (2023). Bottom-up resilience: How civic bottom-up initiatives contribute to community resilience. Yearbook of Swiss Administrative Sciences, 14(1), 58-72.

Atoki, A. M., Dxit, S., & Atoki, P. L. (2024). Sustainability-infused transformational leadership: A catalyst for organizational performance at the Nigerian National Petroleum Corporation Limited. International Management Review, Special Issue(20), 5-14.

Banholzer, M., Fletcher, B., LaBerge, L., & McClain, J. (2023). Companies with innovative cultures have a big edge with generative AI. McKinsey Insights.

Barling, J., Slater, F., & Kelloway, E. K. (2000). Transformational Leadership and Emotional Intelligence: An Exploratory Study. Leadership & Organization Development Journal, Vol. 21 Issue 3, 157-161.

Bas, M., & Aksoy, E. M. (2024). Relationship between transformational leadership, R&D performance and employee based brand equity. Journal of Business Research-Turk / Isletme Arastirmalari Dergisi, 16(2), 739-751.

Bass, B. M. (1985). Leadership and Performance beyond Expectations. New York: The Free Press.

Bass, B. M. (1997). Personal Selling And Transactional/ Transformational Leadership. Journal of Personal Selling & Sales Management, Vol. 17 Issue 3, 19-28.

Bass, B. M. (2003). Face to Face — Power to change: A conversation with Bernard M. Bass. Leadership in Action, Vol. 23 Issue 2, 9-11.

Bass, B. M., & Steidlmeier, P. (1999). Ethics, Character, and Authentic Transformational Leadership Behavior. Leadership Quarterly, Vol. 10 Issue 2, 181-217.

Bhatti, M. A. (2024). Perceived organisational fit influence on employees performance: A study of

sustainable HRM. Transformations in Business & Economics, 23(1), 233-258.
Boekhorst, J. A. (2015). The Role of Authentic Leadership in Fostering Workplace Inclusion: A Social Information Processing Perspective. Human Resource Management, Vol. 54 Issue 2, 241-264.
Boutamine, M., & Benlaharche, S. (2024). The CEO's influence on organizational outcomes at Microsoft: A perspective on transformational leadership in the tech sector. South Asian Journal of Management, 31(2), 7-27.
Brown, S., Marinan, J., & Partridge, M. A. (2020). The Moderating Effect of Servant Leadership on Transformational, Transactional, Authentic, and Charismatic Leadership. Journal of International Business Disciplines, Vol. 15 Number 2, 67-86.
Bulatova, J. (2015). The Role of Leadership in Creation of Organizational Trust. Journal of Business Management, Issue 9, 28-33.
Burns, J. M. (1978). Leadership. New York: Harper & Row.
Caleb, N. (2024). Canadian business leaders prioritize sustainability: Deloitte report. Food in Canada, 84(5), 5.
Chen, T., Gasco-Hernandez, M., & Esteve, M. (2024). The adoption and implementation of artificial intelligence chatbots in public organizations: Evidence from U.S. state governments. American Review of Public Administration, 54(3), 255-270.
Chu, L.-C., & Lai, C.-C. (2011). A Research on the Influence of Leadership Style and Job Characteristics on Job Performance among Accountants of County and City Government in Taiwan. Public Personnel Management, Vol. 40 Issue 2, 101-118.
Chun, J. U., Cho, K., & Sosik, J. J. (2016). A Multilevel Study of Group-focused and Individual-focused Transformational Leadership, Social Exchange Relationships, and Performance in Teams. Journal of Organizational Behavior, Vol. 37 Issue 3, 374-396.
Cooper, R. G., & Brem, A. M. (2024). Insights for managers about AI adoption in new product development. Research Technology Management, 67(6), 39-46.
Cravens, K. S., Goad Oliver, E., Oishi, S., & Stewart, J. S. (2015). Workplace culture mediates performance appraisal effectiveness and employee outcomes: A study in a retail setting. Journal of Management Accounting Research, 27(2), 1-34.
Day, G. S., & Shea, G. (2020). Changing the Work of Innovation: A Systems Approach. California Management Review, Vol. 63 Issue 1, 41-60.
Ding, H., & Lin, X. (2021). Individual-focused Transformational Leadership and Employee Strengths Use: The Roles of Positive Affect and Core Self-evaluation. Personnel Review, Vol. 50 Issue 3, 1022-1037.
Egide, B. C. (2024). The influence of organizational culture on innovation and creativity. Research Output Journal of Arts and Management, 3(2), 28-32.
Elshaer, I. A., Azazz, A. M., Kooli, C., Alqasa, K. M., Afaneh, J., Fathy, E. A., . . . Fayyad, S. (2024). Resilience for sustainability: The synergistic role of green human resources management, circular economy, and green organizational culture in the hotel industry. Administrative Sciences (2076-3387), 14(11), 297-320.
Everett, E. (2021). Leadership in Local Government, Part 2: Leaders Knoew Themselves. Public Management (00333611), Vol. 103 Issue 2, 40-42.
Farkas, T. N., Mendy, J., & Kargas, N. (2020). Enhancing resilience in autistic adults using community-based participatory research: A novel HRD intervention in employment service provision. Advances in Developing Human Resources, 22(4), 370-386.
Flick, U. (2019). An Introduction to Qualitative Research. London, UK: SAGE Publications.
Fornell, C., & Larcker, D. F. (1981). Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics. Journal of Marketing Research, Vol. 18 Issue 3, 382-388.
Gefen, D., & Straub, D. (2005). A Practical Guide To Factorial Validity Using PLSGraph: Tutorial And Annotated Example. Communications of the Association for Information Systems, Vol. 16 Issue 1, 91-109.
Gemasari, A. P., Endratno, H., Widhiandono, H., & Rahmawati, I. Y. (2024). The influence of transformational leadership, organizational culture, and organizational commitment on

innovative work behavior in employees of PT. Herba Emas Wahidatama, Purbalingga Regency. Journal of Economics & Digital Business / Jurnal Ekonomi dan Bisnis Digital (MINISTAL), 3(3), 443-460.
Ghaffary, S. (2024). Anthropic releases 'most intelligent' AI model in rivalry With OpenAI. Bloomberg.com.
Ha, M. T., Ho, D. T., & Nguyen, L. N. (2024). The role of adaptive resilience in the relationship between transformational leadership, affective commitment and turnover intention in the post COVID-19 era: A case of Vietnam. Business: Theory & Practice, 25(1), 200-209.
Haberberg, A., & Rieple, A. (2008). Strategic Management: Theory and Application. New York: Oxford University Press.
Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. The Journal of Marketing Theory and Practice, Vol. 19 Issue 2, 139-151.
Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. (2014). Partial Least Squares Structural Equation Modeling (PLS-SEM): An Emerging Tool for Business Research. European Business Review, Vol. 26 Issue 2, 106-121.
Hartog, D. N., Van Muijen, J. J., & Koopman, P. L. (1997). Transactional versus transformational leadership: An analysis of the MLQ. Journal of Occupational & Organizational Psychology, Vol. 70 Issue 1, 19-34.
Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A New Criterion for Assessing Discriminant Validity in Variance-based Structural Equation Modeling. Journal of the Academy of Marketing Science, Vol. 43 Issue 1, 115-135.
Hicks, R. (2018). Getting Transformative for Optimal Results. Physician Leadership Journal. Jan/Feb2018, Vol. 5 Issue 1, 62-64.
Hofstede, G. (2011). Dimensionalizing cultures: The Hofstede Model in context. Psychology and Culture, 2(1).
Hooi, L., & Chan, A. (2023). Does workplace digitalization matter in linking transformational leadership and innovative culture to employee engagement? Journal of Organizational Change Management, 36(2), 197-216.
Hsu, Y.-T., & Chang, K.-C. (2021). A Study on Top Managers from a Resource-based Perspective. Measuring Business Excellence, Vol. 25 Issue 1, 58-77.
Huck, S. W. (2012). Reading Statistics and Research. Boston, USA: Pearson.
Iacobucci, D. (2012). Mediation Analysis and Categorical Variables: The Final Frontier. Journal of Consumer Psychology 22(4), 582-594.
Imran, M., Ismail, F., Arshad, I., Zeb, F., & Zahid, H. (2021). The mediating role of innovation in the relationship between organizational culture and organizational performance in Pakistan's banking sector. Journal of Public Affairs, 1-15.
Jia, Z., & Li, Z. (2024). Exploring the mediating role of innovative work behavior on the relationship between transformational leadership and turnover intention in the software engineering industry in China. UCJC Business & Society Review, 1st Quarter(80), 512-545.
Jiang, J., & Yang, B. (2016). Who can Voice their Thoughts? The Role of Voice Efficacy and Inspirational Motivation. Academy of Management Annual Meeting Proceedings, Vol. 2016 Issue 1, 1.
Jong, J., & Ford, M. (2020). An Exploration of the Relationship Between Autonomy Congruence, Perceived Supervisor Individualized Consideration, and Employee Outcomes. Review of Public Personnel Administration, 1-1.
Judge, T. A., & Piccolo, R. F. (2004). Transformational and Transactional Leadership: A Meta-Analytic Test of Their Relative Validity. Journal of Applied Psychology, Vol. 89 Issue 5, 755-768.
Judge, W. Q. (2021). Focusing on organizational change. Open Textbooks.
Kaaria, A. G. (2024). Essential human resource metrics and analytics for sustainable work environments: Literature mapping and conceptual synthesis. East African Journal of Business & Economics, 7(1), 241-262.
Kark, R., & Shamir, B. (2002). The Influence of Transformational Leadership on Followers' Relational Versus Collective Self-Concept. Proceedings & Membership Directory - Academy of Management, Section D, 1-6.

Khan, S. K., Memon, M. A., & Ramayah, T. (2018). Leadership and innovative culture influence on organisational citizenship behaviour and affective commitment: The mediating role of interactional justice. International Journal of Business & Society, 19(3), 725-747.
Kline, R. B. (2015). Principles and Practice of Structural Equation Modeling. New York, USA: The Guilford Press.
Knezovic, E., & Drkic, A. (2021). Innovative Work Behavior in SMEs: The Role of Transformational Leadership. Employee Relations, Vol. 43 Issue 2, 398-415.
Koran, J. (2020). Indicators per Factor in Confirmatory Factor Analysis: More is not Always Better. Structural Equation Modeling A Multidisciplinary Journal, Vol. 27 Issue 5, 1-8.
Kovac, J., & Jesenko, M. (2010). The Connection between Trust and Leadership Styles in Slovene Organizations. Journal for East European Management Studies, Vol. 15 Issue 1, 9-33.
Koveshnikov, A., & Ehrnrooth, M. (2018). The Cross-Cultural Variation of the Effects of Transformational Leadership Behaviors on Followers' Organizational Identification: The Case of Idealized Influence and Individualized Consideration in Finland and Russia. Management & Organization Review, Vol. 14 Issue 4, 747-779.
Lafram, A., & Bahji, S. E. (2024). Artificial intelligence in Morocco: Towards holistic, responsible and ethical national AI strategy for Moroccan competitiveness and strategic intelligence. Proceedings of the European Conference on Management, Leadership & Governance, 255-263.
Lauring, J., & Jonasson, C. (2018). Can Leadership Compensate for Deficient Inclusiveness in Global Virtual Teams? Human Resource Management Journal, Vol. 28 Issue 3, 392-409.
Le, T., & Le, B. (2021). Mediating role of change capability in the relationship between transformational leadership and organizational performance: An empirical research. Psychology Research and Behavior Management, 14, 1747-1759.
Li, N., Kim, M., Dai, J., & Vasarhelyi, M. A. (2024). Using artificial intelligence in ESG assurance. Journal of Emerging Technologies in Accounting, 21(2), 83-99.
Liang, Q., Oh, I., & Rowley, C. (2024). Understanding the survival strategies: Organization resilience and innovative capabilities in post-pandemic East Asia. Asia Pacific Business Review, 1-11.
Lok, P., & Crawford, J. (2004). The effect of organisational culture and leadership style on job satisfaction and organisational commitment: A cross-national comparison. Journal of Management Development, 23(4), 321-338.
Longenecker, C. O., & Insch, G. S. (2018). Understanding the Fatal Flaws of Leadership. Industrial Management, Vol. 60 Issue 2, 21-26.
Loon, M., Lim, Y. M., Lee, T., & Tam, C. L. (2012). Transformational leadership and job-related learning. Management Research Review, 35(3/4), 192-205.
Lorinkova, N. M., & Perry, S. J. (2019). The Importance of Group_focused Transformational Leadership and Felt Obligation for Helping and Group Performance. Journal of Organizational Behavior, Vol. 40 Issue 3, 231-247.
Low, M. (2024). Leveraging employee value creation in building organizational resilience: A serial mediation approach. Employee Responsibilities & Rights Journal, 1-20.
Malik, G., & Singh, P. (2024). Fostering social sustainability: Unveiling HR's power in enhancing employee resilience via social exchange and broaden-and-build theories. Employee Relations, 46(3), 675-701.
Manimuthu, A., Venkatesh, V. G., Raja Sreedharan, V., & Mani, V. (2022). Modelling and analysis of artificial intelligence for commercial vehicle assembly process in VUCA world: A case study. International Journal of Production Research, 60(14), 4529-4547.
Marsh, H. W., Hau, K.-T., Balla, J. R., & Grayson, D. (1998). Is More Ever Too Much? The Number of Indicators per Factor in Confirmatory Factor Analysis. Multivariate Behavioral Research, Vol. 33 Issue 2, 181-220.
Martinez-Corcoles, M., Stephanou, K. D., & Schobel, M. (2020). Exploring the effects of leaders' individualised consideration in extreme contexts. Journal of Risk Research, 23(2), 167-180.
Martinez-Corcoles, M., Stephanou, K. D., & Schobel, M. (2020). Exploring the Effects of Leaders' Individualized Consideration in Extreme Contexts. Journal of Risk Research, Vol. 23 Issue 2, 167-180.

McHugh, B. (2024). Situational leadership practices: Essential for today's leaders. Forbes Coaches Council - Council Post, March 11.
Meyerson, B. (2016). Embedding innovation in corporate DNA. Research Technology Management, 30-35.
Mohammed, A. K., & Binti Ahmad, N. H. (2024). The influence of HRM practices on small business performance in Nigeria: The mediating role of staff commitment and moderating role of management support. Global Business & Management Research, 16(Special Issue), 2185-2203.
Motsoeneng, L., Schultz, C., & Lessing, K. (2024). Leadership style predicts human resource management competencies. Journal of Contemporary Management (1815-7440), 21(2), 139-170.
Muchiri, M. K., McMurray, A. J., Nkhoma, M., & Pham, H. C. (2020). Mapping Antecedents of Innovative Work Behavior: A Conceptual Review. Journal of Developing Areas, Vol. 54 Issue 4, 33-40.
Munoz-van den Eynde, A., Cornejo-Canamares, M., Diaz-Garcia, I., & Munoz, E. (2015). Measuring innovation culture: Development and validation of a multidimensional questionnaire. Advances in Research, 4(2), 122-141.
Murtaza, S. H., Khan, A., & Mustafa, S. M. (2024). Eco_centric success: Stakeholder approaches to sustainable performance via green improvisation behavior and environmental orientation in the hotel industry. Business Strategy & the Environment (John Wiley & Sons, Inc), 33(7), 7273-7286.
Mustafa, M. J., Badri, S. K. Z., & Ramos, H. M. (2024). Linking middle-managers' ownership feelings to their innovative work behaviour: The mediating role of affective organisational commitment. Journal of Management & Organization, 30(6), 2418-2435.
Myers, M. D. (2020). Qualitative Research in Business & Management. Los Angeles, USA: SAGE Publications.
Naswall, K., Malinen, S., Kuntz, J., & Hodliffe, M. (2019). Employee resilience: Development and validation of a measure. Journal of Managerial Psychology, 34(5), 353-367.
Nwagbara, U., Ibeawuchi, N., & Stewart, J. (2024). Exploring the pressures of managerialism on achieving transformational educational leadership. Economic Insights - Trends & Challenges, 13(1), 1-10.
O'Brien, D. A. (2015). Leadership Trust. Leadership Excellence, Vol. 32 Issue 4, 20-20.
Orgambídez, A., & Benítez, M. (2021). Understanding the link between work engagement and affective organisational commitment: The moderating effect of role stress. International Journal of Psychology, 56(5), 791-800.
Pedol, M., Biffi, E., & Melzi, S. (2021). Sustainability game. Corporate Social Responsibility & Environmental Management, 28(5), 1540-1548.
Peng, A. C., Lin, H.-E., Schaubroeck, J., McDonough, E. F., Hu, B., & Zhang, A. (2016). CEO Intellectual Stimulation and Employee Work Meaningfulness. Group & Organization Management, Vol. 41 Issue 2, 203-231.
Peterson, S. J., Abramson, R., & Stutman, R. K. (2020). How to Develop Your Leadership Style. Harvard Business Review, Vol. 98 Issue 6, 68-77.
Petrick, J. A., Scherer, R. F., Brodzinski, J. D., Quinn, J. F., & Ainina, M. F. (1999). Global Leadership Skills and Reputational Capital: Intangible Resources for Sustainable Competitive Advantage. Academy of Management Executive, Vol. 13 Issue 1, 58-69.
Podgorodnichenko, N., Edgar, F., & Akmal, A. (2022). An integrative literature review of the CSR-HRM nexus: Learning from research-practice gaps. Human Resource Management Review, 32(3).
Podsakoff, P. M., MacKenzie, S. B., Moorman, R. H., & Fetter, R. (1990). Transformational Leader Behaviors and their Effects on Followers' Trust in Leader, Satisfaction, and Organizational Citizenship Behaviors. The Leadership Quarterly, Vol. 1 Issue 2, 107-142.
Probojakti, W., Utami, H. N., Prasetya, A., & Riza, M. F. (2024). Driving sustainable competitive advantage in banking: The role of transformational leadership and digital transformation in organizational agility and corporate resiliency. Business Strategy & the Environment (John

Wiley & Sons, Inc), 1-20.
Rae, K., Sands, J., & Gadenne, D. L. (2015). Associations between organisations' motivated workforce and environmental performance. Journal of Accounting & Organizational Change, 11(3), 384-405.
Rafferty, A. E., & Griffin, M. A. (2006). Refining Individualized Consideration: Distinguishing Developmental Leadership and Supportive Leadership. Journal of Occupational & Organizational Psychology, Vol. 79 Issue 1, 37-61.
Rao, M. S. (2014). Transformational Leadership – An Academic Case Study. Industrial & Commercial Training. 2014, Vol. 46 Issue 3, 150-154.
Registre, J. R., & Saba, T. (2024). A typology of AI-based tasks for the HR function. Strategic HR Review, 23(5), 170-175.
Restrepo-Morales, J. A., Valencia-Cardenas, M., & Garcia-Perez-de-Lema, D. (2024). The role of technological innovation in the mitigation of the crisis generated by COVID-19: An empirical study of small and medium-sized businesses (SMEs) in Latin America. International Studies of Management & Organization, 54(2), 120-136.
Robinson, M. A. (2017). Using Multi-item Psychometric Scales for Research and Practice in Human Resource Management. Human Resource Management, Vol. 57 Issue 3, 739–750.
Robinson, M. A., & Boies, K. (2016). Different Ways to Get the Job Done: Comparing the Effects of Intellectual Stimulation and Contingent Reward Leadership on Task-related Outcomes. Journal of Applied Social Psychology, Vol. 46 Issue 6, 336-353.
Saha, S., & Kumar, S. P. (2018). Organizational culture as a moderator between affective commitment and job satisfaction: Empirical evidence from Indian public sector enterprises. International Journal of Public Sector Management, 31(2), 184-206.
Sayan, Z., & Surucu, L. (2024). The role of transformational leadership and employee productivity in logistics performance. LogForum, 20(1), 1-10.
Sayyadi, M., & Provitera, M. J. (2024). The art of transformational leadership: A key to a high-performance company. Journal of Values Based Leadership, 17(1), 72-77.
Schuesslbauer, A. F., Volmer, J., & Goritz, A. S. (2018). The Goal Paves the Way. Journal of Career Development (Sage Publications Inc.), Vol. 45 Issue 5, 489-503.
Sekaran, U., & Bougie, R. (2013). Research Methods for Business: A Skill-Building Approach. West Sussex, UK: John Wiley & Sons Ltd.
Shafi, M., Lei, Z., Song, X., & Sarker, M. N. (2020). The Effects of Transformational Leadership on Employee Creativity: Moderating Role of Intrinsic Motivation. Asia Pacific Management Review, Vol. 25 Issue 3, 166-176.
Si, H., Loch, C., & Kavadias, S. (2023). A new approach to strategic innovation. Harvard Business Review, September-October.
Siraj, N., Hagen, I., Cahyadi, A., Tangl, A., & Desalegn, G. (2022). Linking leadership to employees performance: The mediating role of human resource management. Economies, 10(5).
Starc, J. (2013). The Manager - As Personality and Motivator. Journal of Economics & Business Research. 2013, Vol. 19 Issue 1, 185-196.
Stomski, L., & Leisten, J. (2015). Leading into the Next Frontier. Benefits Quarterly. 2015 Third Quarter, Vol. 31 Issue 3, 22-28.
Suifan, T. (2021). How innovativeness mediates the effects of organizational culture and leadership on performance. International Journal of Innovation Management, 25(2), 1-32.
Sulistiasih, S., Widodo, W., & Onaning, K. (2024). Modeling transformational leadership fits organizational citizenship behavior via talent management, learning organization, and job involvement. Quality - Access to Success, 25(202), 320-330.
Sulistiasih, S., Widodo, W., & Onaning, K. (2024). Modeling transformational leadership fits organizational citizenship behavior via talent management, learning organization, and job involvement. Quality - Access to Success, 25(202), 320-330.
Syafri, M., & Rasyid, A. (2025). Sustainable human resource practices: Analyzing their impact on organizational resilience and employee retention. Journal Return, 4(1), 50-57.
Szeto, E. (2021). How do principals' practices reflect democratic leadership for inclusion in diverse

school settings? A Hong Kong case study. Educ. Manag. Adm. Leadersh. 2021, 49, 471–492.
Tairov, I., Stefanova, N., & Aleksandrova, A. (2024). Artificial intelligence application in human resouces management. Business Management / Biznes Upravlenie, 3, 72-88.
Tanner, O. C. (2024). O.C. Tanner unveils AI-enabled insight tools to improve employee experience. Business Wire (English).
Thapa, A., Parimoo, D., Kovid, R. K., & Sharma, G. M. (2024). Mediating effect of CSR on the relationship between transformational leadership and organizational performance in the Indian pharmaceutical industry. Interdisciplinary Journal of Management Studies, 17(1), 95-110.
Toader, S., & Howe, I. S. (2021). Early Cohort Millennials as Transformational Leaders: A Qualitative Case Study of a Professional Auditing Services Firm in Romania. International Leadership Journal, Vol. 13 Issue 2, 16-40.
Van Knippenberg, D., & Sitkin, S. B. (2013). A Critical Assessment of Charismatic—Transformational Leadership Research: Back to the Drawing Board? Academy of Management Annals. 2013, 7(1), 1-60.
Varshini, A., Damini, N., & Pranami, S. (2024). Combining green human resources management and organizational culture to promote environmental sustainability. PRERANA: Journal of Management Thought & Practice, 16(2), 1-12.
Veshne, N. A., & Munshi, M. M. (2020). Enhancing Employee Engagement through Emotionally Intelligent Leaders. Srusti Management Review. Jul-Dec2020, Vol. 13 Issue 2, 32-39.
Wallach, E. J. (1983). Individuals and organisation: The cultural match. Training and Development Journal, 37(2), 28-36.
Watson-Hemphill, K. (2024). Elements of innovation: How culture, advanced analytics and creativity enhance innovation. Lean & Six Sigma Review, 23(4), 22-28.
Weber, M. (2009). The Theory of Social and Economic Organization. New York: The Free Press.
Wong, A. T. (2024). Assessing the mediating effect of team-member exchange on the relationship between transformational leadership and performance of people with disabilities: A study of Hong Kong employers of people with disabilities. Merits, 4(3), 211-223.
Wulandari, F., & Subiyanto, D. (2024). The role of transformational leadership in critical situations: Problem-solving performance in public service as the outcome. Quality - Access to Success, 25(200), 179-187.
Xu, W., Du, F., Zhang, L., & Ge, L. (2024). Introduction to the special issue on human–computer interaction innovations in China. International Journal of Human-Computer Interaction, 40(8), 1795-1798.
Yadav, L. K., & Seth, M. (2021). Invigorating Team Processes through Transformational Leadership: A Theoretical Proposition. Abhigyan. Jan-Mar2021, Vol. 38 Issue 4, 30-43.
Zacher, H., Pearce, L., Rooney, D., & McKenna, B. (2014). Leaders' personal wisdom and leader-member exchange quality: The role of individualised consideration. Journal of Business Ethics, 121(2), 171-187.
Zhao, S., Liu, M., Xi, M., Zhu, C. J., & Liu, H. (2023). The role of leadership in human resource management: Perspectives and evidence from China. Asia Pacific Business Review, 29(1), 1-10.

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Chapter 6 - AI Artificial Intelligence, Sustainability and Strategic Leadership

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Chapter Information

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Abstract

Artificial Intelligence (AI) has grown drastically in recent years. Organization leadership teams are focusing on analyzing the data through Artificial Intelligence (AI) and deriving it to the constructive decisions. This chapter shall focus on the leadership strategies which are used to develop the business operations by simplifying the model of operations with the support of AI, minimizing the timelines, operation cost and enhancing the speed and accuracy of the results, also aligning the sustainable development goals, reducing carbon emission and footprint, which can be done by adapting the approaches like use of solar and wind (renewable) energy, water and waste management, sustainable agricultural developments, use of preserved biodiversity, respectively depending upon suitability in contributing to the different industries and sectors. This chapter will also focus on the use of generative AI, the positive and challenging impact of the same, also how it can be environmentally friendly, by using renewable energy and moderating emissions. Sustainable Business Practices is important but along with this, ethicality and transparency of data usage, code of conduct, proper documentations, managing and analyzing risk along with the responsible behavior is also significant. AI experts, policy makers, Government guidelines and business leaders need to align, plan and design the strategy which is supporting the concept of AI, sustainable development of the company and leadership teams leading the company's defined social and economic goals. The chapter will also shed light on scope and suggestions for future positive outcomes.

Keywords: *Artificial Intelligence, Strategic leadership, Ethicality, Transparency, Operations efficiency, Cost saving, Policy makers, Government guidelines, AI experts, Environment Sustainability, Social and Economic impacts, Renewable energy, Carbon emission;*

6.1. Introduction

6.1.1 Scope and Objectives

The role of Artificial Intelligence (AI) in sustainability manner within business practices has gained meaningful power in new era. As organizations are facing immense to contribute to sustainable development by reducing environmental impact, AI has become an important tool for strategic leadership management. This chapter discovers how AI is being incorporated with sustainability programs and how it shapes an organization's strategies. By considering how AI technologies can contribute to improving sustainable efforts, organization management teams can well arrange their companies for future gaps and challenges such as climate change, resource depletion, and evolving social responsibilities. AI plays an important role particularly in the perspective of sustainability, where in its role is to minimize the environmental effects, preserving supplies, and refining operational effectiveness. The possibility of this chapter includes scrutinizing the role of AI role in reducing carbon emissions, energy consumption, and waste, at the same time aligning these strengths with stronger business strategies. This chapter will explore about the leadership teams in various sectors pertaining to leverage AI to drive sustainable practices, enhance the utilization of renewable energy, manage waste, and develop supply chain sustainability. The objectives of this chapter are to investigate how can AI drive business operations competences which can subsidize to sustainability objectives. Also to examine how strategic managers are integrating AI into their sustainability policies, simultaneously to explore how an ethical consideration of AI in business practices, predominantly in relation to environmental sustainability and social responsibility could be managed. Also to provide suggestions for incorporating AI into business operations to accomplish sustainability and strategic objectives.

6.1.2 Importance of the Chapter

The rising concern and importance of sustainability, which is driven by the firmness of climate change, resource reduction, and social inequality, noises for solution which is innovative enough in every business. AI being one of the most transformative high-tech developments of the 21st era, has the probable to address these worldwide gaps and confronts by enhancing business operations, driving competences in energy use, reducing waste, and resource distribution. In the successful implementation of AI for sustainability, strategic leadership plays a crucial role, where in leaders who embrace AI are not only the one who gain a technological advantage but also safeguard their businesses are resilient to the interruptions caused by ecological and societal challenges. This chapter shall contribute to the present literature by incorporating AI's technological competences with management strategies that encourage environmental, economic, and social sustainability. By highlighting an ethical consideration, gaps and challenges in AI acceptance, this chapter purposes to offer realistic perceptions and future guidelines for businesses looking to influence AI for sustainable business practices.

6.2. Literature Review

6.2.1 Artificial Intelligence and Sustainability

Ability of AI skill set, and knowledges are progressively getting increased, and it has also recognized for their probable to assist sustainable expansion works. One of the most important functions of AI in sustainability is in energy management. AI-powered systems can enhance the usage of energy and control it in real-time, by allowing for the more well-organized use of renewable energy resources like solar and wind power. Smart grids operated by AI can forecast energy need, adjust allocation, and incorporate renewable energy into the grid, decreasing dependency on fossil fuels (Rahman et al., 2022). Furthermore, use of AI in building constructions to control heating, ventilation, air conditioning (HVAC) systems, lighting, and appliances, leading to meaningful energy savings (Harrison et al., 2021).

AI is making improvements in encouraging ecological practices by relieving agriculturalists enhance resource usage in agricultural business at various places. From AI-driven technologies and tools it can be predicted that the crop is yield, schedules of irrigation and the need of pesticides and fertilizers, that when it is required and after what usage it is harmful to the environment. AI powered, accurate farming techniques allows farmers to use resources in a more proficient way, by improving crop yield and simultaneously while minimizing environmental impacts (Bera & O'Neill, 2020). Additionally, AI can be used to oversee soil well-being, biodiversity, and use of water, by providing farmers with data-driven perceptions that help sustainable agricultural practices.

AI plays a vital role in controlling waste management and its recycling. AI can predict the waste pattern by observing the waste management in a systematic way for stipulated time and can improve the process of re-cycling, which further can eventually assist in sorting the waste more efficiently. AI can help drastically by contributing to broadside saving practices by reducing landfill waste and growing recycling rates and confirming that resources are reused rather than disposed of (Cozzolino et al., 2020).

Despite many benefits as above, the study also highlights some gaps and challenges in the implementation of AI in sustainable business practices which leads to the win-win situation for business leaders. The execution of AI for sustainability needs substantial number of investments in infrastructure, technology, and human resources. Furthermore, concerns about data privacy, data biasness, and the environmental impact of AI systems themselves predominantly are those areas that require attention which involve vast computational resources (O'Neil, 2016). These experiments underline the need for ethical frameworks and strong leadership to safeguard usage of AI with responsibility.

6.2.2 Strategic Leadership in the Era of AI

For successful adoption and implementation of AI, management strategic leadership is very important, particularly in the context of sustainability. Today's business leaders must focus on a clear vision which derives AI to meet sustainability goals and make the road map for their organizations which guides through the challenges of incorporating AI into present processes. This is particularly significant in businesses such as energy, agriculture, manufacturing, and logistics, where AI can show substantial enhancements in sustainability.

Transformational leadership, as labelled by Bass and Riggio (2006), is mainly

applicable in this study. Transformational leaders motivate and encourage their team members to hold change, containing the acceptance of AI tools. These leaders focus on operational improvements, also they highlight the broader visualization of sustainability and the long-term advantages of AI. By developing a culture of invention, these managers and business leaders can determine sustainable commercial practices while upholding growth of companies and increase in profitability. Furthermore, strategic leaders need to stabilize the short-term goals of operational effectiveness with the long-term goals of environmental sustainability. This necessitates the incorporation of AI into business strategies that highlights not only the decrease in cost and increase in productivity but also environmental stewardship, social accountability, and ethical business practices (Kiron et al., 2021).

The gap and challenge lie in positioning AI tools with sustainability goals without surrendering the organization's ethical values. Business leaders must ensure clarity, fairness, and inclusivity in AI arrangements, focusing concerns connected to data biasness and the probable shift of workers by robotics. As AI tools are evolving leadership and continuous adaption of AI ensures that functions are aligned with the company's mission, values, and sustainability aims.

6.2.3 AI Implementation in Business Operations

The implementation of AI in business management operations widths an extensive variety of industries, respectively of which has the sole sustainability challenges and prospects. In manufacturing, AI-driven analytical systems help to optimize the equipment performance, reduce the timeline, and reduces the maintenance costs. These techniques can forecast breakdowns before they could happen, safeguarding that system functions at peak effectiveness, which in turn lowers energy depletion and material surplus (Harrison et al., 2021).

In logistics and supply chain management, use of AI is to optimize methods, reduce gasoline, power, energy consumption, and restructure an inventory management. AI-powered methods can forecast requirement, minimize extra inventory, and enhance delivery tracks, which leads to the decrease in greenhouse gas emission and cost of transportation (Binns, 2020). Furthermore, AI can aid in circular economy by refining product lifespan management and letting the companies to reduction of waste and promote the reuse of resources.

The healthcare industry is also adopting the use of AI, where it is being used to diminish waste in medicinal supply chains, improve resource distribution in hospitals, pharmacies and clinics, and forecast healthcare requirements created on population movements. By the better use of AI, healthcare procedures can manage more proficiently, by lessening energy utilization and surplus while enlightening the excellence in precaution (Cozzolino et al., 2020).

6.2.4 Identifying Gaps in Current Literature

Although the existing literature in the articles, journal and other works delivers valuable perceptions into the function of AI in business sustainability, numerous gaps continue. Most study has determined on AI's functional competencies and its possible in cost reduction, with very restricted consideration to its wider strategic consequences for long-term sustainability. Furthermore, the studies are required to explore more AI's role in driving environmental sustainability by adopting sustainable business models that incorporate environmental goals of UN, social, and economic goals of the businesses.

Additionally, the ethical consequences of AI in sustainability energies are the capacities

that involves more consideration. How can AI tools can be proposed and executed in a manner that it encourages fairness, equality, and community responsibility? Study into these subjects will be serious as AI is becoming beyond universal in business tasks and sustainability strategies.

6.3. Research Methodology and Framework

6.3.1 Research Approach

This chapter adopts a mixed methods where qualitative and quantitative research approach that synthesizes existing literature, case studies, survey in Likert scale method and industry reports. In survey method, respondent was from different industries with the role like managers, executive directors, consultants etc. This study is also based on observation method by understanding the existing occurrences of activities in my current organization named Abu Dhabi Precast LLC based in Abu Dhabi, UAE which falls under precast and composite manufacturing industry. Being precast manufacturing industry, automation plays an important role as many machineries and equipment are automated to achieve the labor cost reduction and increase the productivity strategically. However, at the same time environmental sustainability is the biggest concern for company like Abu Dhabi Precast LLC wherein concrete is the base of production. There to cover up the same, the production is shifted to GRC (glass reinforcement concrete products) which is more environmentally friendly. Moreover, the UAE govt is trying to promote more environmentally sustainable business therefore there are stipulated areas allotted for such manufacturing and any expansion of the business needs to have the plans which supports environment (Survey data, 2025). The comprehensive review of peer-reviewed articles and relevant reports from reliable sources such as business leaders, academic periodicals, and government publications are used. This methodology permits better understanding of the connection of AI, sustainability, and strategic leadership.

The emphasis is on examining how is the existing use of AI in current business to drive sustainability across different industries with strategical approach of growing business and reduce carbon emission along with improved business operations in terms of economic, well-being of employees and society and efficiency of business operations. With the assistance of real time case studies and real-world examples, this chapter delivers a thorough inspection of the applied function of AI in driving sustainability aims. Furthermore, the ethical opinions of AI recognition and the function of management in managerial AI incorporation are discovered.

Survey was conducted via emails and LinkedIn to get the understanding from professionals, the response was received from the geographical region of Europe, Middle East, Asia, from the countries like India, Qatar, United Arab Emirates, Switzerland. There were 30 respondents, from the industries Real Estate, Consulting, Education, Manufacturing, Construction. The positions of the respondent were managers, supervisors, executive directors, consultants and analysts.

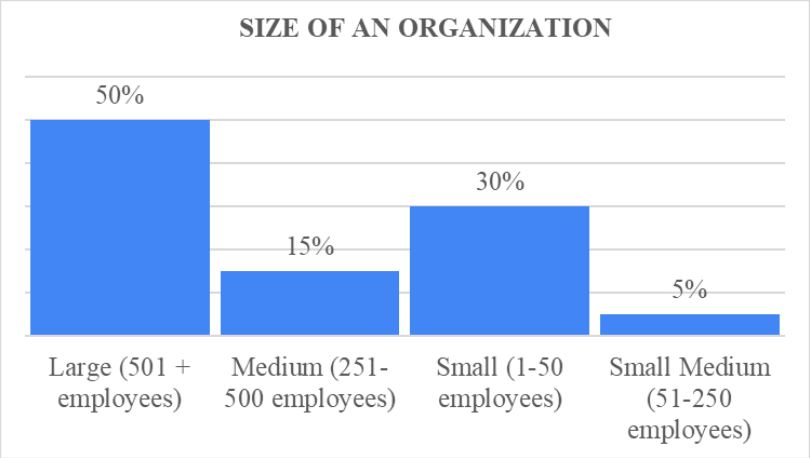

Figure 1

Figure 2

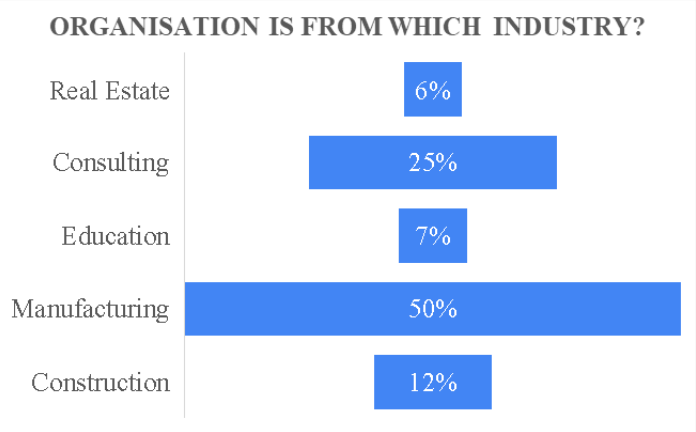

Figure 3

Note. The respondents of this survey are from different sizes of the organization as stated in the figure 1, and the percentage of the roles holding respondents are shown in the figure 2. Whereas maximum respondents are from manufacturing industry as shown in the figure 3

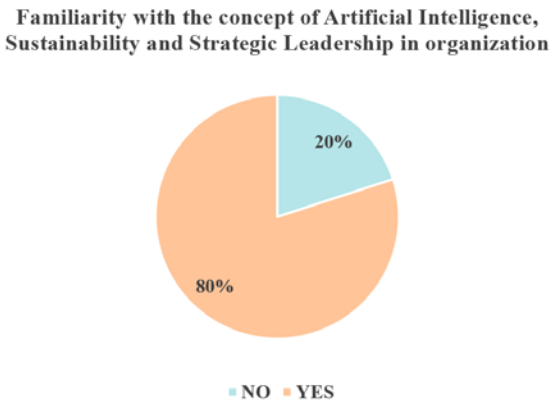

Figure 4

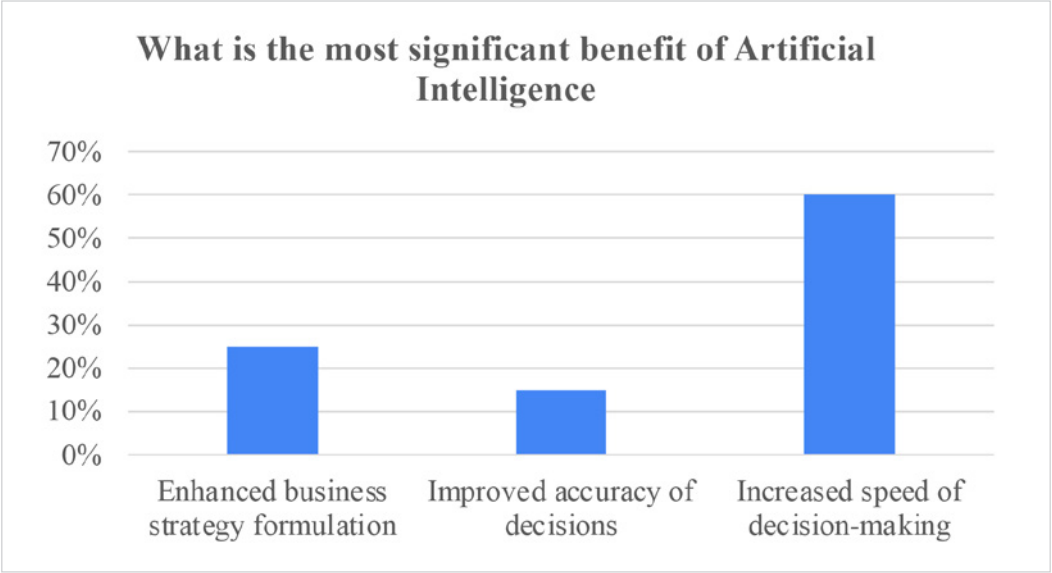

Figure 5

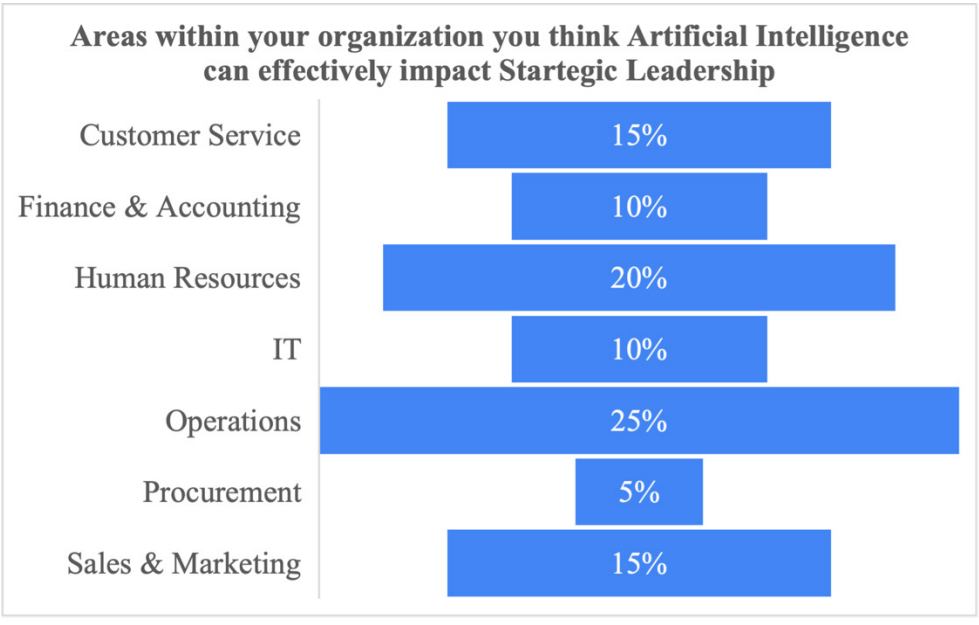

Figure 6

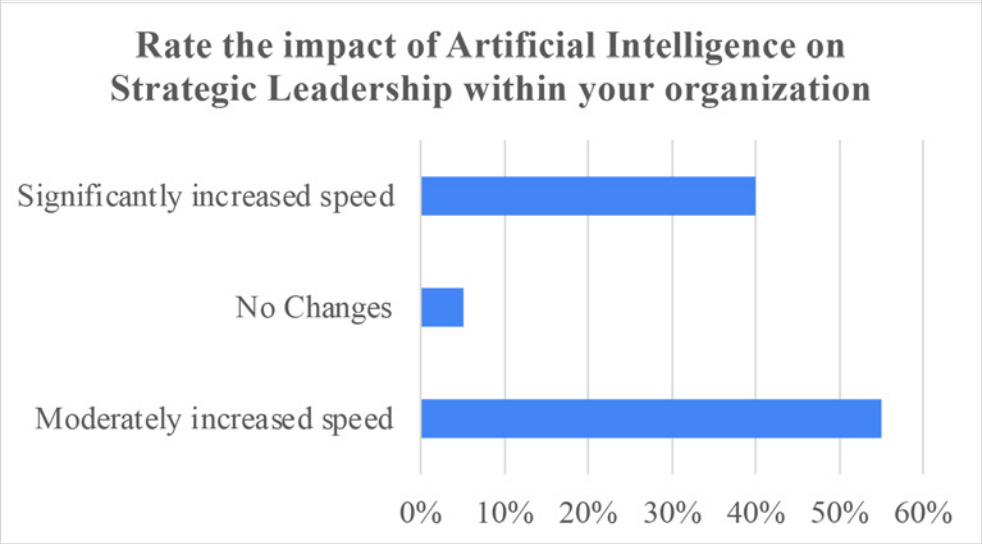

Figure 7

Note. Figure 6 states that an artificial intelligences tools are used in many functions like Operations, Human Resources, Sales and Marketing etc. Whereas in figure 8, it reflects that the impact of AI in strategic leadership is increasing.

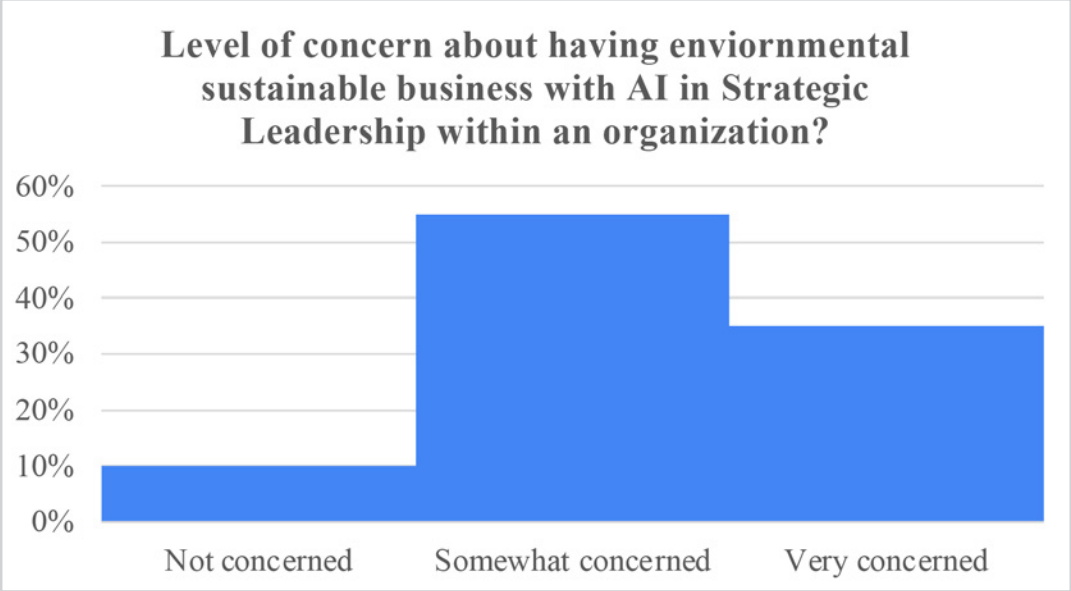

Figure 8

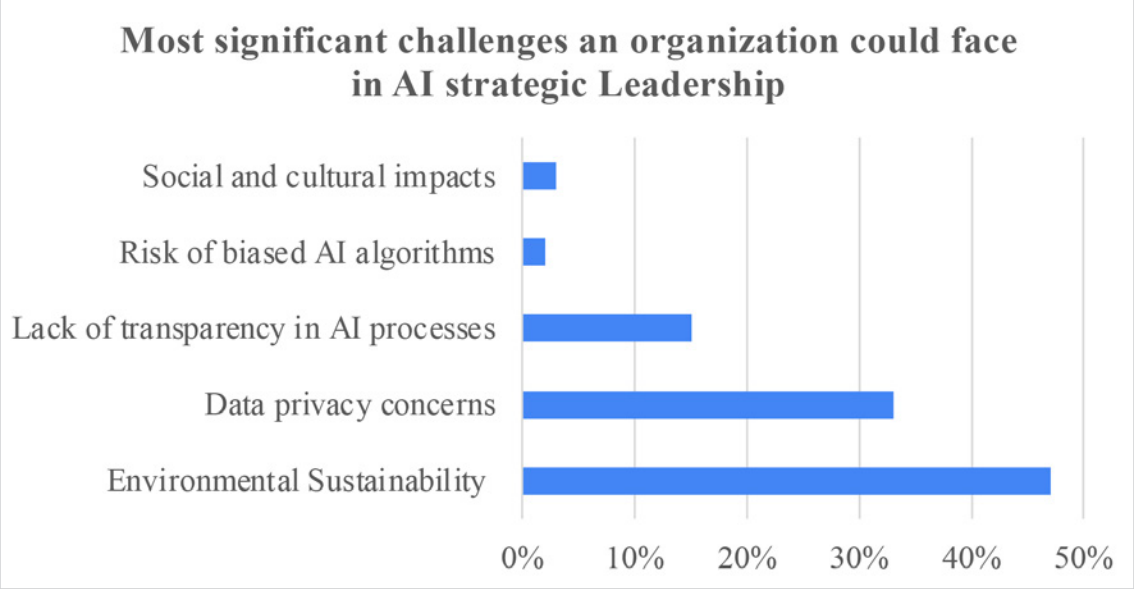

Figure 9

Note. In figure 8 and 9 it states that the concern of environmental sustainability is high and it's the most challenging aspects in AI strategic leadership

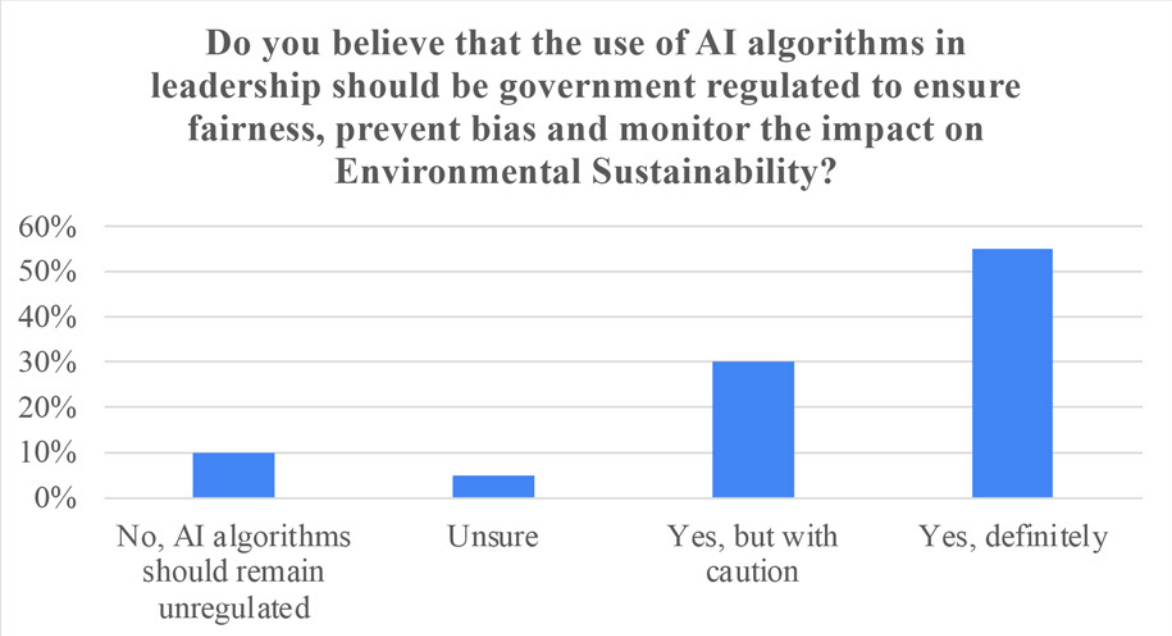

Figure 10

Figure 11

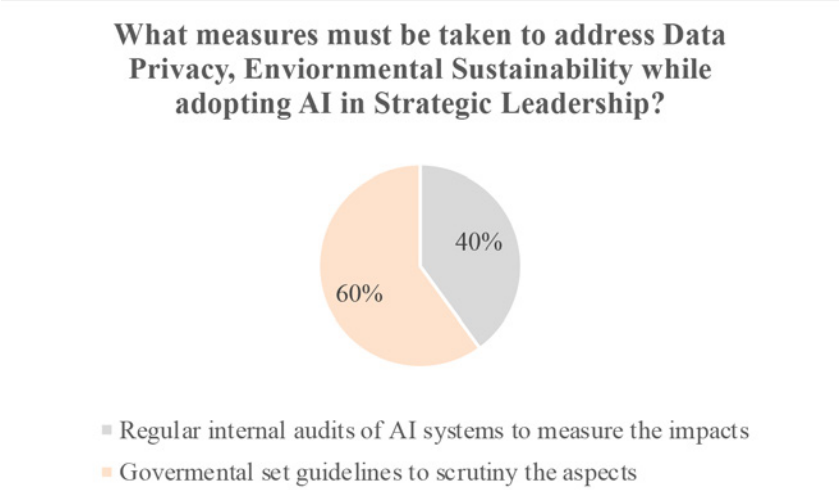

Figure 12

Note. In figure 12, 60% of the respondent thinks that government needs to evaluate in the use of AI in strategic leadership to safeguard, monitor and reduce environmental impact

6.3.2 Academic Framework

The analysis of the Academic framework is established in numerous recognized concepts in strategic leadership and sustainability, including Transformational Leadership Theory (Bass & Riggio, 2006) which is a vital to understand that how business leaders can stimulate and encourage their organizations to grip AI tools while practicing sustainable goals. Another theory is Resource-Based View (RBV) (Barney, 1991), which highlights leveraging businesses capital and resources by involving technological proficiencies, to benefit an economical gain. In this perspective, AI is an appreciated means that can improve sustainability practices and push functional effectiveness. The third one is Triple Bottom Line (TBL) (Elkington, 1997), which is framework that estimates the companies, centered on three pillars: economic, environmental, and social presentation. AI tools can provide to all three scopes by improving business operational effectiveness, diminishing environmental effects, and indorsing social

responsibility. The fourth theory is Dynamic Capabilities Theory (Teece et al., 1997) which hypothesizes that organization can benefit a competitive advantage by emerging adaptable strategies that alter to promptly shifting circumstances. AI allows companies to adjust quickly to marketplace modifications, technological progressions, and sustainability confronts. By using these academic frameworks, the chapter investigates on how strategic leadership can influence organizations to use AI to meet sustainability aims and form long-term significance.

6.4. Discussion and Findings

6.4.1 AI in Driving Sustainability Agendas

As per the (Survey data, 2025), it is understood that respondents believes that the potential use of AI needs to be monitored. AI has been used by many companies at large, medium and small scales, ability of AI to run the sustainability is huge, and companies are willing to use the AI tools and technologies to increase productivity and support the environment as well along with the improvement in efficiency. For instance, in an Energy, the use of AI tools and technology drives the optimum utilization of renewal energy by reducing the dependency on non-renewable energy resources. (Rahman et al., 2022). AI-expert energy management techniques assist companies and business to reduce energy utilization and rise the usage of clean energy, which directly contributes to decrease of carbon emissions.

Furthermore, the use of AI techniques in agricultural businesses are transforming the way the food has been manufactured, reducing the environmental footprint of agricultural practices. AI-driven exactness cultivation techniques grant agriculturalists to boost water use, diminish pesticide function, and increase soil health, which ultimately leads to more sustainable agricultural practices (Bera & O'Neill, 2020). These developments support the worldwide driven supportable food manufacturing methods and gives a roadmap to attend food security confronts in an environmentally sensible approach.

6.4.2 AI in Strategic Leadership in Contemporary Organizations

Strategic leadership is critical role in any organization, management needs to be assured that not only the implementation of AI but also the use of AI is being done in an organization to ensure and get the best return out of investment. Leaders in an organization needs to ensure that AI is used to enhance the sustainability along with the business decisions of making revenue. Management must use the AI initiatives to align with the organization's mission, values, goals and long-term aims. By concentrating on sustainability aims, managers can push revolution and increase in operational effectiveness, by creating strong organizations which are better armed to route ecological and social gaps and challenges.

As it is known that AI helps management leaders to enhance the decision-making skills as the analysis are quick and well reported in quick manner, this guides them to be ready with new strategic initiatives. For instances, AI techniques can forecast market trends, customer and client behavior, and potential interruptions in the supply chain, permitting leaders to articulate practical strategies that boost organizational strength (Kiron et al., 2021). In the agricultural sector, AI techniques enable farmers to rapidly react to fluctuating climatic circumstances by adjusting crop management exercises and modifying planting agendas based on climate predictions and soil data (Bera & O'Neill, 2020).

6.4.3 Accepting to Change: AI as an Initiator of Business Compliance

One of the important advantages of implementation of AI is its capability to assist companies adapting the fast dynamics of the market, technology, and environmental circumstances. In industries like manufacturing, AI-driven projections continue to safeguard that assembly practices remain constant, even at the time of external interruptions (Harrison et al., 2021). The employees of the company are required to adapt the changes in working style for which the proper training is required to be given in the company. Employees are the asset to the company, in many cases the main cause of the failure and success are the employees and their working style, basically company environment and culture plays an important role in the growth of the company itself. AI allows companies to be more flexible, dynamic and fast forward in decision making, as it offers the tools to respond to all the challenges related to environmental, social and economic. This adaptability is essential for long-term sustainability.

6.4.4 Moral Concerns in AI for Sustainability

Although AI embraces important in strategic leadership related to environmental, economic and social sustainability, it also raises important ethical concerns. Disputes such as data confidentiality, algorithmic unfairness, and the ecological impact within the use of Artificial Intelligence tools must be focused to safeguard that AI is used sensibly (O'Neil, 2016). Management leaders must embrace moral frameworks that highlight transparency, impartiality, and inclusivity in the planning and accomplishment of AI tools.

6.5. Conclusion

6.5.1 Summary of Findings

This chapter focusses on the important role of AI in fostering sustainability throughout all the industries, emphasizing on manufacturing and agriculture. Certainly, AI has the prospective to enhance the usage of energy, reduction in waste by doing proper waste management, and enhancing business operational competence, all with supporting the concept of sustainability with wider goals. Nevertheless, the fruitful execution of AI evolves strategic leadership that incorporates AI tools with the organization's sustainability goals. Management leaders must direct companies through the complications of AI embracing, attending moral concerns and safeguarding that AI plans support with ecological, social, and economic sustainability targets.

6.5.2 Future Scope of Research

Future scope of work can emphasis more on ethical issues and concerns of implementation of AI in sustainable business strategies. Which can be done by discovering on how organizations can identify and reduce the fears connected to data privacy, algorithmic fairness, and social discriminations. Furthermore, the studies are required to analyze the long-term influence of Artificial intelligence on employees working in the company, an environment of an organization, its impact on the culture, employee relations and enhancement of employee's skills to name a few. Government, Policymakers, Auditors, AI implementors,

and business leaders should collaborate to build standards that confirm the trustworthy use of AI in succeeding sustainability targets.

6.6 References

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Bass, B. M., & Riggio, R. E. (2006). *Transformational leadership* (2nd ed.). Lawrence Erlbaum Associates.

Bera, A., & O'Neill, R. (2020). Artificial intelligence in agriculture: Applications and challenges. *Agricultural Systems, 178*, 102721. https://doi.org/10.1016/j.agsy.2019.102721

Binns, A. (2020). The role of artificial intelligence in driving sustainability. *Harvard Business Review*. https://hbr.org/2020/09/the-role-of-artificial-intelligence-in-driving-sustainability

Cozzolino, A., et al. (2020). Sustainability-driven innovation in the era of artificial intelligence. *Sustainability, 12*(1), 167. https://doi.org/10.3390/su12010167

Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st-century business*. Capstone.

Harrison, J., et al. (2021). Leveraging AI for sustainable development: Case studies in energy, agriculture, and manufacturing. *Journal of Strategic Sustainability, 10*(2), 45–62.

Kiron, D., et al. (2021). The role of artificial intelligence in strategic decision-making. *MIT Sloan Management Review, 62*(3), 22–29.

O'Neil, C. (2016). *Weapons of math destruction: How big data increases inequality and threatens democracy*. Crown Publishing Group.

Rahman, M. M., Rahman, M. S., & Hossain, G. (2022). Applications of artificial intelligence in energy systems: A comprehensive review. *Energy Reports, 8*, 739-756. https://doi.org/10.1016/j.egyr.2022.01.014

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

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Chapter 7 - AI Development Probe into Decarbonization

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Chapter Information

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Abstract

The rise of artificial intelligence (AI) brings with it a broad range of challenges and opportunities for organizations. As we are aware that AI is a collection of tools, an intelligent toolbox. This article will explain why this toolbox is so valuable in helping humanity overcome key bottlenecks that currently hinder sustainability progress. Each passing year brings new record -high temperatures, larger catastrophic wildfires, and more frequent devasting floods. In response, international agreements have set ambitious global sustainability targets. the United Nations (UN) urges that net zero commitments require credible action for a living climate. Net zero refers to reducing carbon emissions to a chump change of residual emissions. Although there are numerous applications of AI, there is no leading-edge review of how AI applications can reduce net-zero carbon emissions (NZCEs) for sustainable building projects.

By mid-century (2050), carbon dioxide emissions must reach net zero and by 2030, the loss of biodiversity must be suspended and reversed. The encouraging news is that significant progress is being made toward these goals. More than 9,000 companies across more than 140 countries have joined the Race to Zero, a coalition that pledges to take immediate action to halve global emissions by 2030. But change is simply not happening fast enough. The scale and speed of changes that are needed to meet global sustainability goals is daunting. Consider a few examples, such as Global renewable power generation must triple in less than a decade – International Energy Agency (IEA) and methane emissions from fossil fuel operations must be reduced by 75%. Over the next couple of decades, food production must increase by 50%, and we will need to develop 1,000 times more durable carbon removal capacity than exists today.

A total of 124 published articles were retrieved and used to conduct science mapping analyses and qualitative discussions, including mainstream research topics, gaps, and future research directions. AI-powered learning platforms can help by providing:

- Provide personalized training
- Analyze existing skills
- Identifying gaps

• Recommend tailored learning paths

Keywords: *artificial intelligence; net-zero carbon emissions; science mapping approach; AI-powered learning platforms;*

7.1.Introduction

Humanity finds itself at a pivotal junction. It is imperative that we swiftly alter our course from the current trajectory of carbon-intensive and resource-depleting growth and transition towards a sustainable future in which both people and nature can flourish. The establishment of a sustainable future will necessitate transformative changes at an unprecedented pace and scale. Artificial Intelligence (AI) is a vital instrument for fostering the scale and pace that are essential. The era of AI is merely beginning to materialize. There exists considerable uncertainty on the horizon; however, one factor is unequivocal: AI will instigate significant transformations within the global economy, and this study will investigate the implications of these transformations for sustainability.

This research study aims to elucidate the opportunities and the challenges that exist at the intersection of AI and sustainability. In this study, we will gain an understanding of the following:

1. AI serves as a critical instrument for expediting advancements in sustainability. AI should not be regarded as a panacea nor as an assurance for resolving our climate and biodiversity crises.

2. It is essential to identify what must transpire to fully leverage AI's potential for sustainability.

3. An overview of the critical role of AI in transforming job performance, emphasizing key trends, challenges, and opportunities within the changing digital landscape.

AI is emerging as both an enabler and a force multiplier for the sustainability sector, by providing specialized assistance, optimizing workflows, and delivering individualized training. Traditional training modules frequently employ a one-size-fits-all approach, disregarding individual strengths and weaknesses. Artificial Intelligence (AI) enabled individualized training can be a powerful tool to bridge the sustainability gap. It can analyze an individual's existing skills, pinpointing deficiencies, and recommending customized learning pathways. This has the potential to significantly expedite the upskilling process, allowing a greater number of individuals to engage in sustainability initiatives. AI is empowering the workforce to tackle sustainability challenges more efficiently and effectively. As organizations strive to maintain competitiveness in an increasingly intricate and rapidly evolving environment, the adoption of AI technologies has become essential for enhancing productivity, efficiency, and innovation. Machine learning techniques enable AI systems to learn from data and enhance their performance over time, rendering them indispensable tools for improving decision-making processes across various professional sectors. One of the fundamental transformations facilitated by AI integration is the paradigm of human-AI collaboration. Rather than perceiving AI as a substitute for human employees, organizations are

increasingly acknowledging its potential to augment human capabilities and elevate workforce productivity. Intelligent automation permits mundane and repetitive tasks to be assigned to AI systems, thus liberating human workers to concentrate on tasks that necessitate creativity, critical thinking, and emotional intelligence. This symbiotic relationship between humans and AI nurtures a more dynamic and adaptable workforce, where each side complements the strengths of the other.

It is clear that the integration of artificial intelligence is not simply a technological trend but a crucial catalyst for organizational success in the 21st century. Organizations that utilize the capabilities of AI to improve job performance are likely to achieve a substantial competitive edge, while those that do not keep pace may find themselves falling behind in a progressively dynamic and competitive market. This introduction establishes the foundation for a thorough examination of AI empowerment and its effects on job performance. Through a meticulous analysis of significant trends, case studies, and best practices, this paper seeks to offer insights into how organizations can utilize AI to unlock new dimensions of productivity, efficiency, and innovation. By comprehending the opportunities and challenges introduced by AI integration, organizations can devise a strategy for sustainable growth and success in the digital era. The swift advancements in AI algorithms, along with the exponential increase in data, have created unprecedented opportunities for organizations to optimize processes, automate tasks, and derive actionable insights.

As global focus on climate change keeps increasing, there is extensive acknowledgement within the international community regarding the need to lower greenhouse gas emissions and encourage a transition to a low-carbon economy (Wimbadi and Djalante, 2020). In this setup, AI, as a groundbreaking innovative technology, is significantly altering production methods, resource allocation techniques, and energy usage patterns across a range of industries (Waltersmann et al. , 2021), thus having a substantial effect on ECE. ECE denotes the cumulative carbon emissions linked to a product or service throughout its complete lifecycle, covering all phases including production, transportation, consumption, and disposal. This encompasses both direct and indirect emissions produced during the extraction of raw materials, manufacturing, transportation, usage, and final disposal or recycling (Meinrenken et al. , 2020).

Carbon emissions implications of AI necessitate consideration of both the direct and indirect effects of AI utilization on emissions. The direct effects pertain to the emissions produced from constructing and operating AI models. This is commonly termed the carbon footprint. The indirect effects of AI refer to the changes in emissions that may occur due to the manner in which AI tools are utilized. Most evaluations have concentrated on the direct effects, which are simpler to measure. The direct emissions resulting from developing and executing AI models are influenced by three factors:

1. The quantity of electricity required to train and operate models
2. The carbon intensity of the electricity consumed.
3. The greenhouse gas emissions linked to creating the infrastructure for running the AI models. These are referred to as embodied emissions.

A significant factor determining direct emissions from increasing AI operations will be the pace at which the global electricity grids transition to zero-carbon energy sources such as wind, solar, hydro, and geothermal. The speed of grid decarbonization will not only impact the level of emissions from the electricity used for operating AI models, but also the embodied emissions, which largely arise from energy utilized in assembling

digital processors and constructing the facilities to accommodate them. At present, the carbon intensity of Australia's electricity grid is 17 times greater than that of Iceland's grid. Decarbonization rates also differ by region. For instance, in the past five years, the Netherlands decreased average grid carbon intensity by 31%, whereas India reduced average intensity by only 4%. To achieve the global sustainability goal of net zero emissions by 2050, AI tools and the infrastructure supporting them must be designed and operated to reduce their direct emissions. Major companies offering AI services are already making significant investments in renewable energy to meet or offset the energy demands of their data centres. Ongoing innovation will be essential to enhance efficiency, increase the availability of zero-carbon energy, and modernize electricity grids. The positive aspect is that AI can facilitate the acceleration of those innovations.

This section also will elaborate on how the development and operation of AI models require energy. The growth of AI is likely to have a relatively minor effect on energy consumption at a global level but can present local energy difficulties in certain areas. Let's examine the energy requirements of AI. At present, data centers and data transmission networks collectively account for approximately 2% of global electricity use. However, AI models themselves utilize only a small portion of this total. It is estimated that AI represents less than 1/10000 of global electricity consumption. Another approach to understand AI's electricity usage is by comparing it to other electricity consumption activities. For instance, the electricity utilized while watching television. Consider this: currently, ChatGPT processes around 200 million requests daily from users worldwide, consuming roughly 600 megawatt hours of electricity. While this may appear to be a substantial figure, it is equivalent to the electricity consumed in just one minute by individuals in the United States watching television at home. Now, naturally, as the use of AI grows, the energy required to run AI models will also rise. The International Energy Agency anticipates that the energy requirements of AI-specific data centres could rise by as much as tenfold by 2026. Between 2010 and 2020, despite a remarkable 900% increase in computing, electricity consumption increased by only 10% remaining fairly stable thanks to significant advancements in energy efficiency. Now, let's shift from the global viewpoint to the local outlook, where the energy situation can differ considerably. Locally, the electricity demand from data centers can be substantial in relation to supply, potentially imposing strain on local electrical grids. This situation arises because data centers have traditionally been situated in areas with advantageous economic and regulatory conditions. In these areas, data centers can utilize a considerable portion of the local grid's capacity.

7.2 Literature review

7.2.1 The Intersections of AI and Sustainability

The convergence of sustainability and artificial intelligence (AI) presents a transformative potential to tackle global environmental challenges, including climate change, resource depletion, and ecosystem degradation. This study examines the ways in which AI technologies, including machine learning and data analytics, are being employed across diverse sectors to bolster sustainability initiatives. Nevertheless, the incorporation of AI into sustainability practices also poses difficulties, such as the environmental repercussions of AI's energy use, the possibility of algorithmic biases, and the necessity for fair access to the advantages of AI. This section underscores the significance of creating transparent, accountable, and inclusive

AI systems and governance frameworks to ensure that AI positively contributes to sustainability objectives while alleviating potential risks and inequalities. The intersection of sustainability and artificial intelligence (AI) represents an intriguing frontier where technological innovations can substantially aid in addressing the urgent environmental issues we face today. As global apprehensions regarding climate change, resource depletion, and environmental degradation persistently rise, AI emerges as a transformative instrument with the ability to revolutionize sustainable practices across an array of sectors. AI technologies, encompassing machine learning, deep learning, and advanced data analytics, provide exceptional capabilities in processing extensive datasets, detecting complex patterns, and optimizing processes that are vital for sustainability. For example, AI-driven solutions have played a crucial role in enhancing energy consumption within smart grids, resulting in notable reductions in greenhouse gas emissions and improving energy efficiency.

AI constitutes a collection of powerful tools, created by humans. These tools can perform rigorous tasks that, in the past, only humans could execute. The intersection of sustainability and artificial intelligence (AI) represents an exciting frontier wherein technological advancements can make a significant contribution towards addressing the urgent environmental challenges of our era. As global concerns regarding climate change, resource depletion, and environmental degradation continue to rise, AI tools, when utilized efficiently, can serve as substantial accelerators for progress in sustainability. For example, AI-driven solutions have played a crucial role in optimizing energy consumption within smart grids, resulting in significant reductions in greenhouse gas emissions and improvements in energy efficiency. Furthermore, AI has the capability to optimize supply chains by analysing data related to material sources, manufacturing processes, and logistics, thereby identifying environmentally friendly and socially responsible methods that reduce carbon footprints and minimize waste. AI tools perform complex tasks by learning from data, often extensive amounts of data. The following three primary methods illustrate how machines can learn:

i) Supervised learning: Training AI with labelled data to identify patterns (e.g., categorizing images of forests).

ii) Unsupervised learning: Recognizing patterns in data without labels (e.g., enhancing weather forecasting).

iii) Reinforcement learning: Acquiring knowledge through trial and error with feedback (e.g., managing a building's energy system).

These methods empower AI to interpret data, make predictions, and continually enhance its capabilities, thereby adding organizations in the effective development and deployment of sustainability solutions.

The complete potential of AI in fostering sustainability can only be actualized through a comprehensive approach that equilibrates technological advancement with ethical considerations and sustainable practices. Nevertheless, the incorporation of AI into sustainability initiatives is not devoid of challenges. A notable concern is the environmental impact of AI itself, particularly the energy consumption linked to the training of extensive AI models. Shin and Rao address the paradox of utilizing energy-demanding AI technologies to tackle environmental issues, highlighting the necessity for more energy-efficient algorithms and hardware. The ethical ramifications of AI in sustainability also represent a vital area of concern. Khan and Patel investigate the dangers of algorithmic bias within AI systems, which can intensify pre-existing inequalities if not appropriately mitigated. Dubey and Singh further examine the obstacles associated with implementing AI-driven sustainability

solutions in developing regions, where access to technology and data may be restricted, potentially exacerbating the digital divide. The significance of governance frameworks to ensure the responsible utilization of AI in sustainability is emphasized by Zhang et al. , who advocate for collaborative governance models that incorporate multiple stakeholders, including technologists, policymakers, and civil society. Johnson and Lee elaborate on this by discussing the necessity for transparency, accountability, and inclusivity within AI systems to guarantee their alignment with broader environmental and social governance (ESG) objectives.

Despite the progress made in AI-driven sustainability, the literature similarly advocates for a balanced perspective that addresses both the opportunities, and the risks associated with this convergence. The effectiveness of AI in advancing sustainability relies not solely on technological innovation but also on the creation of ethical, transparent, and inclusive frameworks that guarantee the equitable distribution of AI's benefits across society. The literature additionally investigates the convergence of artificial intelligence (AI) and sustainability and continues to underscore the potential of AI in transforming environmental management and policy. Recent research underscores the contribution of AI in improving the efficiency and effectiveness of renewable energy systems. For instance, AI has been implemented to optimize the functioning of wind farms through the prediction of energy production based on weather data, thus minimizing operational costs and enhancing reliability. The findings of this research will assist in the formulation of guidelines and best practices for the responsible implementation of AI in sustainability initiatives, ensuring that AI technologies are utilized effectively to attain long-term environmental and social benefits.

7.2.2 AI Can Help Empower the World's Sustainability Workforce

As we endeavor to fulfil global sustainability objectives, we encounter a significant challenge: an increasing gap in sustainability skills. The world requires a workforce capable of designing, implementing, and monitoring progress toward our sustainability objectives. However, at present, there are simply not enough individuals possessing the necessary skills and expertise to effect change at the pace the world demands. This is where AI can assume a transformative role. AI can function as a virtual assistant, offering specialized support that can enhance productivity. The sustainability workforce, which is already limited in size, is compelled to allocate a considerable portion of their time to repetitive, time-consuming manual tasks, such as data management and reporting. AI has the potential to automate a multitude of these tasks, significantly enhancing the efficiency of workflows. This matter extends beyond mere task efficiency; it also involves optimizing human potential within the sustainability sector. AI can assist companies in making more impactful decisions towards achieving net-zero objectives.

This study examines the transformative capacity of AI in improving productivity, efficiency, and effectiveness across various professional sectors. By utilizing advanced algorithms and machine learning methodologies, AI enables organizations to streamline processes, automate tasks, and derive valuable insights from extensive datasets. A significant element of AI empowerment is its capability to enhance human abilities instead of substituting them. Through intelligent automation, repetitive and monotonous tasks can be assigned to AI systems, permitting human workers to concentrate on higher-level decision-making and creative problem-solving. This cooperative interaction between humans and AI nurtures a more dynamic and adaptable workforce. AI improves decision-making processes universally. Tackling these challenges necessitates a collaborative initiative from policymakers, industry leaders, and educators to guarantee responsible AI implementation and alleviate potential risks. In summary, AI integration offers substantial promise for transforming job performance

by optimizing processes, empowering workers, and fostering innovation. Embracing AI as a strategic partner rather than a threat is essential for unlocking its full potential and establishing a future where humans and machines collaborate seamlessly to achieve unparalleled levels of productivity and success.

Furthermore, AI-driven analytics enable organizations to execute data-driven decisions with accuracy and agility. By leveraging the capabilities of AI analytics, organizations can forecast market trends, enhance resource allocation, and provide tailored experiences to customers, thus securing a competitive advantage in today's data-driven economy. However, the widespread implementation of AI integration also introduces numerous challenges that must be confronted to achieve its full potential. Ethical considerations, including bias in algorithms and privacy concerns, pose significant questions regarding the responsible use of AI technologies. Furthermore, the accelerated pace of technological advancement demands ongoing upskilling and reskilling of the workforce to ensure that employees remain pertinent in an AI-driven economy [3]. By developing ethical guidelines, encouraging transparency, and investing in education and training programs, stakeholders can cultivate an environment favourable to responsible AI deployment and reduce potential risks. AI integration possesses tremendous potential for transforming job performance by streamlining processes, empowering employees, and fostering innovation. Adopting AI as a strategic partner rather than a threat is crucial for organizations aiming to excel in the digital era.

This research utilizes a mixed methods approach to explore the influence of AI integration on job performance across various industries. The methodology includes both quantitative analysis of empirical data and qualitative assessment of case studies and expert perspectives. By integrating these complementary research approaches, this research seeks to deliver a thorough understanding of the complex dynamics of AI empowerment in the workplace. The quantitative analysis entails the collection and examination of numerical data concerning AI adoption, job performance metrics, and organizational outcomes. Surveys and structured interviews are administered to a diverse sample of organizations across multiple sectors, which include manufacturing, healthcare, finance, and retail. These surveys are constructed to collect information on the degree of AI integration within organizations, the perceived effects of AI on job performance, and vital performance indicators (KPIs) such as productivity, efficiency, and revenue growth.

Expert interviews are carried out with industry professionals, academic researchers, and technology specialists in order to acquire varied perspectives on the influence of AI integration on job performance. These interviews investigate emerging trends, ethical considerations, and future ramifications of AI empowerment within the workplace. The insights acquired from these interviews yield valuable qualitative data that enhances the comprehension of AI's transformative capabilities. The results derived from both quantitative analysis and qualitative assessment are amalgamated to deliver a comprehensive and nuanced understanding of the effects of AI integration on job performance. By triangulating data obtained from multiple sources, this study endeavours to corroborate findings, discern patterns, and provide actionable insights for organizations aiming to utilize the potential of AI to enhance productivity, efficiency, and innovation in the workplace.

7.2.3 AI's Impact on the Global Race to Net Zero

As the largest carbon emitter in the world, China's initiatives to cut emissions are closely associated with the global path of climate change (Guo et al. , 2024). Simultaneously, China is among the rapidly advancing nations in the arena of

AI. The extensive use of AI across different sectors significantly influences energy consumption and carbon emissions. Consequently, a detailed comprehension of AI's effect on ECE, especially its unique mechanisms in both production and consumption, is crucial for formulating effective environmental policies and advancing sustainable development. ECE from the production side and ECE from the consumption side are two essential elements of total ECE, reflecting emissions from the viewpoints of production and consumption, respectively (Tian et al. , 2023). Production side ECE includes not just the direct emissions resulting from energy use within manufacturing facilities but also the indirect emissions stemming from activities like the transportation of raw materials and components, along with the energy needed throughout the production process (Ma et al. , 2024). On the other hand, consumption-side ECE emphasizes the emissions produced during the use of products by consumers, which encompasses energy use and other carbon emissions related to usage (Zhang et al. , 2023). In order to provide suitable policy suggestions, this chapter will empirically analyse how the growth of AI has influenced ECE from both the production and consumption perspectives.

In theory, the use of AI technologies can improve energy efficiency in production methods, diminish energy waste, and boost the use of clean energy (Rojek et al. , 2023). Nonetheless, AI technologies exert a complicated and multi-dimensional influence on ECE. Regarding production, AI technologies help decrease energy expenditure and carbon emissions for each product unit by refining automation, streamlining production methods, and enhancing resource allocation (Ahmad et al., 2022). Concerning consumption, the implementation of AI (e. g., intelligent recommendation systems, and smart home technologies) can modify consumer behaviour and consumption habits, thereby affecting ECE from the demand perspective (Puntoni et al. , 2021). Importantly, while advancements in AI improve the efficacy of products and services, they may simultaneously foster new consumer demand (André et al., 2018), which could result in an overall rise in carbon emissions.

Currently, the scholarly community has thoroughly explored the impacts of AI technologies on direct carbon emissions (Liu et al. , 2022; Xu and Song, 2023; Ding et al. , 2024). Most research indicates that AI technologies can assist in lowering direct carbon emissions and energy usage by enhancing energy efficiency (Zhao et al. , 2024), utilizing resources as effectively as possible (Lv et al. , 2022), and fostering technological innovation (Chen and Jin, 2023; Huang et al. , 2023). Specifically, Hsu et al. (2023) found that through automation and enhanced management, implementing AI technologies in manufacturing significantly reduces energy consumption and carbon emissions during the production process. In a similar vein, Liu et al. (2021) observed that the growing adoption of AI technologies would expedite the shift of traditional labour-intensive industries toward smart manufacturing, thereby further improving energy efficiency and diminishing energy consumption and carbon emissions.

The integration of the digital landscape within modern society presents a significant opportunity for advancing energy efficiency and monitoring carbon emissions, particularly in ML algorithms. The exponential growth and reliance on internet enabled devices, coupled with widespread internet accessibility, have revolutionized our understanding of online and offline realms. However, this digital revolution, despite its potential for smarter energy usage and management, has posed substantial challenges in terms of energy consumption [61]. In this context, Information Technology (IT) companies play a pivotal role in steering the transition toward a more sustainable, renewable energy-driven economy, crucial for reducing GHG emissions and mitigating climate change impacts. The IT sector, primarily based in energy-intensive manufacturing hubs like China and, generally, in Asia, currently consumes a considerable amount of global electricity, as depicted in Fig. 2.7. This highlights the pressing

requirement for thorough monitoring and analysis to reduce carbon emissions in ML algorithms, which is essential in managing the environmental impact of this fast-growing technological field.

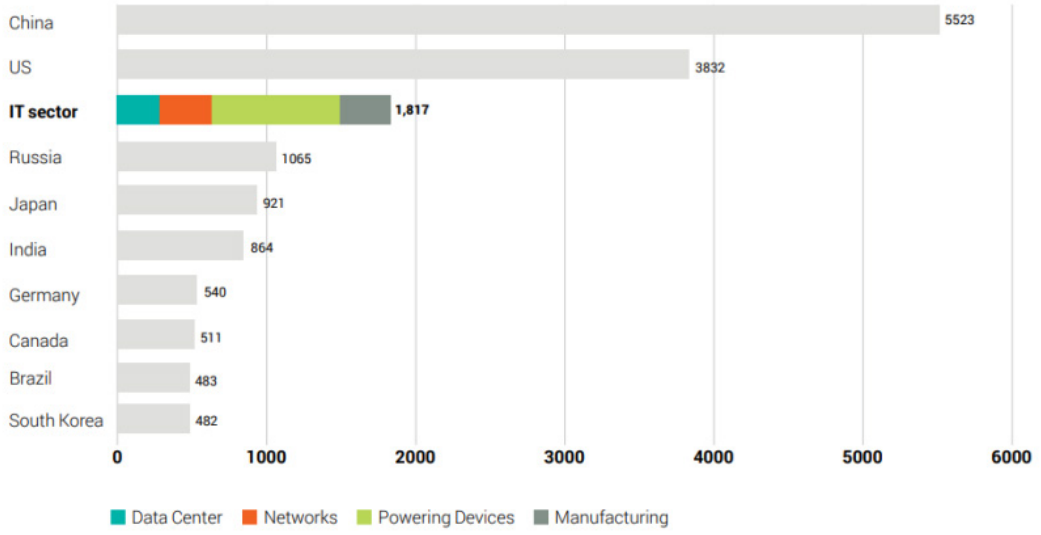

Figure 2.7: Comparison of Global Electricity Consumption in 2012 with the IT Sector's Energy Usage in billion kilowatt-hours (kWh)

In worldwide production networks, carbon emissions are frequently "embedded" in goods and services through cross-border trade and regional production activities (Jakob and Marschinski, 2013; Essandoh et al. , 2020). While the notion of ECE has been extensively utilized in domains like international trade and industrial structural modifications, studies examining the connection between AI development and ECE are still scarce. Yang et al. (2024) employ intricate network analysis techniques to investigate the global embodied carbon emission transfer network. They shed light on how nations engage in global value chains and propose a framework for understanding how stakeholders can take on emission reduction responsibilities to foster regional low-carbon economic development. Current research largely emphasizes spatial attributes of inter-regional carbon transfer, network features (Yang et al. , 2024), the carbon footprints associated with international trade, and the carbon emission efficiency within the manufacturing and service industries (Gao et al. , 2021; Wang et al. , 2024a).

The innovation of this study is reflected in four main aspects.

1. Current research frequently investigates the link between AI development and either production aspects or direct carbon emissions from a single standpoint. This study, in contrast, creatively takes a dual approach, addressing both production and consumption, to thoroughly examine the intricate effects of AI development on ECE and its foundational mechanisms. This dual-perspective analytical framework transcends the limitations of earlier studies and offers a fresh viewpoint for comprehending the intrinsic connection between AI and ECE. It provides significant insights for more precisely pinpointing emission reduction opportunities at various stages.

2. This study presents an innovative methodological contribution by merging the regional input-output model with a double fixed-effects model, thus creating a more extensive

analytical framework. By utilizing the regional input-output model, we initially estimate the carbon emissions on both the production and consumption sides for each province and city, furnishing essential data for the following empirical analysis. Building upon this, we subsequently use the double fixed-effects model to discern the net effects of AI development on ECE in both the production and consumption sectors. Furthermore, we perform a series of robustness checks and sensitivity analyses to confirm the dependability of our results. This methodological integration not only deepens the analysis but also guarantees the rigor of the investigation.

3. This research not only investigates the direct effects of AI advancement on both the production and consumption facets of ECE but also delves into the underlying mechanisms. In particular, it assesses whether AI impacts ECE via four essential channels: enhancements in energy efficiency, optimization of industrial structure, the uptake of low-carbon energy sources, and innovations in green products. This multidimensional analytical framework provides a more thorough grasp of the routes through which AI development influences ECE, offering a strong theoretical foundation for devising targeted strategies for emission reduction.

4. This research additionally expands the analytical scope by probing the moderating roles of both internal and external factors, such as the intensity of environmental regulations, the construction of ecological civilization, the capability for green innovation, and the consumption of renewable energy. From the viewpoints of government, market, and society, the analysis explores how these factors affect the carbon reduction effects of AI.

7.2.4 AI Energy Use – a Local Challenge

Rising energy usage and climate changes rank among the most urgent challenges confronting modern society. The swift increase in energy consumption, fueled by economic growth and technological progress, contributes to a rise in greenhouse gas emissions and accelerates global climate change. In this regard, the necessity of discovering innovative solutions to improve energy efficiency is becoming more pronounced. Artificial intelligence (AI) and machine learning (ML) have progressed quickly in recent years, demonstrating considerable promise in addressing intricate environmental issues, such as improving energy efficiency and lowering carbon emissions. Nevertheless, their influence on energy consumption and climate change is still unclear.

On one hand, AI possesses substantial potential to tackle global challenges identified by the UN, including climate change and various complex environmental and social problems, which encompass the following:

1. By forecasting energy consumption, optimizing energy systems, and incorporating renewable energy sources, AI has the capacity to emerge as a crucial asset in the battle against climate change.
2. Enhancing the energy efficiency of buildings and industrial frameworks and optimizing the functioning of energy systems in real time aids in decreasing total energy consumption and lessening environmental impact.
3. Machine learning (ML) is employed to forecast climate change and its effects on energy systems. Machine learning models enable us to develop scenarios for future

energy consumption and adjust infrastructure to new circumstances.

4. AI can improve the efficiency of renewable energy sources, including wind and solar power plants, which is especially vital in the decarbonization effort.
5. AI serves a vital function in observing, managing, and predicting energy demands, considering future climate change. This entails enhancing energy distribution, integrating renewable sources, and alleviating load on power systems during peak demand periods. These studies offer solutions to augment the sustainability of energy systems and lessen their carbon footprint.

The objective of this research is to compile and organize the available scientific literature, illustrating how artificial intelligence (AI) and machine learning (ML) methods can enhance energy efficiency across various industries and nations. The review additionally seeks to evaluate the role of AI in tracking contemporary climate issues, such as lowering carbon emissions and maximizing resource utilization. To achieve the established goal, the following tasks have been outlined:

- identify the primary trends and research areas where AI and ML are utilized to enhance energy efficiency and confront climate issues.

- evaluate the key technical obstacles that hinder the widespread implementation of AI and ML in practice and pinpoint strategies for overcoming them.

- investigate how AI and ML can aid in decreasing carbon footprints and optimizing resources for sustainable long-term development.

This review offers a thorough and detailed examination of the effects of AI and ML on energy efficiency, considering the interconnected energy and climate factors associated with these digital technologies. In contrast to earlier studies, this review centers on a detailed evaluation of technological obstacles and creative solutions, and it delineates pathways for future investigation. The results are intended to enhance the understanding of both the scientific community and practitioners engaged in the areas of sustainable development and energy management.

7.3 Methodology and Recommendation

AI techniques, particularly machine learning, have been utilized to examine satellite imagery and sensor data for the purposes of monitoring deforestation, land use changes, and biodiversity loss, thus facilitating more effective conservation efforts. Nonetheless, the implementation of AI in sustainability practices is accompanied by a number of challenges. A primary concern is the transparency and interpretability of AI models, which are frequently perceived as "black boxes. " This lack of transparency may impede trust and the acceptance of AI solutions in crucial domains such as environmental policy and public decision-making. Furthermore, the substantial computational requirements of AI models, especially in deep learning, raise apprehensions regarding their energy consumption and carbon footprint, which could, paradoxically, lead to environmental degradation if not adequately managed. Finally, the ethical ramifications of sustainability are increasingly being addressed in the literature, with scholars highlighting the necessity for responsible AI development that emphasizes fairness, accountability, and inclusivity. As the domain continues to progress, it is vital to tackle these

challenges through interdisciplinary research that merges technological innovation with ethical and sustainable practices.

The dynamic interaction between humans and machines has transformed the division of labor, with artificial intelligence (AI) playing a decisive role. It is important for AI implementation to allocate monotonous tasks to machines and technological systems, while reserving creative endeavors for human beings (Jarrahi, 2018). The implications of AI in organizational settings bring forth both advantages and disadvantages. To ensure responsible AI deployment, it is essential to address ethical concerns proactively. As a result, rules and legislation must be improved to protect organisations' and their employees' welfare from any potential repercussion associated with the deployment of AI (Brendel et al., 2021).

Statistical methods, including regression analysis and correlation analysis, are utilized to investigate the relationship between AI adoption and job performance metrics. By measuring the statistical significance of these relationships, this analysis seeks to uncover patterns and trends that clarify the impact of AI integration on organizational outcomes. In addition to quantitative analysis, this study undertakes a qualitative examination of case studies and expert interviews to offer nuanced insights into the mechanisms and implications of AI empowerment in the workplace. Case studies are chosen from prominent organizations recognized for their innovative application of AI technologies aimed at enhancing job performance. These cases are analysed thoroughly to identify best practices, challenges, and lessons learned in the implementation of AI solutions.

In the realm of carbon emissions calculation tools, a deep study reveals a diverse landscape that matches different preferences and study requirements. The first crucial distinction lies in the environment within which each tool operates: whether integrated into a Python script or accessible online. A meticulously organized Table 2.1 catalogs the surveyed tools, delineating them based on their respective environments. The primary divergence stems from whether the analysis is conducted in real-time, as is the case with Python libraries, or post-execution, characteristic of online tools. Regardless of the programming language being used, online tools may be utilized without changing the code. Python libraries provide measurements of the consumption of various parts of the script but clearly can only be used in

Python programming.

Python Libraries	Online Tools
Code Carbon	Green Algorithms
Carbon tracker	
Eco2AI	
Experiment impact tracker	ML Co2 Impact
Cumulator	
Energy usage	

Table 2.1: Commonly used carbon tracking tools available for online estimation afterward or at runtime in Python scripting.

The method used for this literature review was created to thoroughly examine existing studies on the use of artificial intelligence and machine learning techniques within the realm of energy efficiency and their effects on climate change. The main objective is to pinpoint trends and obstacles in the deployment of these technologies and predict their future influence on

climate change.

A systematic methodology is applied to highlight the clarity and replicability of the findings. The literature search took place using the Scopus database, which includes a wide array of peer-reviewed scientific articles and patents. The purpose was to gather a diverse range of research across various fields and disciplines. Key phrases pertinent to the research inquiries were utilized to formulate the search approach. The logical search string was developed as follows: TITLE-ABS-KEY ((“artificial intelligence” OR “machine learning”) AND “energy efficiency” AND “climate change”) AND PUBYEAR AFT 2010 AND PUBYEAR BEF 2025. This search string was crafted to encompass both foundational and contemporary publications from 2010 to 2024, focusing on identifying overlaps between energy efficiency and climate solutions via AI and ML. The terms employed in this literature review were meticulously chosen to guarantee both the thoroughness and significance of the documents concerning the study’s aims and primary research questions. The search yielded 237 pertinent papers and 388 patents.

More than 60% of the documents were published in the previous two years (2023–2024), indicating an increasing interest in the subject. This upward trend is also observable in the industry, with 243 patents registered in the last three years (2022–2024), accounting for 63% of the total over the fourteen-year span. The growing number of patents is evident, with 59 filed in 2022, 85 in 2023, and 99 patents filed in 2024 (as of 16 October). The resulting review data were organized into significant categories, including industries, geographic distribution, and types of research documents.

Figure 1 displays the yearly distribution of published papers (as of 16 October 2024), showcasing trends and research activity over time. Source: Scopus Analytics.

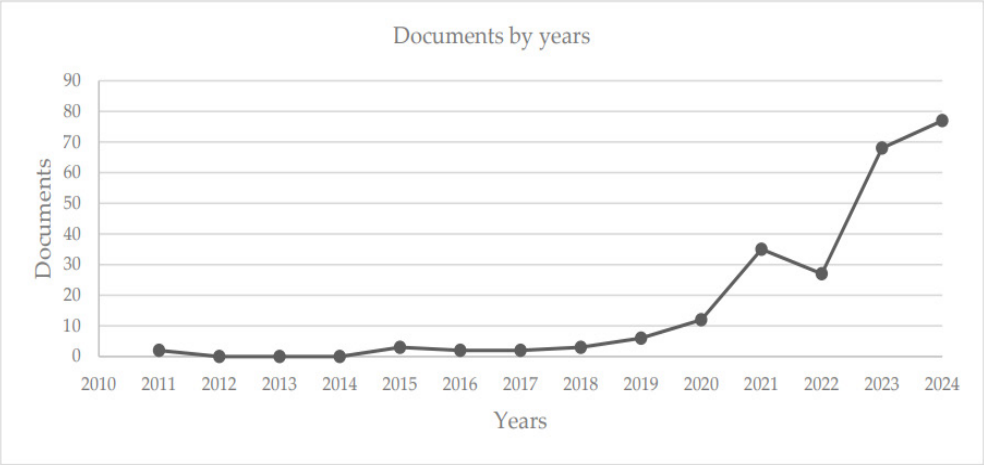

Figure 1. Distribution of documents by years. Source: compiled by authors.

Documents categorized by types, Article Conference Paper Review Book Chapter Conference Review, Book, Editorial Figure 3. Distribution of documents by countries. Source: compiled by authors. Figure 4 depicts the distribution of documents by types, showing that articles and conference publications make up more than 80% of the total, with articles taking the largestportion(Source:ScopusAnalytics).Energies2024,17,xFORPEERREVIEW5of38Figure 3 displays the number of articles released by researchers from different countries, emphasizing the geographic diversity and concentration of research activities, especially in China, India, the UK, and the US (Source: Scopus Analytics). Figure 3. Distribution of documents by countries. Source: compiled by authors. Figure 4 depicts the distribution of documents by

types, showing that articles and conference publications make up more than 80% of the total, with articles taking the largest portion (Source: Scopus Analytics).

A methodical approach was utilized to guarantee thorough coverage of the area. The selection procedure adhered to the methodology described and complied with the guidelines established in ensuring clarity and precision. Publications were assessed utilizing a 3-point quality scoring system to evaluate relevance and validity (refer to Table 1). Each study was examined based on various criteria, including innovation, practical application 0 5 10 15 20 25 30 35 Documents 46% 35% 11% 6% 2% Documents by types Article Conference Paper Review Book Chapter Conference Review, Book, Editorial Figure 4. Distribution of documents by types. Source: compiled by authors. A methodical approach was utilized to guarantee thorough coverage of the area. The selection procedure adhered to the methodology described and complied with the guidelines established, ensuring clarity and precision. Publications were assessed utilizing a 3-point quality scoring system to evaluate relevance and validity (refer to Table 1). Each study was examined based on various criteria, including innovation, practical application and strength of evidence. The systematic review method advocated was implemented to guarantee the clarity and reproducibility of the findings.

Table 1. Evaluation of source quality.

Evaluation Question	Description	Evaluation Metric
1	Stage of implementation of the energy efficiency project using AI and ML	1: Experiments; 2: Economic impact; 3: Scalability.
2	The magnitude of the energy efficiency effect from AI and ML projects.	1: Negligible; 2: Enterprise level; 3: Country level.
3	Identification and discussion of challenges in implementing AI and ML for energy efficiency projects.	1: Minimal; 2: Key issues; 3: Detailed.
4	Proposing future research directions to improve ML models.	1: Some; 2: General; 3: Detailed and innovative.

Source: compiled by authors.

This research examined four essential questions concerning the use of AI and ML in energy efficiency. These evaluative inquiries (refer to Table 1) aided in an extensive evaluation of the research outcomes while maintaining the standards of relevance and impartiality. As a result, this methodology facilitated detailed analysis and the recognition of the most critical areas for additional investigation. One of the main obstacles in the ongoing energy transition is achieving decarbonization via the incorporation of renewable energy sources (RESs), including solar, wind, and geothermal energy. For example, the adoption of smart grids featuring AI can improve the reliability of energy systems and reduce energy losses by enabling more precise forecasting and resource management. Artificial intelligence (AI) is vital for overseeing energy usage, optimizing energy systems, and decreasing CO2 emissions. The application of machine learning and big data analytics allows for real-time forecasts of energy consumption, enhances the energy efficiency of industrial procedures, and lowers the overall carbon footprint. This is especially pertinent for the electronics industry, where refining energy management can lead to substantial emissions reductions.

7.4 Challenges and Considerations

The proposed position at the convergence of sustainability and artificial intelligence (AI) seeks to devise and execute innovative AI-driven solutions that substantially aid in addressing global environmental challenges. This chapter will emphasize the utilization of AI technologies, encompassing machine learning, deep learning, and advanced data analytics, to improve the efficiency and effectiveness of sustainability initiatives across diverse sectors. The primary aim is to construct AI models that optimize resource consumption, minimize environmental repercussions, and facilitate the transition to a low-carbon economy. Within the energy sector, the intended work will encompass the creation of AI algorithms for smart grid optimization allowing for more effective energy distribution and utilization while accommodating renewable energy sources such as solar and wind power. These AI-driven models will accurately forecast energy demand and production, enhancing the equilibrium of supply and demand and decreasing dependence on fossil fuels. Furthermore, the project will investigate the application of AI in augmenting the efficiency of energy storage systems, which are vital for stabilizing the grid as the portion of renewable energy rises.

The research will also explore the utilization of AI in waste management, where predictive models will be developed to anticipate waste generation patterns, enhance recycling processes, and facilitate the establishment of circular economies. By incorporating AI into waste management systems, the proposed work seeks to diminish waste, encourage resource recovery, and lessen landfill use. Another significant area of concentration is the application of AI in urban planning and smart cities. The proposed work will entail the creation of AI-driven tools for designing energy-efficient buildings, optimizing transportation networks, and managing urban resources in a more sustainable manner. These AI models will be employed to simulate various urban development scenarios, allowing city planners to make data-informed decisions that mitigate environmental impacts and improve the quality of life for urban inhabitants. The study will also integrate ethical considerations into the design and implementation of AI systems, emphasizing transparency, accountability, and inclusivity. This encompasses the development of frameworks for responsible AI utilization that avert algorithmic biases and guarantee equitable access to AI-driven sustainability solutions across diverse regions and communities.

The recommended endeavor will encompass interdisciplinary research that amalgamates insights from environmental science, artificial intelligence, ethics, and policy studies to formulate comprehensive solutions that address both the prospects and challenges at the convergence of AI and sustainability. Through the execution of case studies and pilot projects in varied environments, the initiative seeks to illustrate the practical applications of AI in promoting sustainability, while simultaneously identifying possible risks and strategies for mitigation. The results of this research will aid in the formulation of guidelines and best practices for the responsible implementation of AI in sustainability initiatives, ensuring that AI technologies are utilized effectively to attain enduring environmental and social advantages. Ultimately, the proposed undertaking aspires to position AI as a crucial instrument in the collective endeavour to combat climate change, safeguard natural resources, and cultivate a more sustainable and equitable future.

Embracing the integration of artificial intelligence in the workplace is not devoid of its challenges and considerations. One of the primary challenges is the ethical implications associated with AI-driven decision-making. Algorithmic bias, whether inadvertent or systemic, has the ability to sustain inequalities and intensify societal biases. Ensuring fairness, transparency, and accountability within AI systems is crucial in order to mitigate

these risks and uphold ethical standards. Privacy concerns also significantly arise in the age of AI empowerment. The expansion of data collection and analysis prompts inquiries regarding the safeguarding of personal information and the potential for misuse or unauthorized access. Organizations must prioritize the implementation of data security and privacy measures to protect sensitive information and maintain trust with stakeholders. Furthermore, the rapid rate of technological advancement necessitates the continuous upskilling and reskilling of the workforce. As AI automates routine tasks, employees are required to develop new skills and competencies to remain relevant in the changing job market. Investing in training programs and lifelong learning initiatives is vital to empower workers and facilitate a seamless transition to an AI-enabled workforce. Interdisciplinary collaboration presents another key consideration in efforts towards AI integration. Effective deployment of AI necessitates cooperation among diverse stakeholders, including data scientists, domain experts, policymakers, and end-users. Promoting interdisciplinary dialogue and knowledge sharing is essential for harnessing the full potential of AI technologies and tackling complex challenges from various perspectives. Moreover, regulatory compliance presents a considerable challenge within the adoption of AI solutions. As governments globally contend with the ethical and legal ramifications of AI, organizations must navigate a complicated array of regulations and standards. Adhering to data protection laws, industry regulations, and ethical guidelines is imperative in order to circumvent legal liabilities and reputational risks. Beyond external challenges, the organizational culture and mindset are pivotal in the successful integration of AI. Resistance to change, anxiety regarding job displacement, and insufficient support from key stakeholders can obstruct the effective implementation of AI initiatives. Fostering a culture of innovation, openness, and collaboration is vital to surmount these obstacles and nurture an environment conducive to AI empowerment. Addressing these challenges and considerations mandates a comprehensive approach that incorporates technological, ethical, legal, and cultural dimensions. By proactively confronting these challenges, organizations can unlock the transformative potential of AI and create a future where humans and machines collaborate harmoniously to achieve mutual objectives.

According to the theory of production function in economics, advancements in technology like AI can boost productivity by enhancing the efficiency of labor and capital. AI applications during the upstream production process decrease resource requirements, improve energy efficiency, and reduce production side ECE. AI allows companies to utilize tools such as data analysis, predictive modelling, and automated controls to accurately manage energy usage throughout the entire production process (Ahmad et al. , 2021). Building upon the previous theoretical analysis, this study seeks to investigate the connection between the advancement of AI technology and concealed carbon emissions from both production and consumption perspectives. Regarding model specification, the Hausman test is used to evaluate the suitability of applying a fixed effects model compared to a random effects model. The findings of the test reject the null hypothesis at the 1% significance level, suggesting that the fixed effects model is more appropriate. Utilizing the theoretical analysis and model (1), we apply a fixed effects model to analyse the effect of AI development levels on ECE in both production and consumption aspects.

Despite advancements in AI applications, the prediction of energy efficiency at the city level remains insufficiently explored, particularly regarding the interactions among various spatial functions and climate scenarios. Modern research indicates that machine learning (ML) and artificial intelligence (AI) can significantly enhance energy consumption management and reduce the carbon footprint of buildings. For instance, in smart and energy-efficient buildings

(SEEs), ML-based control systems allow thermal comfort and energy consumption to be effectively balanced. Prediction models utilizing ML and genetic algorithms can improve the energy efficiency of existing buildings by analyzing historical data, including considering climate change forecasting. Additionally, the application of multi-criteria optimization techniques for assessing the thermal performance of buildings further underscores the critical role of AI in adapting structures to shifting climatic conditions.

7.5.Findings and Outcomes

The proposed position at the convergence of sustainability and artificial intelligence (AI) seeks to devise and execute innovative AI-driven solutions that substantially aid in addressing global environmental challenges. This research study will emphasize the utilization of AI technologies, encompassing machine learning, deep learning, and advanced data analytics, to improve the efficiency and effectiveness of sustainability initiatives across diverse sectors. The primary aim is to construct AI models that optimize resource consumption, minimize environmental repercussions, and facilitate the transition to a low-carbon economy. Within the energy sector, the intended work will encompass the creation of AI algorithms for smart grid optimization allowing for more effective energy distribution and utilization while accommodating renewable energy sources such as solar and wind power. These AI-driven models will accurately forecast energy demand and production, enhancing the equilibrium of supply and demand and decreasing dependence on fossil fuels. Furthermore, the project will investigate the application of AI in augmenting the efficiency of energy storage systems, which are vital for stabilizing the grid as the portion of renewable energy rises.

The research will also explore the utilization of AI in waste management, where predictive models will be developed to anticipate waste generation patterns, enhance recycling processes, and facilitate the establishment of circular economies. By incorporating AI into waste management systems, the proposed work seeks to diminish waste, encourage resource recovery, and lessen landfill use. Another significant area of concentration is the application of AI in urban planning and smart cities. The proposed work will entail the creation of AI-driven tools for designing energy-efficient buildings, optimizing transportation networks, and managing urban resources in a more sustainable manner. These AI models will be employed to simulate various urban development scenarios, allowing city planners to make data-informed decisions that mitigate environmental impacts and improve the quality of life for urban inhabitants. The study will also integrate ethical considerations into the design and implementation of AI systems, emphasizing transparency, accountability, and inclusivity. This encompasses the development of frameworks for responsible AI utilization that avert algorithmic biases and guarantee equitable access to AI-driven sustainability solutions across diverse regions and communities.

The integration of carbon emissions as a metric in machine learning is a relatively new concept. Nowadays, a predominant focus in research lies in achieving high-performance levels without taking computational efficiency into account. This neglect could be attributed to the lack of familiarity with existing approaches to evaluate energy consumption in this domain.

7.6.Conclusions and Looking Forward

The incorporation of artificial intelligence (AI) into job performance signifies a fundamental shift with extensive implications for organizations, industries, and society at

large. Through an in-depth investigation of AI empowerment, this research has revealed the transformative capabilities, obstacles, and future possibilities of AI incorporation in the workplace. AI empowerment presents significant opportunities for transforming job performance across various sectors.

By utilizing sophisticated algorithms, machine learning methodologies, and big data analytics, organizations are able to optimize operations, automate duties, and uncover valuable insights to enhance productivity, efficiency, and innovation. The collaborative relationship between humans and AI promotes a more dynamic and flexible workforce, wherein each party enhances the other's strengths to achieve remarkable levels of performance and success.

Nonetheless, AI integration also introduces challenges and considerations that must be addressed proactively to fully leverage its potential. Ethical issues related to bias, transparency, and accountability in AI-driven decision-making prompt crucial inquiries regarding the responsible use of AI technologies. Concerns regarding privacy, adherence to regulations, and the necessity for workforce upskilling further highlight the intricacies of AI integration initiatives. Tackling these challenges necessitates a comprehensive approach that includes technological, ethical, legal, and cultural aspects.

AI has the potential to both help and harm the environment, and it is crucial to focus on sustainable AI practices throughout the lifecycle of AI. While deep learning may be necessary for some specific tasks, simpler machine learning algorithms can often achieve similar results with less computational power and energy, making them more environmentally responsible.

The research concentrated on organizing the current scientific literature to pinpoint significant shared themes and patterns in the utilization of AI and ML tools to enhance energy efficiency across various sectors and nations, specifically targeting climate issues, such as minimizing carbon emissions and optimizing resource utilization. This literature survey emphasizes notable advancements in the use of artificial intelligence (AI) and machine learning (ML) methods designed to improve energy efficiency and tackle climate change challenges. The literature review conducted enables us to draw multiple conclusions regarding the function and potential of AI and ML in boosting energy efficiency and confronting climate challenges. Future investigations into the usage of artificial intelligence and machine learning for improving energy efficiency require a comprehensive strategy focused on creating technological solutions, enhancing the sustainability of energy systems, and taking socio-economic factors into account. Essential priorities for the research community in the upcoming years should involve integrating renewable energy sources, enhancing system reliability and cybersecurity, and decreasing the carbon footprint of AI technologies.

7.6.1 The Benefits of AI for Sustainability are not guaranteed

International researchers investigate how AI and broader digitalization might affect the future of greenhouse gas emissions. Together, we outlined three potential scenarios. In the initial scenario that we envisioned, AI and other digital technologies would boost economic productivity but also raise energy demand and resource usage, resulting in an increase in greenhouse gas emissions. This is clearly not a sustainable or preferable course. In the second scenario, AI and other digital technologies hasten the implementation of renewable energy and enhance efficiency while preventing overconsumption, but with limited human agency. This results in a reduction of greenhouse gas emissions but leads to unsustainable social outcomes. In the third scenario, AI technologies are utilized efficiently and effectively under trusted governance, empowering individuals and speeding up decarbonization. This represents a sustainable path that AI can assist the world in achieving. To leverage AI's potential for guid-

ing the world toward a genuinely sustainable path, intentional efforts are necessary to establish the conditions required for success. So, let's conclude by detailing the enabling conditions necessary for achievement.

7.6.2 What's Needed to Unlock AI's Potential for Sustainability

Let me conclude this research study by guiding you through the five essential enabling conditions that are necessary to unleash AI's full capability for sustainability. These were pinpointed in partnership with sustainability researchers and practitioners with extensive experience in the domain

We require increased investment in AI for sustainability, which entails offering financial incentives, generating opportunities for AI research cantered on sustainability, and establishing collaborations between AI and sustainability specialists

1. We need to increased investment in AI for sustainability, which includes providing financial incentives, creating opportunities for AI research-focused on sustainability and fostering partnerships between AI and sustainability experts.

2. We require further development of inclusive digital and data infrastructure. This necessitates investing in bridging crucial data gaps, especially in underrepresented areas of the globe.

3. We must minimize resource utilization and emphasize renewable resources. As demand for AI escalates, reducing the resource footprint of AI activities becomes vital. Prioritizing zero-carbon energy sources in AI infrastructure and operations is crucial for mitigating the environmental footprint associated with developing and operating AI models.

4. We must advance AI policy principles and governance. Establishing solid policy principles and governance frameworks for AI in sustainability is critical. Policies are necessary to facilitate the transition to carbon-free electricity grids, and the assimilation of AI into current sustainability structures.

5. We need to strengthen workplace capacity to utilize AI for sustainability. Unlocking AI's potential for sustainability will depend on a workforce capable of utilizing AI tools. This involves creating educational and training pathways that empower the sustainability workforce with the skills and knowledge to employ AI proficiently.

With these five essential conditions established, AI has the potential to be the transformative force we require to implement sustainability solutions more swiftly, cost-effectively, and efficiently. Consider how you might develop AI capabilities for sustainability and reflect on what actions you or your organization can take to foster the broader enabling conditions necessary for AI to assist the world in advancing towards sustainability.

The timeframe for transitioning to global sustainability is diminishing. Thankfully, the expanding AI toolkit offers a remarkable chance to instigate change at the speed necessary to meet our international sustainability objectives. In summary, as an advancing technology, AI is still in its inception. However, there are several use cases that demonstrate its effectiveness in helping companies decarbonize to achieve their Net Zero goals. However, this can only be achieved if we, as a collective society, concentrate on creating the enabling conditions for success. Together, we can accomplish this.

7.7 References

C. Zhang, S. Yang, and Z. Chen, "AI-driven smart grid optimization for energy efficiency," IEEE Trans. Smart Grid, vol. 11, no. 2, pp. 1213-1222, 2020

K. G. Shin and B. Rao, "The carbon footprint of AI: Addressing energy consumption in AI model training," IEEE Access, vol. 9, pp. 13221-13234, 2021.

S. Khan and A. Patel, "Ethical AI for sustainability: Addressing algorithmic bias," IEEE Technol. Soc. Mag., vol. 40, no. 2, pp. 56- 64, 2021.

Kok, C.L.; Kusuma, I.M.B.P.; Koh, Y.Y.; Tang, H.; Lim, A.B. Smart Aquaponics: An Automated Water Quality Management System for Sustainable Urban Agriculture. Electronics 2024, 13, 820. doi: 10.3390/electronics13050820

Kok, C.L.; Dai, Y.; Lee, T.K.; Koh, Y.Y.; Teo, T.H.; Chai, J.P. A Novel Low-Cost Capacitance Sensor Solution for Real-Time Bubble Monitoring in Medical Infusion Devices. Electronics 2024, 13, 1111. doi: 10.3390/electronics13061111

Kok, C.L.; Tang, H.; Teo, T.H.; Koh, Y.Y. A DC-DC Converter with Switched-Capacitor Delay Deadtime Controller and Enhanced Unbalanced-Input Pair Zero-Current Detector to Boost Power Efficiency. Electronics 2024, 13, 1237. doi: 10.3390/electronics13071237

L. Zhang, P. Zhou, and Y. Qiu, "Collaborative governance for AI in sustainability," IEEE Eng. Manage. Rev., vol. 48, no. 4, pp. 80- 87, 2020.

A. Johnson and M. Lee, "Frameworks for responsible AI in sustainability: Balancing innovation and ethics," IEEE Access, vol. 9, pp. 91458-91472, 2021.

G. Roberts, T. Sanchez, and K. Wang, "AI in urban planning: Designing sustainable smart cities," IEEE Trans. Intell. Transp. Syst., vol. 22, no. 3, pp. 1684-1696, 2021.

H. Liu, D. Xu, and X. Zhang, "AI and remote sensing for biodiversity conservation," IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens., vol. 14, pp. 7103-7112, 2021.

Koh, Y.Y.; Kok, C.L.; Ibraahim, N.; Lim, C.G. Smart Water ATM with Arduino Integration, RFID Authentication, and Dynamic Dispensing for Enhanced Hydration Practices. Electronics 2024, 13, 1657. doi: 10.3390/electronics13091657

Kok, C.L.; Ho, C.K.; Dai, Y.; Lee, T.K.; Koh, Y.Y.; Chai, J.P. A Novel and Self-Calibrating Weighing Sensor with Intelligent Peristaltic Pump Control for Real-Time Closed-Loop Infusion Monitoring in IoT-Enabled Sustainable Medical Devices. Electronics 2024, 13, 1724. doi: 10.3390/electronics13091724

Kok, C.L.; Ho, C.K.; Lee, T.K.; Loo, Z.Y.; Koh, Y.Y.; Chai, J.P. A Novel and Low-Cost Cloud-Enabled IoT Integration for Sustainable Remote Intravenous Therapy Management. Electronics 2024, 13, 1801. doi: 10.3390/electronics13101801

Teo, B.C.T.; Lim, W.C.; Venkadasamy, N.; Lim, X.Y.; Kok, C.L.; Siek, L. A CMOS Rectifier with a Wide Dynamic Range Using Switchable Self-Bias Polarity for a Radio Frequency Harvester. Electronics 2024, 13, 1953. doi: 10.3390/electronics13101953

Kok, C.L.; Ho, C.K.; Tanjodi, N.; Koh, Y.Y. A Novel Water Level Control System for Sustainable Aquarium Use. Electronics 2024, 13, 2033. doi: 10.3390/electronics13112033

Kok, C.L.; Ho, C.K.; Tan, F.K.; Koh, Y.Y. Machine Learning-Based Feature Extraction and Classification of EMG Signals for Intuitive Prosthetic Control. Appl. Sci. 2024, 14, 5784. doi: 10.3390/app14135784

Kok, C.L.; Ho, C.K.; Teo, T.H.; Kato, K.; Koh, Y.Y. A Novel Implementation of a Social Robot for Sustainable Human Engagement in Homecare Services for Ageing Populations. Sensors 2024, 24, 4466. doi: 10.3390/s24144466

C. -L. Kok, Q. Huang, D. Zhu, L. Siek and W. M. Lim, "A fully digital green LDO regulator dedicated for biomedical implant using a power-aware binary switching technique,"

2012 IEEE Asia Pacific Conference on Circuits and Systems, Kaohsiung, Taiwan, 2012, pp. 5-8, doi: 10.1109/APCCAS.2012.6418957.

C. Wu, W. L. Goh, C. L. Kok, W. Yang and L. Siek, "A low TC, supply independent and process compensated current reference," 2015 IEEE Custom Integrated Circuits Conference (CICC), San Jose, CA, USA, 2015, pp. 1-4, doi: 10.1109/CICC.2015.7338488.

J. Kong, L. Siek and C. -L. Kok, "A 9-bit body-biased vernier ring time-to-digital converter in 65 nm CMOS technology," 2015 IEEE International Symposium on Circuits and Systems (ISCAS), Lisbon, Portugal, 2015, pp. 1650-1653, doi: 10.1109/ISCAS.2015.7168967.

K. G. Shin and B. Rao, "The carbon footprint of AI: Addressing energy consumption in AI model training," IEEE Access, vol. 9, pp. 13221-13234, 2021.

N. Dubey and H. Singh, "Ethical AI for sustainability: Balancing innovation with responsibility," IEEE Trans. Human-Mach. Syst., vol. 50, no. 3, pp. 231-243, 2020.

X. Li et al., "A novel voltage reference with an improved folded cascode current mirror OpAmp dedicated for energy harvesting application," 2013 International SoC Design Conference (ISOCC), Busan, Korea (South), 2013, pp. 318-321, doi: 10.1109/ISOCC.2013.6864038.

Z. Xiao, C. L. Kok and L. Siek, "Triple boundary multiphase with predictive interleaving technique for switched capacitor DC-DC converter regulation," 2014 International Symposium on Integrated Circuits (ISIC), Singapore, 2014, pp. 17-20, doi: 10.1109/ISICIR.2014.7029473.

C. -L. Kok, L. Siek and W. M. Lim, "An ultra-fast 65nm capacitorless LDO regulator dedicated for sensory detection using a direct feedback dual self-reacting loop technique," 2012 IEEE International Symposium on Radio-Frequency Integration Technology (RFIT), Singapore, 2012, pp. 31-33, doi: 10.1109/RFIT.2012.6401604.

C. Wu et al., "Asymmetrical Dead-Time Control Driver for Buck Regulator," in IEEE Transactions on Very Large-Scale Integration (VLSI) Systems, vol. 24, no. 12, pp. 3543-3547, Dec. 2016, doi: 10.1109/TVLSI.2016.2551321.

D. Zhu, J. Wang, L. Siek, C. L. Kok, L. Qiu and Y. Zheng, "High accuracy time-mode duty-cycle-modulation-based temperature sensor for energy efficient system applications," 2014 International Symposium on Integrated Circuits (ISIC), Singapore, 2014, pp. 400-403, doi: 10.1109/ISICIR.2014.7029502.

D. Zhu, J. Wang, C. L. Kok, L. Siek and Y. Zheng, "A new time-mode on-chip oscillator-based low power temperature sensor," 2015 IEEE International Conference on Electron Devices and Solid-State Circuits (EDSSC), Singapore, 2015, pp. 411-414, doi: 10.1109/EDSSC.2015.7285138.

C. -L. Kok and L. Siek, "A novel 2-terminal zener voltage reference," 2011 IEEE 54th International Midwest Symposium on Circuits and Systems (MWSCAS), Seoul, Korea (South), 2011, pp. 1-4, doi: 10.1109/MWSCAS.2011.602636

Rayhan, A., Rayhan, R., & Rayhan, S. (2023). The Role Of AI In Healthcare: Revolutionizing Patient Care And Well-Being. DOI: 10.13140/RG. 2.2, 22601.

Adıgüzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. Contemporary Educational Technology.

Mia, M. R., & Shuford, J. (2024). Exploring the Synergy of Artificial Intelligence and Robotics in Industry 4.0 Applications. Journal of Artificial Intelligence General science (JAIGS) ISSN: 3006-4023, 1(1).

Subramani, Raja, Mohammed Ahmed Mustafa, Ghadir Kamil Ghadir, Hayder Musaad AlTmimi, Zaid Khalid Alani, Maher Ali Rusho, N. Rajeswari, D. Haridas, A. John Rajan, and Avvaru Praveen Kumar. "Exploring the use of Biodegradable Polymer Materials in Sustainable 3D Printing." Applied Chemical Engineering 7, no. 2 (2024): 3870-3870.

https://doi.org/10.59429/ace.v7i2.3870
Rusho, Maher Ali. “Introduction to Rushoâ€™ s Transform Lakshmann and Smith Model: A Machine Learning Approach to Earthquake Detection.” International Journal of Sciences 12, no. 01 (2023): 1-5. DOI: 10.18483/ijSci.2646
Raja, S., Hayder MusaadAl-Tmimi, Ghadir Kamil Ghadir, Mohammed Ahmed Mustafa, Zaid Khalid Alani, Maher Ali Rusho, and N. Rajeswari. “An analysis of polymer material selection and design optimization to improve Structural Integrity in 3D printed aerospace components.” Applied Chemical Engineering 7, no. 2 (2024): 1875-1875. https://doi.org/10.59429/ace.v7i2.1875
Usmani, U. A., Happonen, A., & Watada, J. (2023, June). Human-centered artificial intelligence: Designing for user empowerment and ethical considerations. In 2023 5th International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA) (pp. 01-05). IEEE.
Rane, N. (2023). Role and challenges of ChatGPT and similar generative artificial intelligence in business management. Available at SSRN 4603227.
Sheraz, M., Chuah, T. C., Lee, Y. L., Alam, M. M., & Han, Z. (2024). A Comprehensive Survey on Revolutionizing Connectivity Through Artificial Intelligence-Enabled Digital Twin Network in 6G. IEEE Access.
Wu, L. (2023). Agile Design and AI Integration: Revolutionizing MVP Development for Superior Product Design. International Journal of Education and Humanities, 9(1), 226-230.
Rane, N. (2023). Role and challenges of ChatGPT and similar generative artificial intelligence in human resource management. Available at SSRN 4603230.
Kumar, S., Gupta, U., Singh, A. K., & Singh, A. K. (2023). Artificial intelligence: revolutionizing cyber security in the digital era. Journal of Computers, Mechanical and Management, 2(3), 31-42.
Rusho, Maher Ali, and Markus Patrick Chan. “Analysis of Artificial Intelligence and its Impactful Implementation on Job Performance.” Dinkum Journal of Economics and Managerial Innovations 2, no. 10 (2023): 571-576.
Raja, S., Mohammed Ahmed Mustafa, Ghadir Kamil Ghadir, Hayder Musaad AlTmimi, Zaid Khalid Alani, Maher Ali Rusho, and N. Rajeswari. “Unlocking the potential of polymer 3D printed electronics: Challenges and solutions.” Applied Chemical Engineering 7, no. 2 (2024): 3877-3877. https://doi.org/10.59429/ace.v7i2.3877
Navarra, D. Integrating artificial intelligence and sustainable technologies in strategic renewable energy and Power-to-X projects: A review of global best practices, risks and future prospects. Soc. Econ. 2023, 45, 472–493.
Ivanova, S.; Zhidkova, E.; Prosekov, A. Limiting the Carbon Footprint of an Enterprise: Calculation Methods and Solutions. Qubahan Acad. J. 2023, 3, 51–61.
Bültemann, M.; Simbeck, K.; Rzepka, N.; Kalff, Y. Sustainable Learning Analytics: Measuring and Understanding the Drivers of Energy Consumption of AI in Education. Int. Conf. Comput. Support. Educ. CSEDU–Proc. 2024, 1, 272–279.
Meenal, R.; Binu, D.; Ramya, K.C.; Michael, P.A.; Vinoth Kumar, K.; Rajasekaran, E.; Sangeetha, B. Weather Forecasting for Renewable Energy System: A Review. Arch. Comput. Methods Eng. 2022, 29, 2875–2891.
Enescu, F.M.; Marinescu, C.N.; Ionescu, V.M.; ¸Stirbu, C. System for monitoring and controlling renewable energy sources. In Proceedings of the 9th International Conference on Electronics, Computers and Artificial Intelligence, ECAI 2017, Targoviste, Romania, 29 June–1 July 2017; pp. 1–6.

Mohammadi Lanbaran, N.; Naujokaitis, D.; Kairaitis, G.; Jenciut ̄ e, G.; Radziukynien ˙ e, N. Overview of Startups Developing ˙ Artificial Intelligence for the Energy Sector. Appl. Sci. 2024, 14, 8294.
Billio, M.; Casarin, R.; Costola, M.; Veggente, V. Learning from experts: Energy efficiency in residential buildings. Energy Econ. 2024, 136, 107650.
Zhou, Y.; Liu, J. Advances in emerging digital technologies for energy efficiency and energy integration in smart cities. Energy Build. 2024, 315, 114289.
Ukoba, K.; Olatunji, K.O.; Adeoye, E.; Jen, T.-C.; Madyira, D.M. Optimizing renewable energy systems through artificial intelligence: Review and future prospects. Energy Environ. 2024, 35, 3833–3879.
Shafiq, M.; Bhavani NP, G.; Venkata Naga Ramesh, J.; Veeresha, R.K.; Talasila, V.; Sulaiman Alfurhood, B. Thermal modeling and Machine learning for optimizing heat transfer in smart city infrastructure balancing energy efficiency and Climate Impact. Therm. Sci. Eng. Prog. 2024, 54, 102868.
Renganayagalu, S.K.; Bodal, T.; Bryntesen, T.-R.; Kvalvik, P. Optimising Energy Performance of buildings through Digital Twins and Machine Learning: Lessons learnt and future directions. In Proceedings of the 2024 4th International Conference on Applied Artificial Intelligence, ICAPAI 2024, Halden, Norway, 16 April 2024.
Qiu, J.; Zhao, J.; Wen, F.; Zhao, J.; Gao, C.; Zhou, Y.; Tao, Y.; Lai, S. Challenges and Pathways of Low-Carbon Oriented Energy Transition and Power System Planning Strategy: A Review. IEEE Trans. Netw. Sci. Eng. 2023, 11, 5396–5416.
Um-e-Habiba Ahmed, I.; Asif, M.; Alhelou, H.H.; Khalid, M. A review on enhancing energy efficiency and adaptability through system integration for smart buildings. J. Build. Eng. 2024, 89, 109354.
Asif, M.; Naeem, G.; Khalid, M. Digitalization for sustainable buildings: Technologies, applications, potential, and challenges. J. Clean. Prod. 2024, 450, 141814.
Gooroochurn, M. Mechatronics Implementation of Passive Building Elements to Improve Thermal Comfort and Promote Energy Efficiency in Buildings. In Artificial Intelligence, Engineering Systems and Sustainable Development: Driving the UN SDGs; Fowdur, T.P., Rosunee, S., Ah King, R.T.F., Jeetah, P., Gooroochurn, M., Eds.; Emerald Publishing Limited: Leeds, UK, 2024.
Paré, G.; Kitsiou, S. Methods for literature reviews. In Handbook of eHealth Evaluation: An Evidence-Based Approach; Lau, F., Kuziemsky, C., Eds.; University of Victoria: Victoria, BC, Canada, 2017; Study 9.
Brocke, J.V.; Simons, A.; Niehaves, B.; Niehaves, B.; Reimer, K.; Plattfaut, R.; Cleven, A. Reconstructing the giant: On the importance of rigour in documenting the literature search process. In Proceedings of the 17th European Conference on Information Systems (ECIS 2009), Verona, Italy, 8–10 June 2009.
Kitchenham, B.; Charters, S. Procedures for Performing Systematic Reviews; Joint Technical Report, NICTA 0400011T.1; Technical Report TR/SE-0401; Keele University: Keele, UK, 2004.
Pimenowa, O.; Fyliuk, H.; Sitnicki, M.W.; Kolosha, V.; Kurinskyi, D.; Pimenov, S. Sustainable business model of modern enterprises in conditions of uncertainty and turbulence. Sustainability 2023, 15, 2654.
Babiarz, B.; Krawczyk, D.A.; Siuta-Olcha, A.; Manuel, C.D.; Jaworski, A.; Barnat, E.; Cholewa, T.; Sadowska, B.; Bocian, M.; Gnieciak, M.; et al. Energy Efficiency in Buildings: Toward Climate Neutrality. Energies 2024, 17, 4680.
Zakizadeh, M.; Zand, M. Transforming the Energy Sector: Unleashing the Potential of AI-

Driven Energy Intelligence, Energy Business Intelligence, and Energy Management System for Enhanced Efficiency and Sustainability. In Proceedings of the 2024 20th CSI International Symposium on Artificial Intelligence and Signal Processing, AISP 2024, Babol, Iran, 21–22 February 2024.

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Chapter 8 - AI Agents and Sustainable Development Goals: Bridging the Gap Through Innovation

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Abstract

Autonomous AI agents represent an innovative advancement in artificial intelligence, transitioning from AI copilots and assistants reliant on human input to independent operators. The reasoning capabilities of large language models enable agents to develop strategies, plan and then execute tasks autonomously to achieve high-level goals. When finding problems, they can solve them automatically by utilizing resources such as the Internet, numerous data sources and specialized applications, such as delegating tasks to other specialized AI agents. They independently research problems and adapt without human oversight, presenting transformative potential for Sustainable Development Goals (SDGs) through scalable solutions to global challenges. The autonomous application of AI potentially improves many areas such as water management, agriculture, and biodiversity conservation, thereby optimizing decision-making processes for greater efficiency. Agentic AI possesses the capability to analyze extensive datasets, systematically identify gaps in sustainability efforts, and model potential intervention outcomes. This analytical capacity directly aligns with the goals of environmental conservation, resource efficiency, and equitable access to essential services. However, challenges, including environmental costs, energy consumption, and algorithmic biases, threaten fairness and inclusivity, which are important for realizing AI agents' potential for achieving the goals. Establishing robust ethical frameworks is essential for guiding the deployment of AI agents, ensuring transparency and accountability. By embedding principles of fairness and inclusivity, autonomous AI agents can facilitate responsible advancements toward the Sustainable Development Goals.

Keywords: *AI Agents, Sustainability, SDG, Ethical, multi-agent, agentic AI, opportunities;*

8.1. Introduction

AI has evolved from a niche field into a transformative force across all aspects of life including healthcare, finance, and education. In 2023, researchers identified over 600 AI solutions advancing the 17 UN Sustainable Development Goals (SDGs), with 492 already deployed, evidence of AI's growing role in global sustainability (Bankhwal et al., 2024). The most significant impact was observed in SDG 3 (Good Health and Well-being), with 165 AI-enabled healthcare use cases identified, with 128 active deployments, reinforcing AI's transformative potential in early disease detection, predictive diagnostics, and telemedicine solutions (Bankhwal et al., 2024; Gosselink et al., 2024). AI-driven predictive healthcare models improve diagnostics and patient outcomes, while real-time monitoring systems enhance disease surveillance and response capabilities (see Appendix A). AI agents (agentic AI/multi-agents) operate autonomously, perceiving environments, learning from real-time data, and executing tasks with minimal oversight.

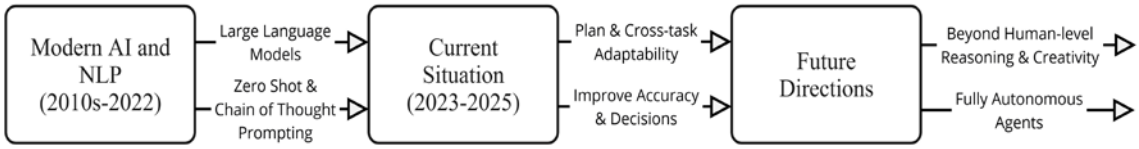


Figure 1: Progression towards AI Agents
Note. Source: Researcher

Utilising advancements (Figure 1) such as large language models (with human-like reasoning), natural language processing (NLP) and reinforcement learning AI Agents interpret human language, adapt to dynamic inputs, and take on unclear goals by researching, planning and delegating tasks (Gosselink et al., 2024; Mollick et al., 2024; Wang et al., 2023).

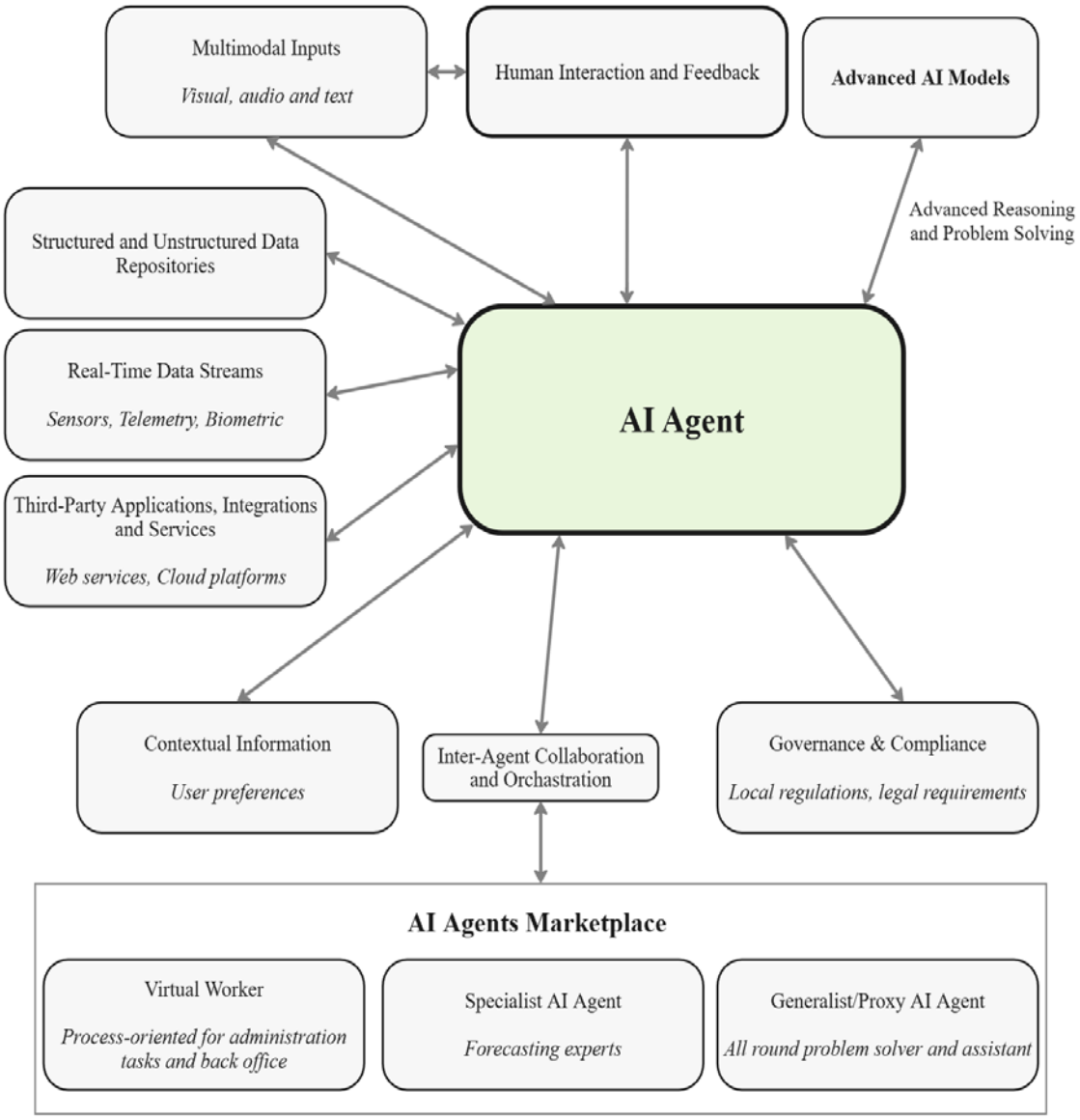


Figure 2: AI Agent: Inputs and Interactions
Note. Source: Researcher

Figure 2 illustrates some key inputs and interactions related to an AI Agent, highlighting its ability to autonomously process multimodal inputs, integrate structured and unstructured datasets, and respond to real-time data streams. They integrate with third-party applications, cloud services, and specialized AI Agents (via marketplaces), enabling interoperable digital ecosystems (Mollick et al., 2024). AI Agents, act as virtual teams that extend human capabilities, autonomously process vast data, apply reasoning, and generate predictive insights to support SDG interventions. Due to the LLM context size, AI limits the storage and memory of the AI Agents. This leads to specialist AI Agents, who have specific skills and memory that they can access, like human expert team members (Wang et al., 2023). They are coordinated by a team leader (Generalist/Proxy AI Agent) who orchestrates, communicates and reviews all work.

Despite technological advancements, only 17% of SDG targets are on track, while 80% have stalled or regressed, largely due to resource limitations, slow policy adaptation, and insufficient data-driven decision-making (Gosselink et al., 2024; United Nations, 2024).

This chapter examines the technological and ethical dimensions of AI Agent deployment in SDGs, addressing the research question:

How can the operational, ethical, and governance challenges of deploying agentic AI for Sustainable Development Goals be effectively addressed?

AI Agents can drive sustainability efforts through automation, large-scale real-time analytics, human-like reasoning, and automated task creation and reviews. However, they face challenges such as bias, governance gaps, and rising resource demands. Addressing these requires a structured approach that ensures a balanced assessment of their potential and limitations in advancing a sustainable and equitable future.

8.2. Literature Review

AI Agents are increasingly recognized as tools in advancing the Sustainable Development Goals (SDGs), with abilities to automatically research a complex problem, weigh up nuanced options and then plan and delegate a set of tasks. However, their effectiveness depends on both technological advancements and frameworks that ensure ethical and transparent deployment and operations. This literature review systematically examines AI Agents' functional capabilities and ethical considerations, highlighting their potential and limitations in addressing sustainability challenges.

AI Agents operate within an interconnected digital ecosystem (see Figure 2), integrating structured and unstructured data sources to facilitate scalable human-like decision-making and actions (Sandini et al., 2024; Zhou et al., 2023).

AI Agents exhibit eight fundamental capabilities in SDG applications:

1. Perception and Social Processing
2. Explainable Cognitive Reasoning
3. Action and Execution
4. Adaptive Learning and Memory
5. Synergistic Collaboration and Coordination
6. Security and Compliance
7. Natural Language Processing and Communication
8. Integration and Implementation

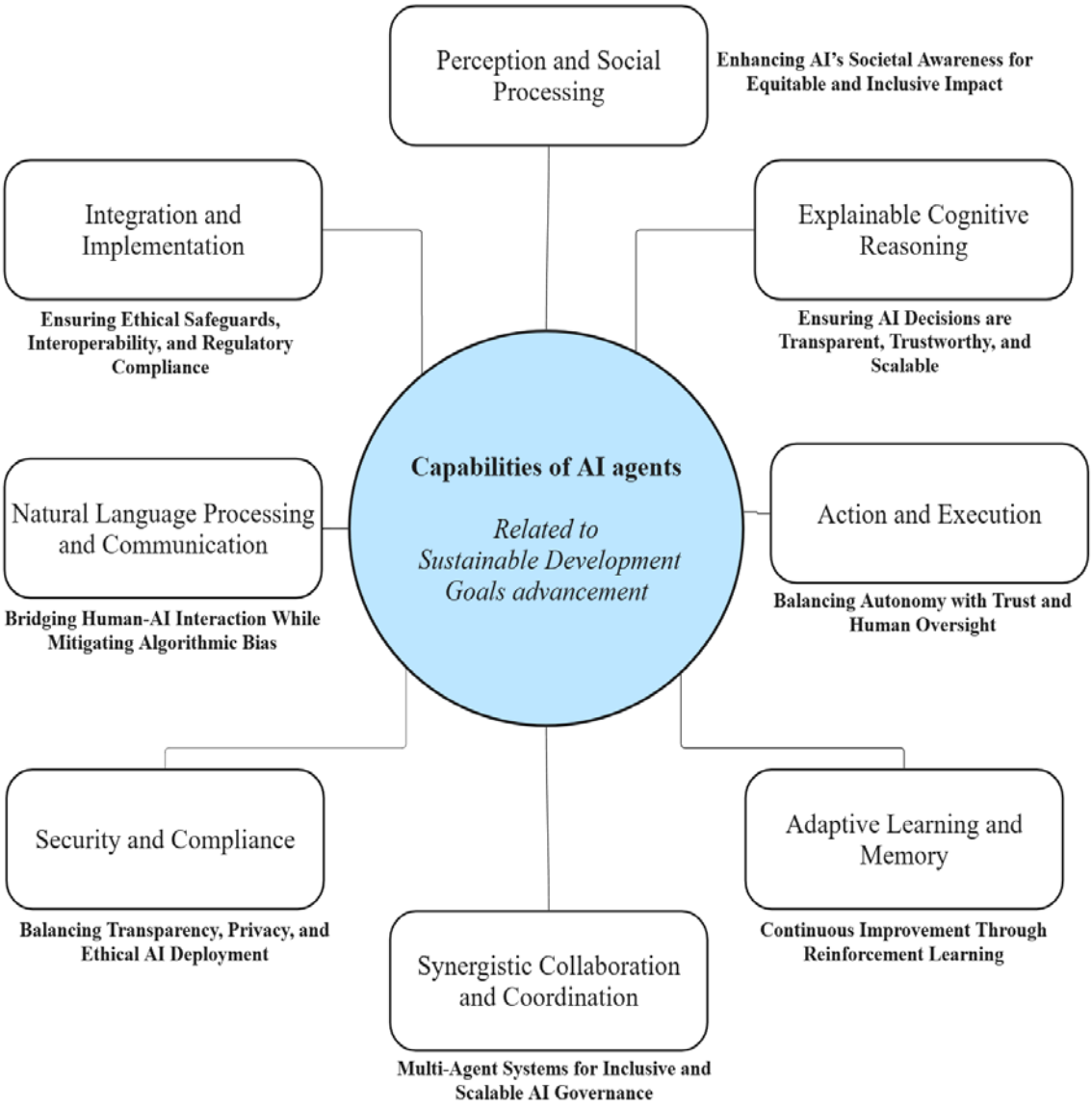


Figure 3: AI Agent Capabilities for SDG Advancement: Key Challenges and Considerations

Note. Source: Researcher

• Perception and Social Processing – collects and processes real-time environmental data through IoT sensors, satellite feeds, and user interactions (Sandini et al., 2024). Barros et al. (2023) argue that neglecting social metrics can hinder organisations' contributions to SDGs. AI Agents that lack awareness of rivalry and social cues struggle in competitive environments, which limits their effectiveness in contributing to SDG 9 and SDG 17. By integrating social interactions, these agents can better understand nuances, social influences, political lobbying pressures and hidden agendas. This enhancement fosters inclusive and resilient geopolitical partnerships.

• Explainable Cognitive Reasoning – responsible for reasoning, planning, and decision-making, is important for interpreting sustainability data correctly and optimising agentic AI-driven SDG interventions (Ruan et al., 2023). Advancements in LLMs like GPT-4o further enhance AI agents' ability to process unstructured data and generate adaptive solutions (Ruan et al., 2023). Newer models, exemplified by OpenAI o1 and DeepSeek R1, refine reasoning

by assessing feasibility prior to generating responses, thereby improving decision accuracy. This could address complex sustainability challenges, such as climate resilience (SDG 13) and resource efficiency (SDG 12), by identifying root causes of climate vulnerabilities and resource inefficiencies and predicting the consequences of actions and policies.

However, as Sandini et al. (2024) observe, reliance on correlation-based analysis may obscure causal relationships, limiting AI's ability to drive meaningful change. This underscores the need for explainable AI to improve transparency, trust, and accountability in high-stakes SDG applications, including healthcare equity (SDG 3) and sustainable urban planning (SDG 11). Sastry et al. (2024) research found that as AI cognitive capabilities scale, the training of these systems often requires substantial computational resources, which in turn necessitates considerable energy usage. This aspect raises concerns about the environmental impact associated with the expansion of AI technologies, particularly in terms of their carbon footprint and overall sustainability (Ueda et al., 2024). However, DeepSeek R1 has proven that a highly capable open-source LLM with advanced reasoning can be built with fewer resources.

• Action and Execution – Gronauer & Diepold (2022) research supports the execution of tasks or communication interventions (e.g., triggering alerts for disaster relief under SDG 13). AI Agents can now use cognitive abilities to research a complex problem, figure out a plan, subdivide into tasks and test out different actions, expecting failure to occur to replan (Kim et al., 2024; Wang et al., 2023; Xu et al., 2023). However, Lawless (2024) highlights the importance of trust and safety, noting that public scepticism towards AI systems can hinder their effectiveness. Gronauer & Diepold (2022) point out difficulties in coordination among multiple AI agents, which can lead to inefficiencies in resource allocation during collaborative efforts, such as managing healthcare resources. At the same time, autonomous decision-making enables AI to act independently, though a lack of trust in full autonomy (Jannelli et al., 2024) necessitates human oversight. Sekiguchi & Ohsawa (2024) state that AI should only augment human capabilities, while Jannelli et al. (2024) argue that AI agents can autonomously make correct decisions without requiring human intervention. Kahungi (2023) warns that research from Africa shows that AI has been perpetuating bias due to the data available in systems, at scale this will become more prevalent, so AI Agent key decisions require human intervention and feedback (Figure 2).

• Adaptive Learning and Memory – responsible for refining performance over time, whether through reinforcement learning or historical data analysis. This adaptive capacity is important in settings like climate prediction, as AI Agents can automate climate model development and retune the model based on contextualised predictions based on past events or trends. Zhou et al. (2023) highlight the need for agents to store and retrieve long-term memories and regularly update short-term working memories, fostering continuous improvement and allowing agents to adapt to new contexts. Gronauer & Diepold (2022) study on multi-agent reinforcement learning supports the idea of adaptive learning (Sandini et al., 2024).

• Proactive Behaviour and Anticipatory Action - support predictive interventions (Malmio, 2024) but can be constrained by psychological, cognitive, and ethical factors, limiting AI's proactivity.

• Synergistic Collaboration and Coordination – Masterman et al. (2024) research endorses agents that engage in collaborative human-machines decisions. For example, a generalist agent can orchestrate virtual worker agents (figure 2) focusing on community input and can share feedback with data analysis agents (specialists) to refine project strategies (for human feedback). However, Klieger et al. (2024) find that if agents do not clearly communicate roles or findings, confusion and ineffective feedback loops may arise in the decision-making process. Automated collaboration and coordination further enhance climate monitoring and

disaster response (Ziemba et al., 2024) by sharing responsibilities with specialised AI Agent experts, though it raises concerns over computational resource consumption and sustainability (Chaudhary, 2023).

• Security and Compliance – essential for data protection, privacy, and alignment with regulations like GDPR to protect people, communities and organisations. Lawless (2024) stress the need for robust security measures to secure sensitive data and maintain public trust. (Chan et al., 2024) highlight the importance of transparency through activity logs and real-time monitoring yet warn that privacy concerns may conflict with detailed oversight. Sandini et al. (2024) note that rapid AI advancements may outpace the development of adequate privacy protections, raising concerns about effective responses to evolving threats. Similarly, over-regulating AI could hinder technological progress Zhao & Gómez Fariñas (2023), though proper governance can ensure accountability.

• Natural Language Processing and Communication: This area facilitates human-AI interaction using mass personalisation, simplifying complex information in different languages. It supports the automated reporting and monitoring required by all SDGs.

• Integration and Implementation – AI Agent solutions require ethical safeguards, interoperability standards and regulatory alignment to ensure responsible integration within global technology eco-system (Kahungi, 2023; Malmio, 2024). Zhao & Gómez Fariñas (2023) note that over-regulation may discourage innovation, while insufficient oversight can compromise trust and ethical standards.

While these capabilities define AI agents' core functions, their impact depends on real-world implementation. The next section explores their applications across SDG domains, highlighting benefits and challenges.

8.2.1 Applications of AI Agents in Sustainable Development: Opportunities and Gaps

Environmental applications include autonomous systems that optimise energy grids, enhance climate modelling, and monitor resources through satellite imagery and automated spatial analytics, though current progress is limited (Akinboyewa et al., 2024; Fraisl, 2024). Meanwhile, in healthcare, AI serves primarily as assistive technology for predictive diagnostics and surgical procedures, with limited research on self-learning agents capable of independent interaction with patients and providers.

The socioeconomic impact of AI Agents extends to poverty reduction and financial inclusion by efficiently allocating resources to vulnerable populations, though most systems remain rule-based rather than truly autonomous (Diener & Špaček, 2021).

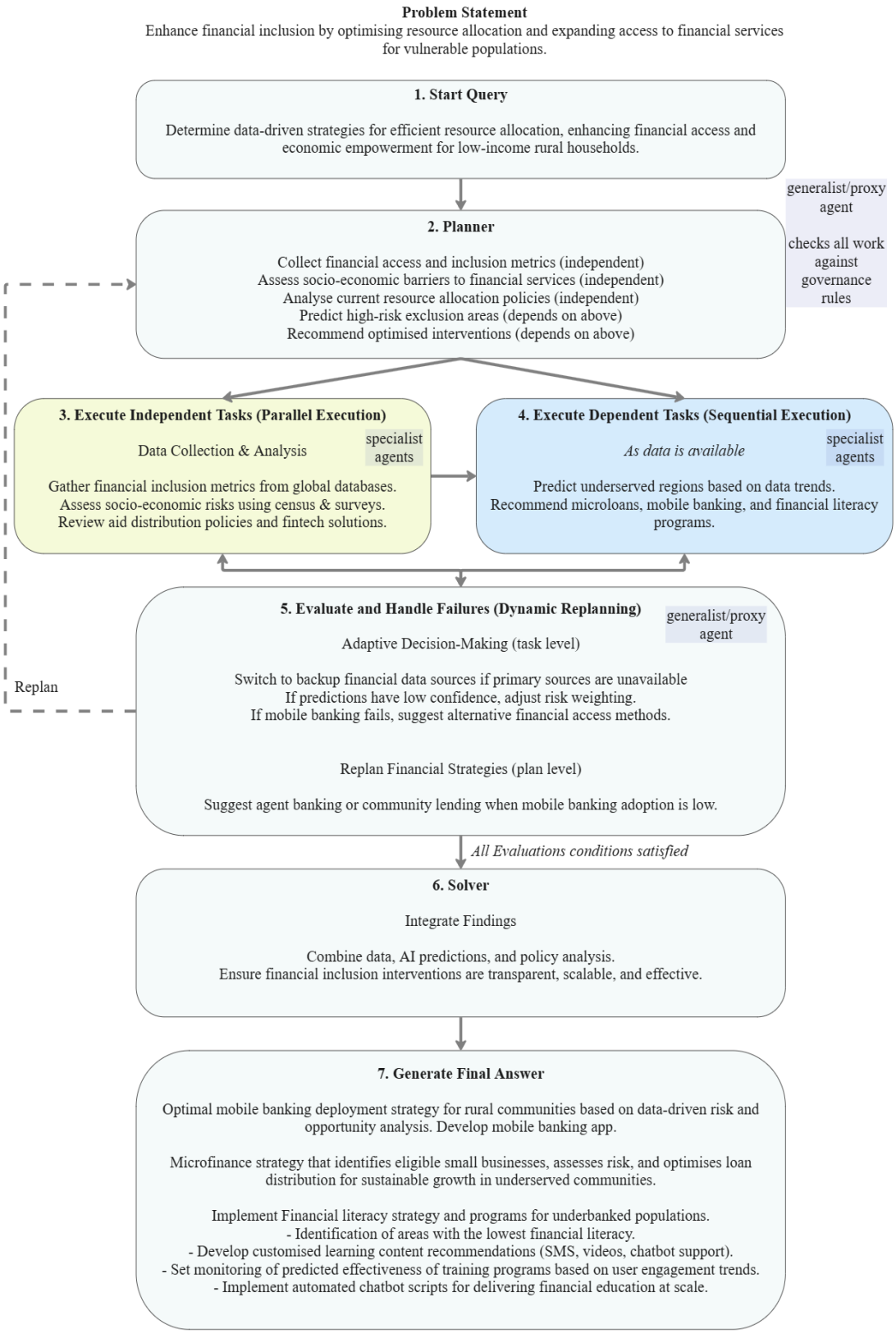


Figure 4: Example of how AI Agents can be applied to work on SDG problems

Figure 4 shows how AI Agents can take a problem, break this into a query and develop a plan and set of required tasks (Wang et al., 2023), aligning with agreed governance rules. Some of the tasks are independent so can be worked on in parallel (Kim et al., 2024; Wang et al., 2023), whereas others will be dependent on either a task to be completed or data or service to become available. If a task is not possible to be completed (such as satellite data not available), alternative tools and approaches will be taken to solve the task (Kim et al., 2024), otherwise as is the case with complex SDG-related problems, if the plan is not possible, alternative strategies will be automatically replanned (Xu et al., 2023). This capability to replan, when faced with failures, allows AI Agents to keep trying alternative unknown approaches (for a solution) using available and approved resources, without having a final clear direction. Finally, once the tasks are all successfully passing evaluations (including compliance with necessary rules and regulations), the problem would have been addressed with multiple solutions and actions completed. The approach can be implemented in open-source platforms that allow the creation of AI Agents, such as LangGraph, Crew AI and Microsoft AutoGen.

However, significant challenges persist, including algorithmic bias, decision opacity, and infrastructure limitations in resource-constrained regions (Bankhwal et al., 2024; Kahungi, 2023), which must be addressed through robust governance frameworks to ensure scalable automated AI Agent deployment doesn't exacerbate existing inequalities. Without proper research and oversight, these powerful tools risk reinforcing systemic problems rather than solving them.

8.3. Research Methodology

8.3.1 Methodology/Framework

This section outlines the methodologies employed to investigate the role of AI agents in advancing the Sustainable Development Goals (SDGs), combining both the quantitative survey and the literature review components.

8.3.2 Data Collection

The research utilized a two-pronged approach for data collection: a literature review and a quantitative survey.

Literature Review: A systematic search was conducted using Google Scholar to identify relevant open-access academic articles focused on AI agents and their contributions to the SDGs. The search criteria focused on literature published from 2023 onward. This time frame was chosen due to the emergence of advanced large language models that exhibit enhanced reasoning capabilities and can effectively process multimodal content (see figures 1 and 2).

The Google Scholar search results revealed a total of 69,500 papers using the term "AI and SDG" so this was refined (Appendix B), see below:

-chatbot -conversational -"autonomous driving" "SDG" AND ("ai agent" OR "autonomous agent" OR "autonomous ai" OR "automated AI" OR "multiagent")

This search term provided 400 results (between 2023 and 2024), which were manually selected and limited to open-access publications.

The inclusion criteria focused on scholarly, peer-reviewed open-access publications published in English between 2023 and 2024 that explicitly connected AI agents to sustainable

development. The exclusion criteria eliminated studies unrelated to sustainability, including those focused on topics like autonomous driving or conversational chatbots, which were not the focus of this research.

Quantitative Survey: A structured questionnaire was designed and distributed electronically to a targeted sample of 384 individuals, including AI professionals, sustainability practitioners, business professionals, and students. The aim was to capture a diverse range of insights regarding their perceptions of AI agents within sustainability contexts, producing 316 valid responses from 48 countries.

The survey asked 20 questions via a 7-point Likert scale to measure various dimensions, including respondents' familiarity with AI agents, perceived effectiveness in addressing sustainability challenges, and ethical concerns associated with their potential implementation. Key themes explored included opinions on regulatory measures, equitable access to AI benefits, and the implications of multi-agent deployment on economic and social outcomes, all important in progressing SDGs.

8.3.3 Theoretical Framework

This research is anchored in the frameworks of responsible AI governance and Value-Sensitive Design (VSD), which focuses on the need for fairness, accountability, and transparency in the deployment of AI technologies (Peters et al., 2020). Sastry et al. (2024) highlight the necessity of ethical governance frameworks in guiding AI applications to mitigate risks and progress AI benefits for sustainable development (see Appendix C).

The OECD's Principles on Artificial Intelligence and Asilomar AI principles (Morandín-Ahuerma, 2023) promote inclusive growth and sustainable development, focusing on AI's benefits and safety for people and the planet. These principles stress the importance of accountability in AI systems to prevent worsening inequalities or creating ethical dilemmas (Chan et al., 2024), necessary for all SDGs.

8.3.4 Research Findings

This section presents the key insights derived from the literature and survey analysis, highlighting respondents' attitudes, perceptions, and experiences regarding the role of AI Agents in sustainable development. The analysis is based on 316 anonymous responses (representing 48 countries), all of which were voluntarily accepted to complete the survey.

Table 1: Top 10 highest responses by country

Rank	Country	Number of Responses
1	United Kingdom	50
2	United States of America	28
3	Canada	27
4	Australia	25
5	India	24
6	Saudi Arabia	17
7	Germany	12

Rank	Country	Number of Responses
8	United Arab Emirates	9
9	Algeria	6
10	New Zealand	5

This distribution demonstrates a notable skew toward English-speaking countries, with five of the top eight being primarily English-speaking nations. Saudi Arabia shows significant participation with 17 responses, making it the top Middle Eastern country represented.

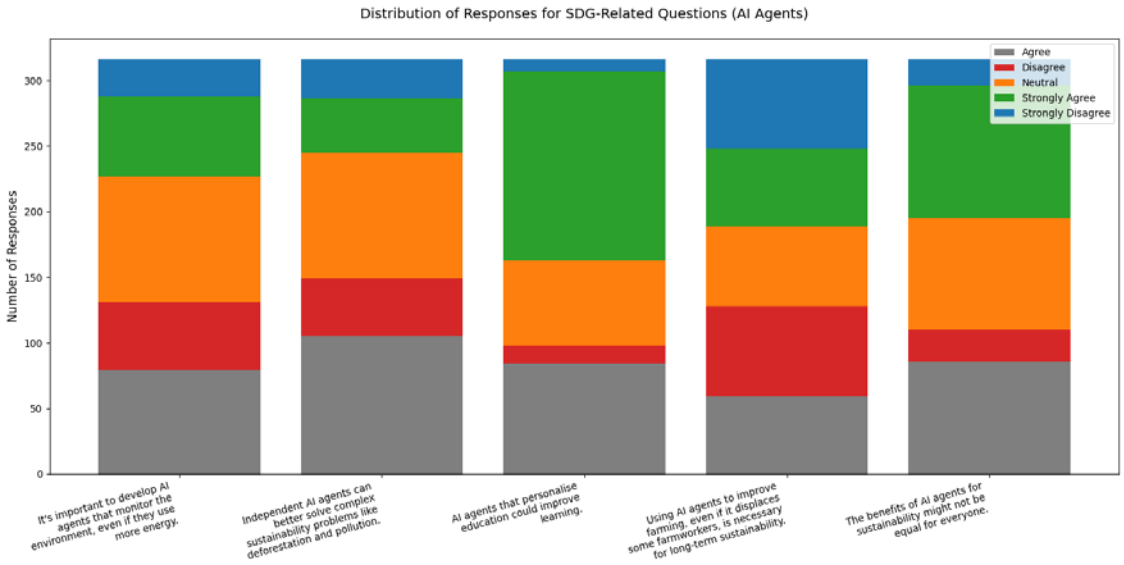


Figure 5: Distribution of Responses for SDG related questions (AI Agents)

Table 2 provides insights based on the response pattern from Figure 5.

Table 2: Analysis of AI Agents and Sustainability Survey Responses

Finding	Survey Statement	Response Pattern	Insight
Highest Agreement	AI agents that personalize education could improve learning	Large proportion of "Strongly Agree" responses with minimal disagreement	Respondents show strong confidence in AI Agents' potential to enhance personalized education
Most Polarized View	It's important to develop AI agents that monitor the environment, even if they use more energy	Relatively even distribution across all response categories	Divided opinions on the energy consumption vs. environmental monitoring trade-off

Finding	Survey Statement	Response Pattern	Insight
Strongest Disagreement	Independent AI agents can better solve complex problems like deforestation and pollution	Highest level of "Disagree" and "Strongly Disagree" responses	Skepticism about AI Agents independently solving complex environmental challenges
Ethical Trade-off Recognition	Using AI agents to improve farming, even if it displaces some farmworkers, is necessary for long-term sustainability	Moderate agreement but significant disagreement	Recognition of the complex balance between agricultural productivity gains and potential farmworker displacement
Equity Concerns	The benefits of AI agents for sustainability need to be equal for everyone	Strong overall agreement	Respondents value the equitable distribution of sustainability benefits from AI Agents

Note. Source: Researcher

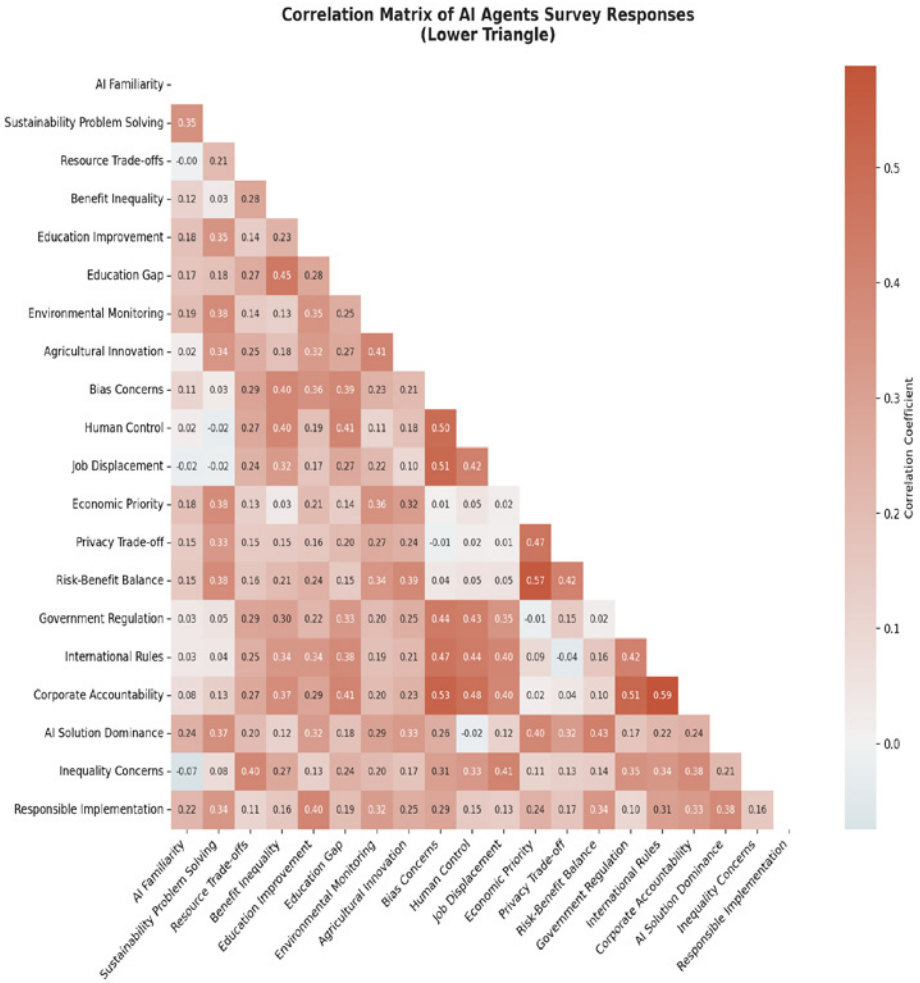


Figure 6: Correlation Matrix of AI Agents Survey Responses

Note. Source: Researcher

Below are the key insights found in the correlation matrix (Figure 6).

Table 3: Correlation analysis of the survey (AI Agents and Sustainable Development Goals)

Correlation	Correlation	Description
Corporate Accountability & International Rules	(r = 0.588)	Respondents who believe that companies making AI agents need to prove social and environmental benefits tend to also favour international regulations to ensure these agents are not used harmfully. This suggests a consistent view that both corporate practices and international oversight are key to responsible AI deployment, aligning with Peters et al. (2020).
Risk-Benefit Balance & Economic Priority	(r = 0.567)	Participants who believe that the potential benefits of AI Agents for sustainability outweigh their risks are also inclined to prioritise economic growth. This indicates that for many, the economic opportunities provided align with a strong belief in its potential to contribute positively to sustainable development goals.
Corporate Accountability & Bias Concerns	(r = 0.530)	There is a notable relationship showing that those who demand evidence of corporate accountability also worry about the risk of AI systems reinforcing biases. Concerns about bias call for companies to be more responsible in the development of AI Agents.
Job Displacement & Bias Concerns	(r = 0.509)	The correlation suggests that those who are concerned about the potential job losses due to AI Agents also have significant worries about biases. This indicates an overall cautious outlook regarding the broader societal impacts of rapidly deploying AI solutions, aligning with Figure 7.

Note. Source: Researcher

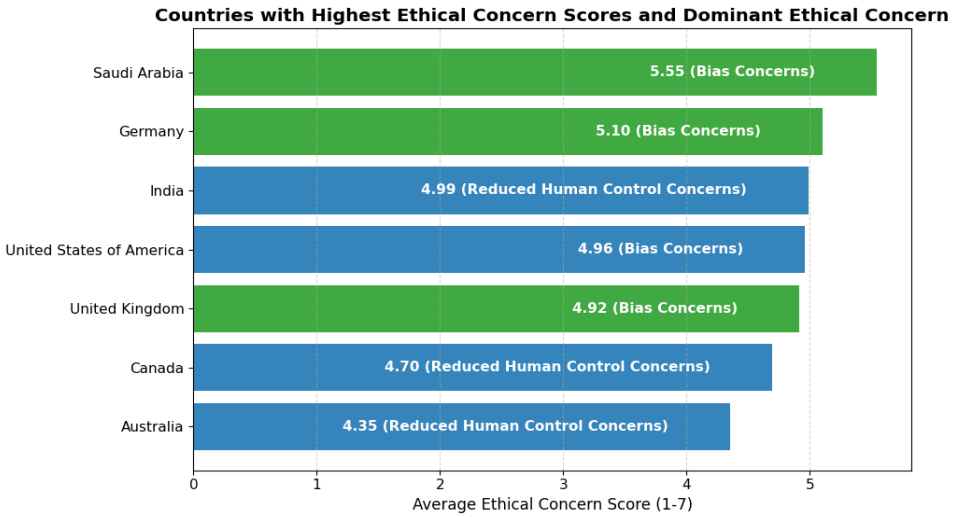


Figure 7: Countries with Highest Ethical Concern Scores and Dominant Ethical Concern

Note. Source: Researcher

Bias Concerns are the dominant ethical concern in 4 out of the 7 countries (Saudi Arabia, Germany, United States and United Kingdom). This indicates that respondents in these countries are particularly worried about AI systems reinforcing or amplifying biases, which could lead to unfair or discriminatory outcomes. India, Canada, and Australia stand out with Reduced Human Control as their dominant concern. This suggests that respondents in these countries are more concerned about AI systems making decisions without sufficient human oversight, potentially leading to a loss of control over critical processes (relevant to all SDGs).

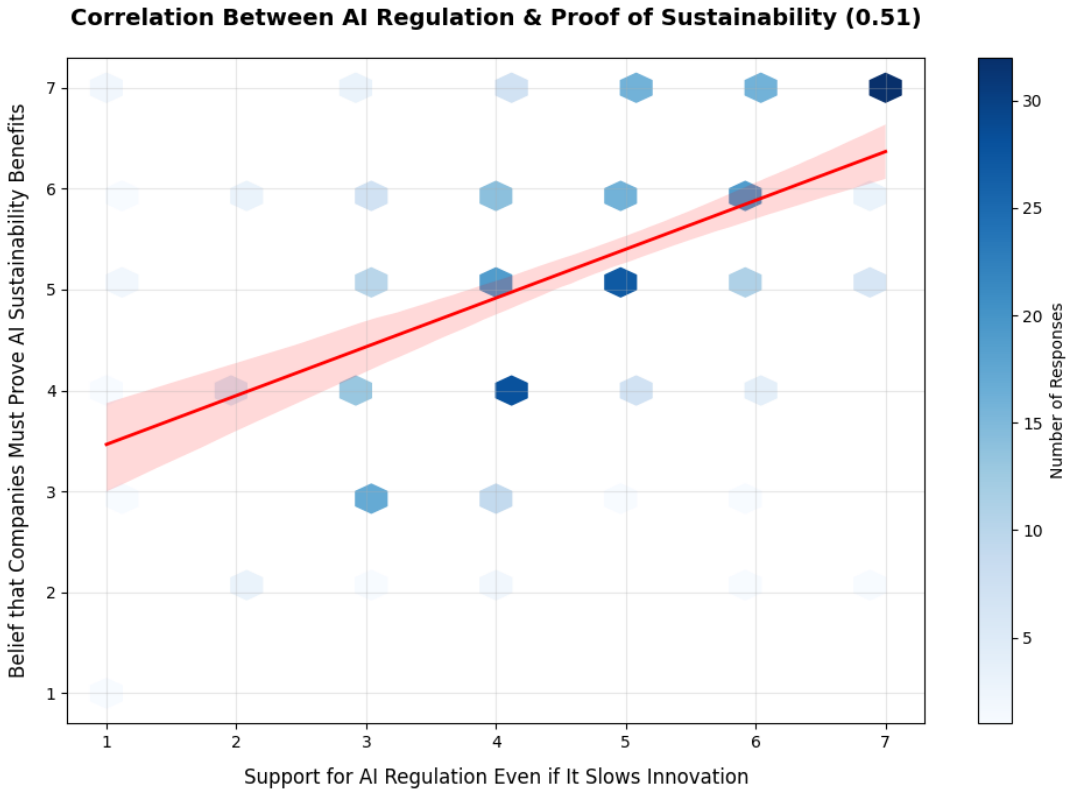


Figure 8: Hexbin Density Plot: AI Regulation vs. Proof of Sustainability
Note. Source: Researcher

Individuals who support stronger AI regulations also tend to demand proof of AI's sustainability benefits (r = 0.514). The regression line confirms this trend, showing that higher agreement with regulation correlates with greater expectations for corporate accountability, despite some variation in responses. These correlations show that while respondents see AI Agents as beneficial for sustainability, they also the need for accountability and safeguards to mitigate risks like bias and job displacement.

8.3.5 Access and Equity Issues

The survey findings revealed significant discrepancies in access to AI technologies, with respondents from developing regions expressing greater concerns about AI potentially exacerbating existing inequalities.

Figure 9 below corroborated this by showing that respondents with lower economic circumstances reported higher anxiety regarding equitable access to AI Agent technologies, highlighting the necessity for inclusive initiatives that ensure accessibility to underprivileged communities.

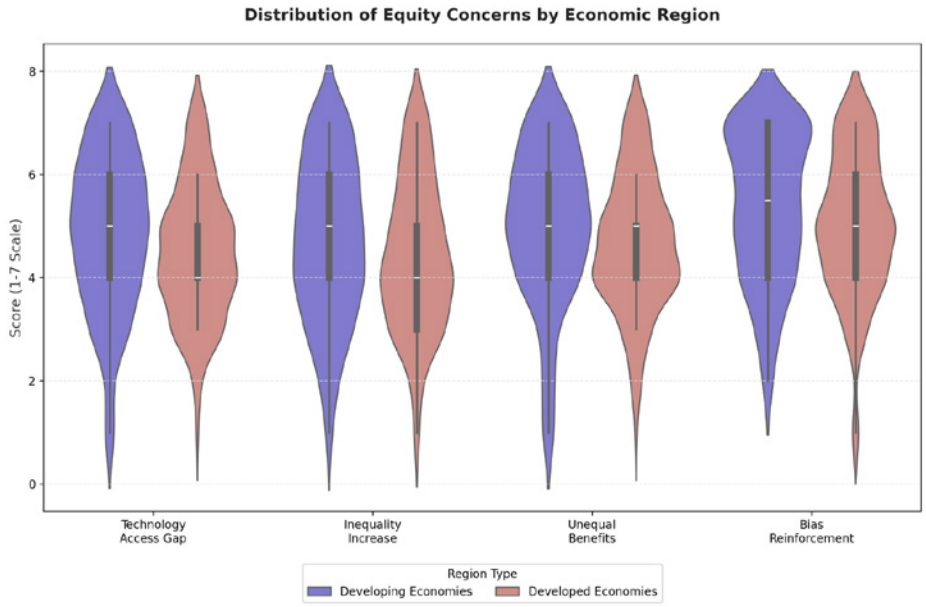


Figure 9: Distribution of Equity Concerns by Economic Region
Note. Source: Researcher

This concern aligns closely with the broader literature (Dwivedi et al., 2021; Kahungi, 2023) advocating for proactive policy measures that address equity issues, ensuring that AI Agents serve as a tool for empowerment rather than deepening socio-economic divides.

8.4. Challenges and Opportunities

Reaching the United Nations Sustainable Development Goals (SDGs) requires innovative solutions. Survey data indicate that increased familiarity with AI agents is associated with greater confidence in their effectiveness (r = 0.65). However, the academic literature on AI Agents and SDG applications remains sparse, and findings also reveal that stakeholders from developing regions express heightened concerns about equal access to such technologies. These gaps underscore the urgent need for further research and inclusive innovation.

8.4.1 Technical Complexity & Real-Time Integration

Developing large-scale multi-agent solutions requires thoughtful architecture and design that continuously process live data (e.g., social cues, sensor networks, satellite feeds), include timely human interactions/feedback and adapt to dynamic environmental and complex socio-economic conditions.

8.4.2 Ethical, Environmental & Social Concerns

Survey findings reveal significant ethical apprehensions, with an average ethical concern score of 5.6 and strong correlations between accountability demands and worries about bias. High energy requirements, carbon footprints, and potential e-waste from continuous real-time processing present serious environmental challenges. Automation may lead to job displacement, underscoring the importance of proactive reskilling and social inclusion initiatives.

8.4.3 System Robustness & Continuous Oversight

Ensuring stability in unpredictable, real-world environments remains challenging. Survey data indicate that continuous human auditing and interaction is important to quickly address issues and prevent cascading failures in globally inter-connected AI Agent solutions.

8.5 Opportunities

AI Agents can help address resource limitations and get the Sustainable Development Goals (SDGs) back on course. Currently, only 17% of the targets are on track but these technologies can optimise resource allocation, hire virtual workers, and assemble a team of specialised AI Agents to work on ongoing challenges and undetermined tasks. These agents can optimise sustainable logistics for responsible consumption (SDG 12) by continuously tracking inventory in real-time and eliminating waste across supply chains. For climate action (SDG 13), AI Agents can enhance disaster preparedness through predictive analysis and can provide detailed emissions tracking, enabling precise environmental interventions and increased accountability.

In education (SDG 4), AI Agents can create personalised learning experiences that adapt to each student's needs, making quality education accessible in remote areas. These adaptive systems can identify knowledge gaps, adjust difficulty levels automatically, and deliver customised feedback to bridge digital divides (Mollick et al., 2024). To maximise these benefits, open-source frameworks, ethical design principles, and trust-building initiatives can ensure AI deployments remain transparent and equitable while accelerating sustainable impact globally.

8.5.1 Ethical Framework for Scaling Agentic AI

There is an opportunity for agentic AI to make further progress toward the SDGs on a global scale. Importantly, the solutions must operate with empathy and fairness, ensuring that benefits reach both developed and developing regions and include transparent, auditable decision processes. The following are the key focus areas that need to be considered together to support organisations implementing multi-agent solutions in progressing SDGs.

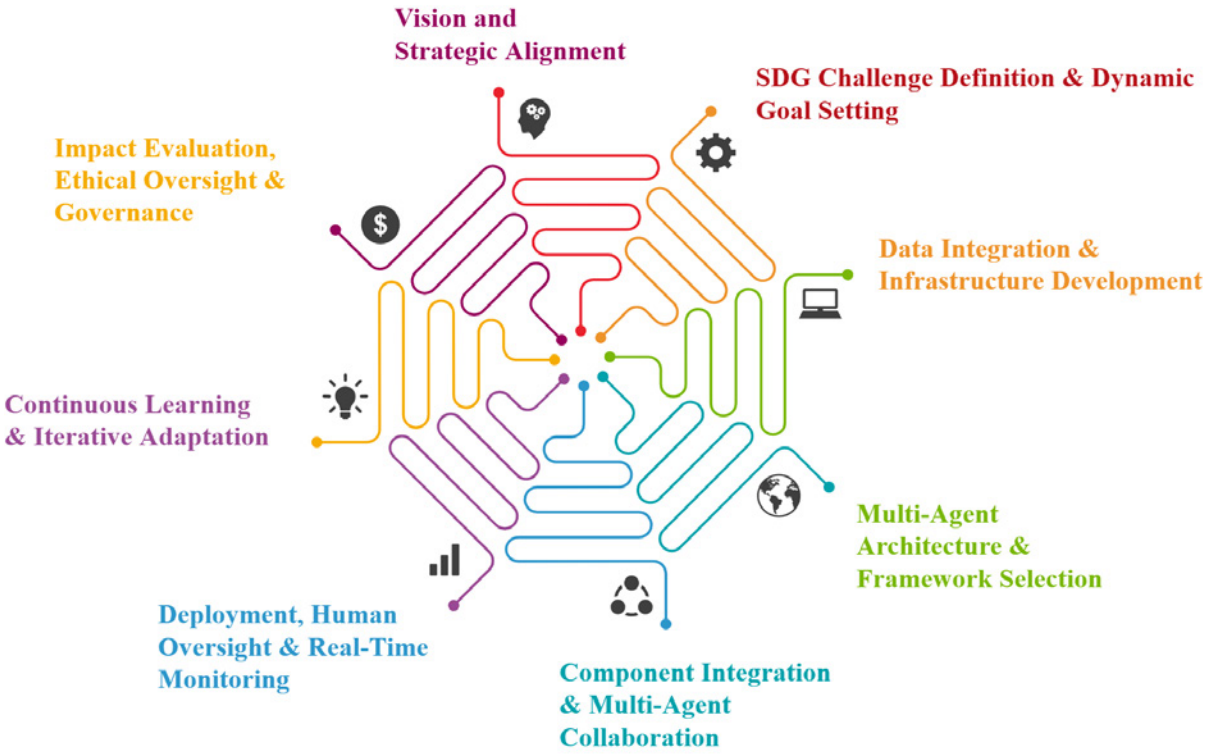


Figure 10: Key Focus Areas related to Agentic AI: Governance, Deployment & Sustainable Impact

Note. Source: Researcher

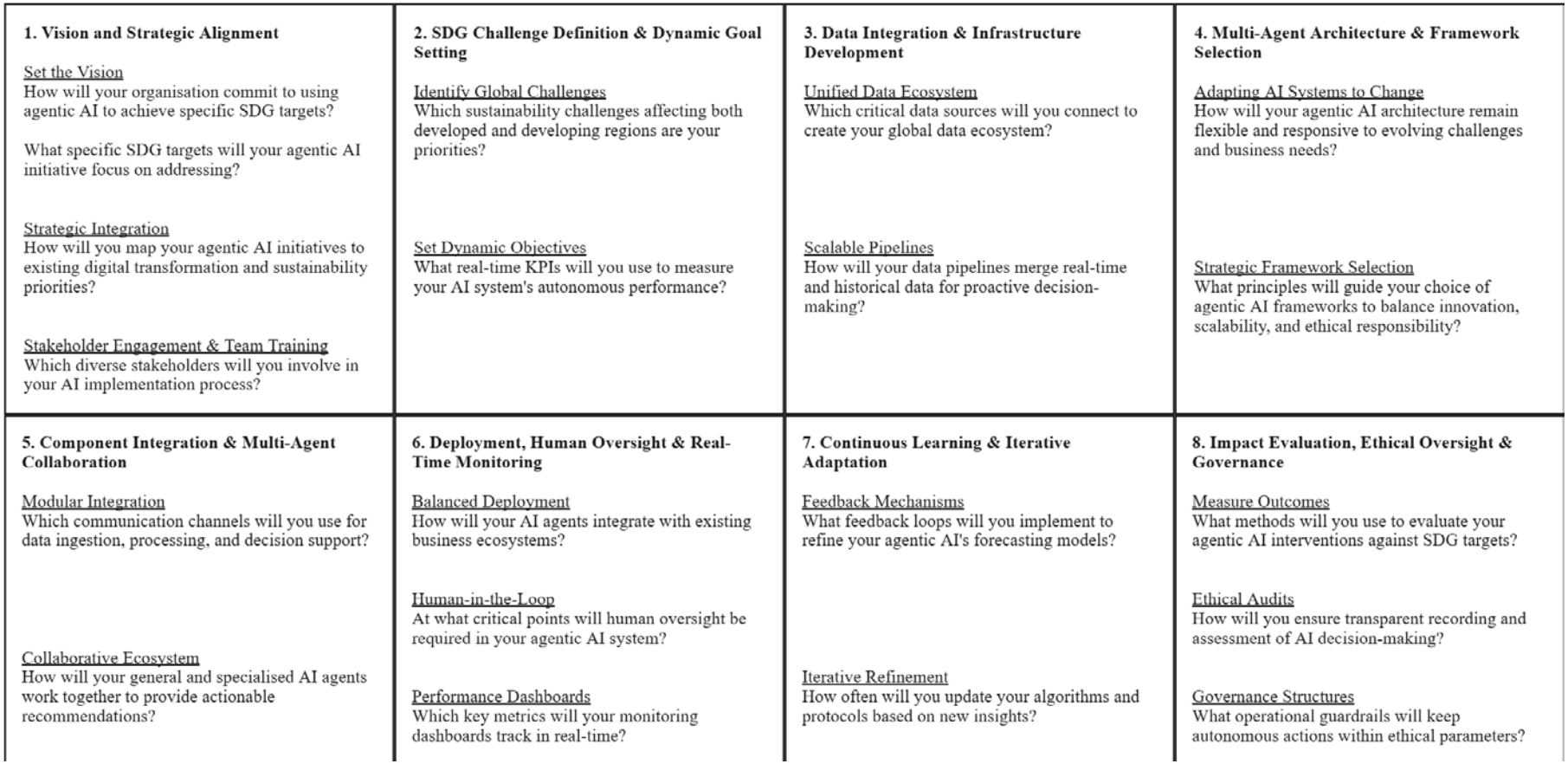
Table 4: Strategic Actions and Considerations for Agentic AI Focus Areas

Key Focus Area	Strategic Actions & Considerations
Vision and Strategic Alignment	Define a clear Multi-Agents vision for SDGs, aligning initiatives with corporate and public strategies. Engage stakeholders and provide training to ensure fair, ethical implementation.
SDG Challenge Definition & Dynamic Goal Setting	Identify global sustainability challenges and set real-time, adaptable KPIs for insights and goal-setting.
Data Integration & Infrastructure Development	Create a unified data ecosystem by integrating real-time and historical data from diverse sources. Develop scalable pipelines for continuous analysis and proactive decision-making.
Multi-Agent Architecture & Framework Selection	Design the enterprise architecture to integrate AI Agents' perception, execution, and memory while embedding ethical human-in-the-loop oversight to maintain transparency, scalability, and responsible AI governance (Peters et al., 2020).

Component Integration & Multi-Agent Collaboration	Foster collaboration among expert AI agents for scalable and resilient analysis. Understand service needs and potential AI Agent specialists which need to be approved.
Deployment, Human Oversight & Real-Time Monitoring	Deploy automated reasoning, planning and task assignment in event-driven environments with clear human involvement. Use real-time monitoring and governance dashboards to track SDG progress and ensure transparency in decision-making.
Continuous Learning & Iterative Adaptation	Establish feedback loops for AI Agents' learning and model refinement. Continuously update understandings and guardrails based on new data and evolving SDG objectives.
Impact Evaluation, Ethical Oversight & Governance	Evaluate agentic AI impact on SDG targets using quantitative and qualitative methods. Conduct ethical audits, implement governance structures, and maintain transparency in related actions. Understand which tasks must require greater visibility, control and transparency.

Note. Source: Researcher

Based on the insights gathered, this ethical framework (Figure 11) helps organizations deploy multi-agents for advancing SDG impact by aligning global challenges with varied aspects. It enables seamless data integration, adaptive architectures, and accountability. With human oversight, performance monitoring, and continuous learning, multi-agent AI-based solutions remain flexible and ethical. Impact evaluation and governance structures ensure transparency, driving responsible adoption for a sustainable and inclusive future.



1. Vision and Strategic Alignment	2. SDG Challenge Definition & Dynamic Goal Setting	3. Data Integration & Infrastructure Development	4. Multi-Agent Architecture & Framework Selection
Set the Vision How will your organisation commit to using agentic AI to achieve specific SDG targets? What specific SDG targets will your agentic AI initiative focus on addressing? Strategic Integration How will you map your agentic AI initiatives to existing digital transformation and sustainability priorities? Stakeholder Engagement & Team Training Which diverse stakeholders will you involve in your AI implementation process?	Identify Global Challenges Which sustainability challenges affecting both developed and developing regions are your priorities? Set Dynamic Objectives What real-time KPIs will you use to measure your AI system's autonomous performance?	Unified Data Ecosystem Which critical data sources will you connect to create your global data ecosystem? Scalable Pipelines How will your data pipelines merge real-time and historical data for proactive decision-making?	Adapting AI Systems to Change How will your agentic AI architecture remain flexible and responsive to evolving challenges and business needs? Strategic Framework Selection What principles will guide your choice of agentic AI frameworks to balance innovation, scalability, and ethical responsibility?
5. Component Integration & Multi-Agent Collaboration	**6. Deployment, Human Oversight & Real-Time Monitoring**	**7. Continuous Learning & Iterative Adaptation**	**8. Impact Evaluation, Ethical Oversight & Governance**
Modular Integration Which communication channels will you use for data ingestion, processing, and decision support? Collaborative Ecosystem How will your general and specialised AI agents work together to provide actionable recommendations?	Balanced Deployment How will your AI agents integrate with existing business ecosystems? Human-in-the-Loop At what critical points will human oversight be required in your agentic AI system? Performance Dashboards Which key metrics will your monitoring dashboards track in real-time?	Feedback Mechanisms What feedback loops will you implement to refine your agentic AI's forecasting models? Iterative Refinement How often will you update your algorithms and protocols based on new insights?	Measure Outcomes What methods will you use to evaluate your agentic AI interventions against SDG targets? Ethical Audits How will you ensure transparent recording and assessment of AI decision-making? Governance Structures What operational guardrails will keep autonomous actions within ethical parameters?

Figure 11: Agentic AI Ethical Framework

Note. Source: Researcher

8.6 Conclusion and Recommendations

Achieving the UN SDGs demands adaptive solutions, and agentic AI offers a scalable approach through real-time perception, reasoning, action, and learning. Survey findings show AI Agents familiarity correlates with confidence ($r = 0.65$), though concerns persist around equity, complexity, and ethics, especially in resource-limited areas.

Challenges like bias, job displacement, and performance consistency require careful mitigation, yet real-time optimization, open-source frameworks, and ethical design offer viable solutions. The proposed Agentic AI Ethical Framework provides a guideline for transparent, equitable deployment, aligning solutions design with dynamic goal-setting, real-time data integration, and human-in-the-loop governance protocols to foster public trust.

With strong oversight, inclusive data practices, and collaborative planning, AI agents can accelerate global sustainability efforts, advancing the UN's 2030 Agenda through responsible, impactful innovation.

8.6.1 Limitations of This Study

This study acknowledges several limitations. The focus on 2023–2024 research may not fully capture emerging trends in AI Agents. Sample bias could affect survey findings, as regional and professional perspectives might influence views on AI familiarity, ethics, and benefits. The rapidly evolving nature of AI technologies means the proposed Agentic AI Ethical Framework needs regular updates based on newer research. Additionally, the lack of longitudinal data limits understanding of short-term trends and the long-term effects on perceptions and implementation of AI. Future research should explore diverse cultural contexts, longitudinal effects, and evolving global standards.

8.6.2 Recommendations

To maximize the potential of AI Agents for sustainable development, adopting the Ethical Agentic AI framework is recommended, as it offers a structured method for planning and deploying these technologies. This includes establishing guidelines for fairness and accountability while engaging local communities to address specific risks. Creating inclusive data ecosystems that integrate various data sources and investing in energy-efficient technologies is important. Ensuring human-in-the-loop and related auditing in key decisions and using dashboards to monitor progress against Sustainable Development Goals (SDGs) will help maintain accountability. Enhancing education and capacity-building initiatives to improve AI literacy among policymakers and communities is important for equal benefits. More investigation is required regarding AI Agents and their relation to the SDGs, as this is a new field with significant potential. By implementing these strategies through the Ethical Agentic AI framework, organizations can effectively utilise AI Agents to advance the SDGs while promoting ethical practices.

8.7 References

Akinboyewa, T., Li, Z., Ning, H., & Lessani, M. N. (2024). *GIS Copilot: Towards an Autonomous GIS Agent for Spatial Analysis*. https://shorturl.at/bI4Ep.

Ametepey, S. O., Aigbavboa, C., Thwala, W. D., & Addy, H. (2024). The Impact of AI in Sustainable Development Goal Implementation: A Delphi Study. *Sustainability (Switzerland)* , *16*(9). https://doi.org/10.3390/su16093858

Amin, H. A., & Alanzi, T. M. (2024). Utilization of Artificial Intelligence (AI) in Healthcare Decision-Making Processes: Perceptions of Caregivers in Saudi Arabia. *Cureus*. https://doi.org/10.7759/cureus.67584

Bankhwal, M., Bisht, A., Chui, M., Roberts, R., & van Heteren, A. (2024). *AI for social good: Improving lives and protecting the planet*.

Barros, P., Yalçın, Ö. N., Tanevska, A., & Sciutti, A. (2023). Incorporating rivalry in reinforcement learning for a competitive game. *Neural Computing and Applications*, *35*(23), 16739–16752. https://doi.org/10.1007/s00521-022-07746-9

Chan, A., Ezell, C., Kaufmann, M., Wei, K., Hammond, L., Bradley, H., Bluemke, E., Rajkumar, N., Krueger, D., Kolt, N., Heim, L., & Anderljung, M. (2024). Visibility into AI Agents. *2024 ACM Conference on Fairness, Accountability, and Transparency, FAccT 2024*, 958–973. https://doi.org/10.1145/3630106.3658948

Chaudhary, G. (2023). Environmental Sustainability: Can Artificial Intelligence be an Enabler for SDGs? *Nature Environment and Pollution Technology*, *22*(3), 1411–1420. https://doi.org/10.46488/NEPT.2023.v22i03.027

Diener, F., & Špaček, M. (2021). Digital transformation in banking: A managerial perspective on barriers to change. *Sustainability (Switzerland)*, *13*(4), 1–26. https://doi.org/10.3390/su13042032

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., Duan, Y., Dwivedi, R., Edwards, J., Eirug, A., Galanos, V., Ilavarasan, P. V., Janssen, M., Jones, P., Kar, A. K.,

Kizgin, H., Kronemann, B., Lal, B., Lucini, B., … Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *57*. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Fraisl, D. (2024). *DIGITALISATION The Potential of Artificial Intelligence for the SDGs and Official Statistics*.

Gosselink, B. H., Brandt, K., Croak, M., Desalvo, K., Gomes, B., Ibrahim, L., Johnson, M., Matias, Y., Porat, R., Walker, K., & Manyika, J. (2024). *AI in Action: Accelerating Progress Towards the Sustainable Development Goals*.

Gronauer, S., & Diepold, K. (2022). Multi-agent deep reinforcement learning: a survey. *Artificial Intelligence Review*, *55*(2), 895–943. https://doi.org/10.1007/s10462-021-09996-w

Jannelli, V., Schoepf, S., Bickel, M., Netland, T., & Brintrup, A. (2024). *Agentic LLMs in the Supply Chain: Towards Autonomous Multi-Agent Consensus-Seeking*. http://arxiv.org/abs/2411.10184

Kahungi, N. W. (2023). *Culpability in the Era of Artificial Intelligence in Kenya: An Overview*. https://course.elementsofai.com/1/1

Kim, S., Moon, S., Tabrizi, R., Lee, N., Mahoney, M. W., Keutzer, K., & Gholami, A. (2024). *An LLM Compiler for Parallel Function Calling*. https://github.com/SqueezeAILab/LLMCompiler.

Klieger, B., Charitsis, C., Suzara, M., Wang, S., Haber, N., & Mitchell, J. C. (2024). *ChatCollab:*

Exploring Collaboration Between Humans and AI Agents in Software Teams. http://arxiv.org/abs/2412.01992

Lawless, W. (2024). Bidirectional Human-AI/Machine Collaborative and Autonomous Teams: Risk, Trust and Safety. *Human Factors in Robots, Drones and Unmanned Systems*, *138*. https://doi.org/10.54941/ahfe1005014

Malmio, I. (2024). Artificial intelligence and the social dimension of sustainable development: through a security perspective. In *Discover Sustainability* (Vol. 5, Issue 1). Springer Nature. https://doi.org/10.1007/s43621-024-00677-6

Masterman, T., Besen, S., Sawtell, M., & Chao, A. (2024). *The Landscape of Emerging AI Agent Architectures for Reasoning, Planning, and Tool Calling: A Survey*. http://arxiv.org/abs/2404.11584

Mollick, E., Mollick, L., Bach, N., Ciccarelli, L., Przystanski, B., & Ravipinto Generative Lab at Wharton, D. A. (2024). *AI AGENTS AND EDUCATION: SIMULATED PRACTICE AT SCALE*.

Morandín-Ahuerma, F. (2023). *Twenty-three Asilomar principles for Artificial Intelligence and the Future of Life*. Open Science Framework. https://doi.org/10.31219/osf.io/dgnq8

Peters, D., Vold, K., Robinson, D., & Calvo, R. A. (2020). Responsible AI—Two Frameworks for Ethical Design Practice. *IEEE Transactions on Technology and Society*, *1*(1), 34–47. https://doi.org/10.1109/tts.2020.2974991

Rajesh, V., & Adapa, K. (2024). AI for Climate Action: Leveraging Artificial Intelligence to Address Climate Change Challenges. In *IJFMR240529015* (Vol. 6, Issue 5). www.ijfmr.com

Rana, S. M., & Shuford, J. (2024). *AI in Healthcare: Transforming Patient Care through Predictive Analytics and Decision Support Systems*. https://ojs.boulibrary.com/index.php/JAIGS

Ruan, J., Chen, Y., Zhang, B., Xu, Z., Bao, T., Du, G., Shi, S., Mao, H., Li, Z., Zeng, X., Zhao, R., & Research, S. (2023). *TPTU: Task Planning and Tool Usage of Large Language Model-based AI Agents*. https://github.com/Significant-Gravitas/Auto-GPT

Sandini, G., Sciutti, A., & Morasso, P. (2024). Artificial cognition vs. artificial intelligence for next-generation autonomous robotic agents. *Frontiers in Computational Neuroscience*, *18*. https://doi.org/10.3389/fncom.2024.1349408

Sastry, G., Heim, L., Belfield, H., Anderljung, M., Brundage, M., Hazell, J., O'Keefe, C., Hadfield, G. K., Ngo, R., Pilz, K., Gor, G., Bluemke, E., Shoker, S., Egan, J., Trager, R. F., Avin, S., Weller, A., Bengio, Y., & Coyle, D. (2024). *Computing Power and the Governance of Artificial Intelligence*. http://arxiv.org/abs/2402.08797

Savec, V., & Jedrinović, S. (2024). The Role of AI Implementation in Higher Education in Achieving the Sustainable Development Goals: A Case Study from Slovenia. *Sustainability (Switzerland)*, *17*(1). https://doi.org/10.3390/su17010183

Sekiguchi, K., & Ohsawa, Y. (2024). Aiding narrative generation in collaborative data utilization by humans and AI agents. *AI and Society*. https://doi.org/10.1007/s00146-024-02156-y

Tulcanaza-Prieto, A. B., Cortez-Ordoñez, A., & Lee, C. W. (2023). Influence of Customer Perception Factors on AI-Enabled Customer Experience in the Ecuadorian Banking Environment. *Sustainability (Switzerland)*, *15*(16). https://doi.org/10.3390/su151612441

Ueda, D., Walston, S. L., Fujita, S., Fushimi, Y., Tsuboyama, T., Kamagata, K., Yamada, A., Yanagawa, M., Ito, R., Fujima, N., Kawamura, M., Nakaura, T., Matsui, Y., Tatsugami, F., Fujioka, T., Nozaki, T., Hirata, K., & Naganawa, S. (2024). Climate change and artificial intelligence in healthcare: Review and recommendations towards a sustainable future. In *Diagnostic and Interventional Imaging*. Elsevier Masson s.r.l. https://doi.org/10.1016/j.

diii.2024.06.002
United Nations. (2024). *The Sustainable Development Goals Report*.
Wang, L., Xu, W., Lan, Y., Hu, Z., Lan, Y., Lee, R. K.-W., & Lim, E.-P. (2023). *Plan-and-Solve Prompting: Improving Zero-Shot Chain-of-Thought Reasoning by Large Language Models*. http://arxiv.org/abs/2305.04091
Xu, B., Peng, Z., Lei, B., Mukherjee, S., Liu, Y., & Xu, D. (2023). *ReWOO: Decoupling Reasoning from Observations for Efficient Augmented Language Models*. http://arxiv.org/abs/2305.18323
Youn, S. Y., & Luan, C. C. (2024). Soft Biometrics in Retail Service: Understanding Privacy Paradox and Cross-Cultural Differences Regarding 3D Body Scanning Technology. *Clothing and Textiles Research Journal*, *42*(3), 222–241. https://doi.org/10.1177/0887302X231220616
Zhao, J., & Gómez Fariñas, B. (2023). Artificial Intelligence and Sustainable Decisions. *European Business Organization Law Review*, *24*(1), 1–39. https://doi.org/10.1007/s40804-022-00262-2
Zhou, W., Jiang, Y. E., Li, L., Wu, J., Wang, T., Qiu, S., Zhang, J., Chen, J., Wu, R., Wang, S., Zhu, S., Chen, J., Zhang, W., Tang, X., Zhang, N., Chen, H., Cui, P., & Sachan, M. (2023). *Agents: An Open-source Framework for Autonomous Language Agents*. http://arxiv.org/abs/2309.07870
Ziemba, E. W., Duong, C. D., Ejdys, J., Gonzalez-Perez, M. A., Kazlauskaitė, R., Korzynski, P., Mazurek, G., Paliszkiewicz, J., Stankevičienė, J., & Wach, K. (2024). Leveraging artificial intelligence to meet the sustainable development goals. *Journal of Economics and Management*, *46*, 508–583. https://doi.org/10.22367/jem.2024.46.19

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Chapter 9 - Human-AI Collaboration for Inclusive Growth and Sustainable Development

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Chapter Information

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Abstract

AI is a transformative technology that, when paired with human intelligence, can serve as the foundation of inclusive economic prosperity and sustainable development, rather than just an automation tool. As such, human-AI collaboration is essential for designing responsible AI systems, maximizing resource efficiency, and guaranteeing access to AI-powered opportunities. AI-human synergy will improve innovation, better decision-making and a more sustainable and inclusive economy. We explore the role of AI in achieving the United Nations Sustainable Development Goals (SDGs), using case studies from smart cities, precision agriculture, green supply chains, AI-enabled financial inclusion and workforce augmentation. The conversation emphasizes the need for regulation, outlines ethical dilemmas and discusses the environmental consequences of AI systems. It also examines how AI could be deployed responsibly to meet global challenges, lessen inequalities and augment not replace humans workers. The chapter closes with policy recommendations and a road map by which AI can inform a transition to sustainable business and economic models, as well as to ensure that benefits of AI are equitably shared across industries and communities.

Keywords: *artificial intelligence, human resource, sustainability;*

9.1 Introduction

Artificial Intelligence (AI) is emerging as one of the most revolutionary technologies in the 21st century, with a profound impact on almost every industry and facet of human life. Generative AI is reshaping the economic landscape, driving innovations and improvements in productivity, unlocking new businesses and economic models.

AI offers a wide range of capabilities, from automation and predictive analytics to advanced decision-making and natural language processing, with implications for a spectrum of fields from healthcare and finance to transportation and education. But AI's implementation into societies and economies is not without challenges. Despite the great strides AI has made, the adoption of its tech raises fundamental uncertainties about employment, ethical factors, privacy matters, and the digital divide, forcing for a more organized framework to manage the balance between technological advancement and human well-being.

A COVID-19 article from MIT from July 2020 argued that shifts to homeworking could help to understand the future of globalization, and its implications for income inequality. AI-powered automation may take over in repeating tasks, but it opens doors for innovation, job evolution, and new sectors.

Workplace collaboration specifically between humans and AI is being recognised more and more as a way to optimize AI potential, ensuring that technology enhances rather than detracts from human capabilities.

The future of work will necessitate a collaboration between AI and human intellect, creating a framework in which AI enhances decision-making, streamlines monotony, and empowers humans to delve into strategic, innovative, and relational responsibilities.

Governments, enterprises and the academia are consistently pouring money into AI based research, and AI related development and policy frameworks to harness the best AI technology can deliver while minimizing risks. Numerous countries established AI strategies in order to safeguard inclusive economic growth and sustainable development. From AI-enabled governance and policy-making to environmental monitoring and resource utilization, the growing diversity of AI applications stresses both promise and pitfalls in its implementation.

AI can process vast amounts of data and deliver actionable insights, making it a highly effective tool for stimulating economic prosperity, enhancing public service efficiency, and addressing complex socio-economic challenges.

9.2 Heading Towards Inclusive Growth with Human-AI Collaboration

✓ Human-AI collaboration will be necessary to ensure that AI adoption leads to equitable economic growth.

✓ AI will not create a world where humans are irrelevant; it will enhance human strengths, drive productivity and create layers of opportunity.

✓ A well-managed AI ecosystem creates jobs in emerging technologies, replicative jobs, it also drives economic inclusivity by integrating AI into various sectors of the workforce.

The only other differentiators while collaborating with humans are:

1. **Increased Efficiency:** By working together with humans, AI can offer redundant work to automate and share the load, enabling more time-efficient and high-level analytical work.

2. **Job Creation and Skill Development:** Automation will eliminate some tasks, but it is also leading to an increase in hiring in many areas like AI professionals, data science, AI ethics, and so on.

3. This means that governments and businesses **must invest in upskilling and reskilling** programs to equip workers for the new job market.

4. **Enhanced Decision Making:** AI-powered analytics provide insights that enhance decision making process in business, healthcare, governance, and finance industry.

5. **Innovation & market expansion:** From AI-led entrepreneurship, new industries such as AI-assisted healthcare, fintech and smart manufacturing will begin to grow, opening up more economic opportunities for companies and people.

To leverage AI for inclusive growth, all stakeholders must prioritize AI literacy, workforce development, and ethical deployment.

Governments should enact and enforce policies that establish a framework for the responsible use of AI, with the end goal being to ensure that AI remains an asset that empowers, not one that excludes.

9.3 How can AI address sustainability challenges and support the UN Sustainable Development Goals (SDGs)?

From predicting tomorrow to reallocating resources or analyzing massive datasets, the power of AI has proven its worth across industries ranging from energy to disaster management.

AI can be utilized for sustainability due to the following reasons:

Artificial Intelligence (AI), when harnessed responsibly in collaboration with human expertise, has the potential to revolutionize industries, making them more sustainable, efficient, and equitable. By integrating AI into various sectors, we can drive transformative change while ensuring environmental stewardship.

A. **Energy: Advancing Renewable Solutions**

AI-driven smart grids and predictive analytics are optimizing renewable energy use by improving energy storage, forecasting supply and demand, and reducing transmission losses. Human intervention ensures ethical decision-making in energy distribution and policies, fostering global access to clean power.

B. **Climate Action: Strengthening Environmental Monitoring**

AI-powered climate modeling, satellite imaging, and carbon tracking systems allow for real-time monitoring of deforestation, biodiversity loss, and pollution. Scientists, policymakers, and environmentalists use these insights to develop proactive climate strategies, ensuring that data-driven decisions align with long-term sustainability goals.

C. Agriculture and Food Security: Sustainable Farming and Supply Chains

AI is revolutionizing precision agriculture, using real-time weather predictions, soil analysis, and automated irrigation systems to maximize yield with minimal resource use. Additionally, AI-driven supply chain optimization reduces food waste, improves distribution networks, and ensures equitable access to food. Farmers and agribusinesses, in collaboration with AI, can work towards a climate-resilient agricultural system.

D. Urban Development: Creating Smarter, Greener Cities

AI-powered solutions in urban planning enhance traffic flow optimization, waste management automation, and energy-efficient infrastructure. By working alongside urban developers and governments, AI facilitates the creation of inclusive and climate-friendly smart cities where sustainability and quality of life go hand in hand.

E. Manufacturing: Driving the Circular Economy

AI is accelerating the circular economy by reducing industrial waste, optimizing resource utilization, and supporting smart manufacturing processes. Predictive maintenance, AI-driven material recycling, and supply chain transparency contribute to reducing carbon footprints while improving operational efficiency.

F. Healthcare: Sustainable Health Solutions

AI enhances medical diagnostics, drug discovery, and remote healthcare solutions, reducing the need for physical infrastructure and extensive energy use. It also plays a crucial role in pandemic response planning and disease prevention, ensuring that healthcare is both accessible and environmentally sustainable.

G. Transportation and Mobility: Greener Travel

AI-powered autonomous vehicles, route optimization, and public transport improvements reduce fuel consumption and emissions. Human-AI collaboration in designing electric vehicle (EV) charging networks, smart logistics, and eco-friendly transportation systems is paving the way for a low-carbon mobility future.

H. Water Conservation and Ocean Sustainability

AI-driven water management systems help monitor leaks, reduce wastage, and ensure equitable distribution of clean water. In marine ecosystems, AI-powered ocean monitoring drones track pollution, illegal fishing, and coral reef health, supporting conservationists in their efforts to protect global water resources.

I. Financial Services: Sustainable Investments and Green Financing

AI-driven ESG (Environmental, Social, and Governance) analytics empower investors to make responsible decisions, funding sustainable businesses and green initiatives.

AI also supports carbon footprint tracking in banking, ensuring financial growth aligns with environmental responsibility.

J. Education and Workforce Development: Upskilling for Sustainability

AI-driven personalized learning platforms provide access to sustainability education, equipping individuals with the skills needed for a green economy. By fostering AI-human partnerships in training and workforce development, industries can transition towards sustainable business models that benefit both people and the planet.

9.4 Context: Local-Level (UAE) and Global-Level AI Adoption

The UAE is a leading global player when it comes to AI adoption, as can be seen by the keen efforts to include AI into much of the economy and governance. The UAE AI Strategy 2031 — the framework for AI use in the UAE — aims to position the UAE as a leader in AI-powered progression in areas such as healthcare, energy, education and smart cities.

Some focus areas are:

• Smart Dubai Initiative: AI will boost public service such as AI will help to automate government services,
• AI-based urban planning, thus augmenting the effectiveness and citizen engagement.
• AI for optimizing Energy in a blended approach with simulation model — DEWA | Dubai Electricity and Water Authority.
• AI in Healthcare: Using AI for predictive diagnostics and telemedicine, the Ministry of Health and Prevention (MOHAP) works to better connect healthcare access and patient needs.
• AI adoption is being accelerated around the world, across industries. Many countries including America, China and Germany have AI development framework which nurtures new innovations, while keeping in mind the legal and ethical concerns. Multiple cases from around the world exemplify how AI contributes to better governance, increased financial inclusion, and deeper industrial automation.

For example:

• **AI-driven Tesla AItomas Transportation:** AI-powered self-driving automobiles are revolutionizing travel, making it safer while minimizing our carbon footprint
• **IBM Watson for Health:** Providing AI-driven diagnostic and personalized treatment recommendations, IBM improves patient experience and global healthcare provisioning.
The Solution: Integrated, Ethical, and Inclusive AI

A human-centered approach to AI deployment is needed to ensure that AI contributes to inclusion and sustainable development. This requires the collaboration of policymakers, industry, and research institutions to develop ethical standards, regulatory policies, and the governance of AI.

The actionable steps to influence responsible AI adoption are:

1. Establishing AI Ethics Guidelines: The principles of AI systems must be transparency, fairness, and accountability.
2. Regulating the Impact of AI on Employment: Policies need to protect workers from displacement by AI,"
3. Increasing AI Literacy and Education: AI aspects should be made part of the national curricula to prepare future generations for the AI economy.

9.4.1 Research Problem

The AI revolution around the world comes with a paradox:

While AI can power inclusive economic growth, uncontrolled and unregulated implementation can deepen disparities for the following reasons:

1. One of the factors to be addressed is that if AI and the automation of intelligent labor will threaten you or people working in the industry as a whole
2. On the other hand, this also creates an AI-driven skills gap in many industries where employees are unable to transition into the new digital economy and the skills they require, a scenario that will potentially cause job losses and economic disparity
3. Automation's adverse effects are disproportionately felt by low-skilled workers, exacerbating the socio-economic divide and necessitating policy interventions and workforce reskilling initiatives to create an inclusive AI-enabled future.
4. Another aspect of AI deployment is that it doesn't just focus on changing the workforce. Ethical concerns—such as data privacy, algorithmic bias, transparency, and accountability—remain major challenges. These issues have yet to be fully resolved.
5. Although AI has made extraordinary results in areas like medical diagnostics, accounting, and the administration of governments, the use of AI in key areas of our lives without human oversight is likely to cause social biases and lead to discriminatory results.
6. Ensuring that AI systems are developed and used with consideration to these concerns necessitates appropriate legislation, cross-sector teamwork, and the incorporation of ethical AI values in the design and usage of AI systems.
7. Additionally, the environmental cost of AI represents a major area for inquiry. AI's acceleration can't come without energy considerations: both by building more energy-efficient AI systems, and as part of environmental efforts that AI can contribute to. Research needs to be continuously directed towards finding ways for AI to make energy consumption more efficient and reduce wastage, potentially aiding in the fight against climate change.
8. In addition to these challenges, the role of AI in closing global development gaps is also a concern. While AI has the power to drive access to learning, health care and financial services for underserved communities, its rollout invariably favors advanced economies that have the needed resources.
9. There is an urgent business to tackle how AI can also become deployed and used in the emerging markets, so that innovation in AI does not further widen the digital and economic gaps between people in the Industrialized world and the Emerging Markets, but rather forms an equitable part of the digital economy.

Against the backdrop of these struggles, this research will examine how AI systems and business models can promote inclusive growth, reduce socio-economic inequality, and how to ensure AI-driven innovation does not undermine long-term sustainability goals. The research will further analyze the regulatory and governance frameworks needed to respond to AI's ethical dilemmas and its environmental consequences.

9.4.2 Research Objectives

This research aims to:

 Increase AI Role in Economic Expansion: Look into ways AI improves Productivity, Business Innovation and Job Pavement Across Industries The research will assess the impact of AI on sectors and evaluate the extent that AI-enabled advancements contribute towards a more economically inclusive society.

 It will also examine the potential of AI to augment human capabilities, enable hybrid work and redefine the nature of work itself.

 Discover AI's Synergy with United Nations Sustainable Development Goals (SDGs): Evaluate AI solutions mapping to SDGs, including poverty alleviation, education and health access improvement, and development of clean energy solutions.

 Navigate the Ethical and Regulatory Landscape: Confront the ethical implications of AI implementation, such as algorithmic biases, data privacy issues, and the need for governance structures that promote equality and transparency. The research will evaluate the state of current AI regulations and elicit recommendations on how to adopt AI in an ethical manner.

 Research Environmental Impact and Sustainability Value in AI: Identify how AI can be utilized to reduce environmental degradation, to optimize energy use, and help with climate change solutions. It will also specifically research the tools provided by artificial intelligence (AI) that can determine how businesses manage their resources moving forward, as well as their carbon footprint, their ability to maneuver and take risks while preserving resilience and sustainability.

 To examine the impact of AI on economies and societies, how people and AI can work together to create a future that seeks to be inclusive, sustainable, and ethically driven through technological advancement. This research will ultimately contribute to a roadmap for sustainable AI deployment that is informed by its economic, ethical, and environmental implications, ensuring that technological advancements are in line with human-centered values.

9.5 Literature Review: Review of Results and Gaps in Research

AI has been the focus of considerable academic interest on topics such as economic growth, the changing nature of work and sustainable development. The existing literature emphasizes the transformative potential of AI across sectors but also highlights major challenges related to implementation, ethics and inclusivity. In this section, we summarize the relevant literature on AI's impact on economic growth, its use in sustainability efforts, and the open gaps.

9.5.1 The Current State of Research on AI and Economic Growth

There has been a lot of studies on how AI adds to productivity, efficiency, and economic growth.

 AI is estimated to add $15.7 trillion to the global economy by 2030, according to PwC (2023), mainly driven by automation, better decision making, and new AI based business models.

 AI has already made impact into sectors like financial services, manufacturing, and healthcare, where data-driven insights can help optimize operations and improve customer experiences.

 But the studies also cautioned against the risks of adopting A.I., especially potential disruptions in the labor market.

 As much as AI opens up career avenues like AI Specialists and Automation Engineers, it eliminates traditional jobs as well. According to World Economic Forum (2023),35% of jobs worldwide will be displaced by AI-driven automation by 2025, yet AI will create new roles requiring advanced digital skills. This underscores the importance of reskilling programs to help ensure workers are relevant in AI-enhanced environments.

9.5.2 Artificial Intelligence for Sustainability and the UN Sustainable Development Goals (SDGs)

The role of AI in promoting UN SDGs has already been well documented, especially in domains like climate action, energy access and health. AI-enabled models are already helping optimize renewable energy grids, spot environmental hazards and improve food security through precision agriculture. While AI has shown potential in these areas, research has also indicated that areas such as the carbon footprint of AI; ethical governance of AI; and digital divides require further exploration.

9.5.3 Case Studies from the UAE

A. AI for Smart Sustainable Cities – Masdar City, Abu Dhabi

Collaboration between AI & Urban Planners

Masdar City, a global leader in sustainable urban development, integrates AI to enhance energy efficiency, water conservation, and mobility solutions. AI-powered building management systems regulate energy use, while autonomous eco-friendly transport solutions improve connectivity. AI-driven environmental analytics help policymakers make data-backed sustainability decisions.

Key Impact:
- 40%reduction in water consumption through AI-driven monitoring
- AI-powered smart grids optimize renewable energy consumption

B.AI-Powered Sustainable Agriculture – UAE's AgTech Innovations

Collaboration between AI & Farmers

The UAE, known for its arid climate, is pioneering AI-powered vertical farming and hydroponics to ensure food security. Companies like Pure Harvest Smart Farms and Badia Farms use AI-based climate control systems to optimize crop production, reducing water usage by up to 90% compared to traditional farming.

Key Impact:
- AI reduces water wastage while enhancing crop yields
- Supports UAE's food security goals and desert agriculture

C. AI & Financial Inclusion – UAE's FinTech Revolution

Collaboration between AI & Financial Institutions

AI-driven FinTech solutions in the UAE, such as Emirates NBD's AI-powered chatbots and AI-backed credit scoring systems, enable financial inclusion for small businesses and underserved populations. AI helps assess creditworthiness beyond traditional banking data, providing microloans and financial services to more people.

Key Impact:
- AI expands access to financial services for SMEs and entrepreneurs
- Promotes inclusive economic participation and sustainable growth

9.5.4 Global AI Success Stories

A. AI for Disaster Resilience – Japan's Early Warning Systems

Collaboration between AI & Disaster Response Teams

Japan's AI-powered earthquake prediction system, developed in partnership with tech companies and seismologists, analyzes real-time seismic data to provide early warnings, allowing communities to evacuate before disasters strike. AI-driven flood and tsunami forecasting models also enhance preparedness and minimize losses.

Key Impact:
- AI-driven alerts reduce disaster fatalities
- Supports climate adaptation and urban resilience

B. AI in Inclusive Healthcare – India's Apollo Hospitals & Microsoft

Collaboration between AI & Medical Professionals

Apollo Hospitals, in partnership with Microsoft AI, developed an AI-driven cardiac risk assessment tool to predict heart disease risks among underserved communities. The AI model, trained on diverse patient datasets, provides personalized recommendations, enabling early intervention and equitable healthcare access.

Key Impact:
- AI reduces diagnostic disparities for rural populations
- Enhances early disease detection and treatment

C.AI for Sustainable Supply Chains – Unilever & AI-Powered Waste Reduction

Collaboration between AI & Supply Chain Managers

Unilever deploys AI to optimize manufacturing, logistics, and material usage, reducing waste across its supply chain. AI-powered demand forecasting prevents overproduction, and machine learning algorithms optimize packaging materials, cutting plastic use.

Key Impact:
- AI reduces supply chain waste by 15%
- Supports circular economy and eco-friendly manufacturing

D.AI for Clean Water Access – IBM & The Water Project in Africa

Collaboration between AI & Humanitarian Organizations

IBM's AI-driven Water Management System is used in sub-Saharan Africa to monitor water quality and detect contamination in real-time. AI analyzes satellite data and IoT sensor inputs to identify clean water sources, helping NGOs and governments deploy resources efficiently.

Key Impact:
- AI improves water access for vulnerable communities
- Enhances public health and reduces waterborne diseases

E. AI & Inclusive Education – UNESCO & Adaptive Learning Technologies

Collaboration between AI & Educators

AI-powered adaptive learning platforms are being deployed in low-income communities to personalize education based on student needs. UNESCO's partnership with EdTech companies uses AI to provide multilingual, accessible, and skill-based learning, bridging the global digital education gap.

Key Impact:
- AI expands education access for marginalized students
- Supports lifelong learning and workforce development

F. AI for Marine Conservation – OceanMind's AI & Illegal Fishing Detection

Collaboration between AI & Marine Biologists

OceanMind, a nonprofit organization, uses AI-powered satellite imaging and machine learning to detect illegal fishing activities. By analyzing ship movements and oceanographic data, the AI system helps governments enforce sustainable fishing policies, protecting marine biodiversity.

Key Impact:
- AI reduces industrial carbon emissions
- Supports net-zero climate goals

G. AI for Carbon Capture – Carbon Clean's AI-Enhanced CO2 Reduction

Collaboration between AI & Environmental Scientists

Carbon Clean Solutions, a UK-based company, integrates AI into its carbon capture technology, improving efficiency in removing CO2 from industrial emissions. AI optimizes the capture process, reducing energy costs.

Key Impact:
-AI reduces industrial carbon emissions
-Supports net-zero climate goals

9.5.5 Identified Knowledge Gaps

While there has been extensive research on the contribution of AI to both economic and sustainability gains, this has left several key knowledge gaps unaddressed. Closing these gaps is critical to ensure AI's longer-term benefits surrounding equitable distribution are realized across societies and industries.

Effect of AI on Low-Skilled Labor Markets

In high-tech industries, the consequences of AI adoption have seen extensive treatment, while its implications for low-skilled workers, especially in developing economies, are still under-researched.

AI-powered automation is set to replace countless conventional jobs in the manufacturing, agricultural, and service sectors. Despite this, we lack comprehensive studies evaluating the specific effects on these workers, such as displacement rates, wage consequences, and reskilling prospects.

Implications for Future Research:

1. How can we use AI to create opportunities for low-skilled workers?
2. How can governments and industries retrain displaced workers in AI driven economies?
3. How can emerging economies access AI without adding to unemployment and wage inequality?

AI and Regulatory Frameworks

One of the biggest challenges is the lack of standardized frameworks for global AI governance. Though a few, like the UAE and the EU, have ushered in ethical AI policies, the vast majority of regions lack cohesive regulatory frameworks that guarantee a responsible implementation of AI. Without harmonious AI laws across different jurisdictions, regulatory

fragmentation, ethical inconsistencies, and difficulties in enforcement may arise.

Future Research Implications:

1. What constitutes the best practice for global AI governance, and how can it be harmonized across economies?
2. How can we create regulatory framework enabling ethical AI without restricting innovation?
3. What role can international organizations play in AI governance to facilitate accountability and fairness?
4. How might AI systems be designed to function in a low-energy mode?
5. What novel strategies will be able to decrease the carbon footprint of AI, while retaining computational efficiency?
6. What role AI can play in making sustainability efforts without introducing unnecessary environmental harm?

Moving Toward AI-Enabled Financial Inclusion

In emerging markets, unmet financial needs could be met through AI-driven solutions. That being said, AI-based credit reporting and automated lending platforms can also contribute to new risks, such as data privacy issues and algorithmic biases. There is also a need of further empirical studies on the effectiveness of AI to increase financial inclusion, especially in regions that are remote or have poor digital infrastructure.

Considerations for Future Research:

1. How could AI-driven financial tools be modified to make them more accessible to the underprivileged while safeguarding data privacy and equity?
2. What regulatory safeguards can prevent bias in AI-powered financial services?
3. What potential do AI-driven microfinance models have, and how can they be scaled to promote sustainable economic development in low-income areas?

AI for decision-making in the Public Sector

AI is being deployed across governance, healthcare, and law enforcement to supplement decision-making processes. Nevertheless, concerns over transparency, accountability, and biases in AI deployments in the public sector persist. The poor explainability of many AI models makes it impossible to determine if AI decisions are fair and free from unintended bias.

Research Implications in Future:

1. How do you ensure transparency and accountability in the implementation of AI in governance and public administration?
2. How to build public trust in the decision-making of new AI-based systems?
3. How to ensure AI is developed according to the principles of ethical governance and Human Rights?

9.6 Conclusion

The implementation of AI needs to be done responsibly and equitably. Although the UAE and international organizations such as the World Bank, the OECD conduct such studies, the knowledge gaps on how AI affects labor markets, regulatory frameworks, environmental sustainability, financial inclusion and governance continue to be major causes for concern.

To realize the full potential of AI, future research needs to be directed to:

- Building inclusive AI policies to safeguard vulnerable workers and guarantee equitable economic engagement.
- Developing environmentally responsible AI approaches to reduce energy consumption and climate consequences.
- Building holistic global governance structures to help enable responsible AI use and minimize regulatory fragmentation.
- Widening the use of AI-led financial inclusion approaches to uplift underprivileged groups with careful transparency and fairness.
- Improving the functions of governance, policies and decisions through AI, transparent and accountable practices.

Filling these gaps will be critical to ensuring AI continues to serve as a force for good, for the benefit of all sectors of society and the broader global community, ultimately delivering a more inclusive and sustainable future.

9.7 References

Bencsik, A., Horváth, C., & Juhász, T. (2016). Y and Z generations at workplaces. *Journal of Competitiveness, 8*(3), 90–106.

Amazon. (2023). *AI upskilling program: Investing in the workforce of the future.* Retrieved from https://www.amazon.com

Brynjolfsson, E., & McAfee, A. (2017). *Machine, platform, crowd: Harnessing our digital future.* W.W. Norton & Company. European Union. (2023). *The AI Act: Regulating artificial intelligence for ethical deployment.* Retrieved from https://europa.eu

IBM. (2023). *AI-driven water management solutions in Africa.* Retrieved from https://www.ibm.com

McKinsey & Company. (2023). *The state of AI in 2023: Generative AI's breakout year.* Retrieved from https://www.mckinsey.com

PwC. (2023). *AI's global economic impact: The $15.7 trillion opportunity.* Retrieved from https://www.pwc.com

Russell, S., & Norvig, P. (2020). *Artificial intelligence: A modern approach* (4th ed.). Pearson.

United Nations. (2022). *AI for Sustainable Development Goals (SDGs): Harnessing technology for global progress.* Retrieved from https://www.un.org

World Economic Forum. (2023). *The future of jobs report 2023: AI and workforce evolution.* Retrieved from https://www.weforum.org

Zuboff, S. (2019). *The age of surveillance capitalism: The fight for a human future at the new frontier of power.* PublicAffairs.

Brynjolfsson, E., & McAfee, A. (2017). *Machine, platform, crowd: Harnessing our digital future.* W. W. Norton & Company.

Bughin, J., Hazan, E., Ramaswamy, S., Chui, M., Allas, T., Dahlström, P., Henke, N., & Trench, M. (2018). *Notes from the AI frontier: Modeling the impact of AI on the world economy.* McKinsey Global Institute. Retrieved from https://www.mckinsey.com

Crawford, K., & Calo, R. (2016). *There is a blind spot in AI research. Nature, 538*(7625), 311–313. https://doi.org/10.1038/538311a

Dignum, V. (2019). *Responsible artificial intelligence: Designing AI for human values. IT Professional, 21*(6), 16–21. https://doi.org/10.1109/MITP.2019.2965871

Floridi, L., & Cowls, J. (2019). *A unified framework of five principles for AI in society.* In *Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society* (pp. 1–7). https://doi.org/10.1145/3306618.3314234

United Nations. (2021). *The age of digital interdependence: Report of the UN Secretary-General's High-level Panel on Digital Cooperation.* United Nations. https://www.un.org/en/digital-cooperation-panel

World Economic Forum. (2020). *Unlocking technology for the global goals.* World Economic Forum. https://www.weforum.org

Organization for Economic Co-operation and Development. (2021). *AI and the future of skills: AI's role in workforce transformation.* OECD Publishing. https://doi.org/10.1787/ae4dcec1-en

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Chapter 10 - Leading in the Age of Artificial Intelligence: Empowering Gen Z in a data driven world Enabling the Next Generation to Build Sustainable Success in Business and Beyond

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Abstract

Artificial intelligence (AI) has foreseen mind-boggling developments along with digital transformation. New business patterns emerge, establishing a ground for leadership, both an opportunity and a challenge in this age of dramatic insecurity caused by technology. To leverage their digital fluency and commitment to honor integrity, they are also incorporating the ideas of sustainability that have been engraved by living in a boundless virtual world where things are ever-changing as rapidly as electricity goes off and on. To what extent can Generation Z navigate these changes? What kind of impact will their accomplishment have on organizational success, including how much of that influence extends to different levels of respect and authority one has? Indeed, on the one hand, was the degrading resolve by many young Generation Z shift toward transparent working processes, along with an unassuming manner, the absence of red carpeting to enter an executive's office or double-doored conference room in the array rather than lines and so forth seems to change. However, its potential and outlook far surpass previous generations that reprioritize the working environment as a cooperative community. Numerous industries are struggling long-term because they are slow to embrace new leadership models such as those of Generation Z. This eventually leads to conflict between traditional management ways and what young people look forward to as a way of life. Ethical AI governance, digital literacy, and sustainability have emerged as critical areas where Gen Z leaders can impact. However, the current leadership development systems leave them without essential skills or opportunities to pursue these fields. In light of the increasing influence that Generation Z leadership is playing in shaping future work trends, this chapter

looks into the problems and opportunities for a new generation capable of ethical AI adoption and sustainable business practices. Using qualitative research and case studies based on real events, the study delivers insight into how organizations might strengthen Generation Z leaders through mentorship programs, training in digital ethics, and inclusive leadership strategies. The study found that organizations pursuing Gen Z's leadership vision are more likely to achieve integrative success in the digital economy vision. Investing in the next generation of leaders and aligning its strategies with their values can promote innovation, increase employee engagement, and build a more sustainable and ethical corporate culture. This work is an image created for this comfortable society, furnishing our knowledge store with valuable insights into changes needed by leaders that the rising AI era demands. Thus, it offers practical suggestions to organizations hoping for some survival modes, and then dust settles on an age past.

Keywords: *Generation Z, leadership, ethical AI, digital transformation, corporate sustainability.*

10.1 Introduction

In the current fast-paced business world, the power of AI (artificial intelligence) coupled with the implementation of digital transformation is changing leadership styles and organizational structures. Generation Z (Gen Z): Born between 1997 and 2012, Gen Z is the first genuinely digital-native generation to—starting in recent years—begin to enter leadership at a time of unprecedented change. Unlike generations before them, Gen Z focuses on collaboration, transparency, and accountability—pushing back on the ingrained hierarchical structures that have long governed corporate leadership.

Although Gen Z may have leadership potential, a significant void exists in terms of how Gen Z can drive ethical AI and sustainability. Much of this is due to an established industry that is slow to change, hindering young leaders' ability to implement innovative practices. Moreover, organizations face additional challenges in integrating Gen Z leadership due to a lack of holistic digital literacy training and ethical AI frameworks.

This chapter starts with the specifics of Gen Z's leadership style and the challenges of building an ethical business culture. Gen Z leaders will likely employ technology to instigate innovation and advocate for sustainable business. However, they frequently face pushback when implementing these changes. Using qualitative research and practical examples, it explores how Gen Z is overcoming these challenges, offering specific recommendations for organizations looking to incorporate their viewpoints into leadership development initiatives.

By empowering Gen Z leaders, organizations can tap into new, progressive solutions that resonate with today's values. By following their vision, they offer an opportunity to make corporate culture fairer and more sustainable. This chapter encourages readers to think about how this generation will change business in the future via innovation, ethical leadership, and digital savviness.

10.2 Literature Review

10.2.1 Insights about Gen Z and Leadership from a Generational Dynamics Perspective

The report shows that as natives of the digital world, Generation Z (Gen Z) is a group with excellent technological skills, high ethical leadership, social responsibility, and commitment to sustainability (Khamis et al., 2017). Gen Z is believed to change corporate culture by requiring transparency, inclusivity, and accountability when dealing with the brands they interact with (Seemiller & Grace, 2016; Twenge & Campbell, 2018). Gen Z leaders prefer to promote open communication with their colleagues rather than a manager who does not listen or listens selectively. They strive for group cooperation rather than relying upon individual effort. Because they see themselves as equals having equal responsibility to shoulder work experience, they experience a different kind of collectively in which each person is more conscious about his or her tasks than ever before (Bencsik et al., 2016).

10.2.2 Gen Z Employees Praise Collaborative Spaces with Low Barriers to Communication and Flat Organization Levels

However, vast differences in perspective also provide fertile ground where these viewpoints can meet (Horváth & Juhász, 2016). This means that more traditional ways of developing young people must suit a very different type than those garnered from old traditional lines by leaders to capture Gen Z's growing leadership capabilities. The literature lacks any attempt at outputting Gen Z into established leadership training programs of study so that they or their followers can take on a completely different role (Deloitte, 2020).

Meanwhile, while the potential of Gen Z leaders has been referred to in theory as a part of corporate assessment, there is no empirical research into their specific activities connected with ethical AI adoption and sustainable practices. AI technologies are relatively young, and the ethical elements involved in inheriting an AI empire remain unexplored, especially in cases where the older generation of leaders transmits them. Most existing literature views AI as a tool to improve startup efficiency. However, no research has measured Gen Z's ability to initiate and implement ethical AI practices (Jobin, Ienca, & Andorno, 2019).

Moreover, present training and development methods often cannot provide a complete system of digital literacy and ethical reasoning skills. This is vital for Gen Z leaders, who are created in a rapidly changing technological environment (Lloyd, 2021). This gap poses a substantial challenge to enterprises looking to prepare employees for the AI-driven future.

In conclusion, while literature has explored various aspects of Gen Z leaders' unique characteristics and potential, little is known about how they can best be integrated into organizations. Further research is needed to guide institutions as they negotiate this new leadership order, allowing Gen Z to lead the way for sustainable AI deployment and sustainability in business. Closing these gaps will be critical to companies aiming to build on this generation's potential in cultivating an ethical and accountable corporate landscape.

10.2.3 Insights on Generational Dimensions for Organizational Business Leadership Perspectives: An Emerging Perspective on Generation Z (Gen Z)

The question of integrating Gen Z into existing leadership frameworks remains a mystery. However, another study at Shenzhen University looks towards defining and multiplying the potential leadership qualities of Gen Z leaders (Khamis et al., 2017). Gen Z, a product of the digital age, is destined to challenge corporate culture as never before, demanding transparency, diversity, and accountability standards from any organization it deals with (Seemiller & Grace, 2016; Twenge & Campbell, 2018). This earlier generation striving for success does not go in for hierarchical work structures; instead, many Gen Z leaders feel more comfortable working as a team. With rising non-traditional business models such as freelancing on the internet and even leading cooperatives that offer themselves as providers (Bencsik, Horváth & Juhász, 2016), new leadership development approaches must be devised to accommodate these generational preferences. As a result, traditional industries have been slow to adapt, leaving scant literature on how Gen Z fits within established leadership frameworks.

However, although it has been posited theoretically that Gen Z has the leadership potential to rise, as Georgia Zhou puts it, is there empirical evidence? We cannot infer from available data that Gen Z drives ethical AI; merely proposing it makes no sense (Zhou, 2020). How do the existing tools affect operational AI? This article gives only a partial answer (Chen, 2019). Most existing literature considers AI to enhance organizational efficiency, but few papers study Gen Z's ability to steer ethical AI implementation (Jobin, Ienca, & Andorno, 2019).

However, the development has not had this overarching framework in many existing ways of developing talent. For example, it does not incorporate core competencies such as digital literacy and ethical reasoning. Preparation for Gen Z leadership in a technologically advanced world (Lloyd, 2021) typically ignores these critical areas for genuinely preparing future leaders. This gap poses serious challenges for companies contemplating an AI-driven digital transformation that should nurture a workforce capable of operating in a digital world.

Gen Z's expectations for a work-life balance and corporate social responsibility raise further demands on leadership structures designed for previous generations. Not meeting these expectations will decrease the engagement and retention of young talents. Gen Z workers value employment in organizations that embrace diversity, environmental sustainability, and fair compensation of their staff (Robinson & Stubberud, 2020). Organizations that make these values a part of their leadership framework will probably see their employees of the future stick around longer and feel more motivated in general.

Furthermore, for digital platforms and social media networks upon which Gen Z Leader Development relies, these tools provide unprecedented access to information and connectivity. They also bring new challenges into leadership training and mentorship areas. Unlike previous generations, who moved up through the ranks of large companies, Gen Z is the first generation growing up in the digital age (Prensky, 2010). Corporate literature has documented extensively how the younger generation, Gen Z, has an idealistic nature, ingenuity, and potential as leaders. However, research still needs to show how these Gen Zers might smoothly be integrated into a workplace or organization.

More research is needed to investigate what institutions can do with Gen Z's strengths as they work towards ethical AI adoption and business sustainability. Bridging these research gaps will be important to company transformation as it enters into new, responsible, transparent, and fair business models that can flourish under Gen Z leadership.

To sum up, post-2000 generations have great imagination, but there is still a considerable gap in how they can be effectively integrated into contemporary organizations. Research has

not determined how enterprises could utilize their strengths to promote responsible AI use and sustainable business strategy. Although it is widely recognized that post-2000 cohorts prioritize transparency, inclusion, and technological adaptability, we do not understand what form these values should take in leadership models.

10.3 Empowering Gen Z in a data driven world Enabling the Next Generation to Build Sustainable Success in Business and Beyond

10.3.1 Addressing the Problem: The Challenge of Integrating Gen Z into Leadership Frameworks

Generation Z is not only leaving its mark on the corporate industry as managers but also playing around with that power to get to work literally; their unique characteristics in the business world now leave one in no doubt. One aspect is their distinct generational identity. Even though some may just be finishing up at university, and others may also be completing high school and starting to enter society, they are already working as young people who hold different leadership positions from their forebears.

They seem to see the current domestic Gen Z generation, who style themselves after youth from the 1990s and first noughties, "to rub out" on conditions, tabula rasa as its motto, precisely, how they use efficient technology. They neither expect nor hope for structured leadership, nor can they help them grow up. Understanding their perspectives and accepting all kinds of impossibilities is crucial. Research summaries presented earlier share this perspective.

Gen Z advocates for diversity, transparency, and partnership-driven organizations rather than vertical structures, requiring a reassessment of leadership development strategies (Horváth, Bencsik et al., 2016; Juhász, 2016). However, industries have been slow to adapt, resulting in a considerable gap in understanding how to effectively incorporate this new generation into leadership positions (Deloitte, 2020). This poses a dilemma for enterprises striving to align their leadership approach with Gen Z's anticipation and value system.

10.3.2 Leading in the Age of Artificial Intelligence

Integrating ethics, AI, and sustainability in modern business practice will take a new type of leader with the right skills; however, this is not an area for graduates, and few senior executives exist to take on such roles. Knowledge Gap: Lack of Research on Gen Z's Role in Ethical AI and Sustainable Practices. Currently, there is substantial theoretical research but no empirical evidence on Gen Z's leadership potential or involvement in implementing ethical AI technology and sustainable development.

Training Program Failures: Current training programs fail to equip young leaders with the necessary digital literacy and reasoning skills to navigate AI-driven workplaces profitably (Lloyd, 2021). Lack of Systematic Framework: The result is that there is no systematic framework available to organizations to develop Gen Z leaders who can meet these challenges and lead in a nanotechnology era.

Companies today need leaders who can generate a completely new model to supervise behaviour, such as job-holding-own balance, societal responsibility, and digital cooperation (Robinson & Stubberud, 2020). If entry-level employees are not given opportunities, they will

seek better prospects elsewhere. To retain and support Gen Z leaders, a company must create technology-driven adaptive workplaces that support ethical AI deployment and sustainable business practices.

10.3.3 Case Studies: Generation Z in Bahrain's Business Landscape

Zain Bahrain: Leading with Ethical Commitment and Sustainability

Zain Bahrain, a primary telecom provider, is an example of a company firmly committed to Corporate Social Responsibility (CSR) and environmental protection. This underpinned business ethos not only resonates with Zain Bahrain's ethical business practices but also fits in well with Gen Z's core values. In addition to delivering quality telecommunications services, the company also makes an effort in other areas. Their work includes cutting carbon emissions, supporting local community programs, and promoting responsible use of digital tools.

Gulf International Bank (GIB): Sustainability at the Heart of Business Operations

Gulf International Bank (GIB) has made sustainability an integral part of its operations. This fits in with its long-term strategy to incorporate principles of environmental responsibility and AI ethics into financial services. GIB's emphasis on finance for green policies, sustainable investments, and socially responsible banking aligns with a general trend toward harmonizing sustainability with business practices. It is a forward-looking approach with much to recommend to cultured and forward-thinking Gen Z, which has an abiding concern for ecological issues.

Bahrain Petroleum Company (Bapco) Transitioning to Ethical Business Model Bahrain

Petroleum Company (Bapco) has made a significant move toward integrating Corporate Social Responsibility (CSR) with its commercial operations. This shift supports the company's commitment to environmental protection and meets a call for ethical business practices within energy areas. Given that Gen Z is such a strong advocate for corporate responsibility, Bapco's new business model comfortably marks it out as a leader in clean energy and ethically oriented business operations.

10.3.4 Leading in the Era of AI

How to Bring the Next Generation of Business Gen Z into AI-Driven Environments for Leaders?
Artificial Intelligence (AI) is taking over the business world, bringing with it not only new prospects but also ethical dilemmas. However, for a generation that has grown up in the digital era, Gen Z, AI is a good area to make innovation happen and take leadership. For them, mobile technologies, social media, and digital tools are as every day as things come—so they are a powerful force in AI-driven business environments. Their specific perspective, of course, helps ensure the ethical integration of AI so that technology does indeed benefit companies and society at large.

Financial Innovation and Leaders Coming Next-Bahrain

Bahrain's FinTech is a veritable melting pot of innovation with a special emphasis on

integrating Gen Z leadership. The progressive direction taken by the Bahraini government toward FinTech, alongside a supportive startup ecosystem, has spawned the next generation of young leaders to grow up in Bahrain.

In Bahrain's financial sector, companies use AI to improve financial services, secure them better, and increase the efficiency of transactions. Thanks to the area's technological expertise, Gen Z will be the ones to take over developing these creative financial solutions while acting in a civil and socially responsible way.

The Financial Technology Boom in Bahrain and the Call of Gen Z

Bahrain has become a leader in the Middle Eastern financial world by its strategic location and forward-looking economic policies. The country boasts an extensive system of FinTech companies that features deep integration between AI and financial services. In the Kingdom of Bahrain, a variety of next-next financial service systems cater to younger people's needs. Whether you are dealing with Eazy Financial Services (Easypay) or The Benefit Company, these platforms promise a lucrative windfall for investors eager to explore the possibilities of AI.

The Role of AI in the Financial Sector

Integrating AI with Bahrain's Financial Technology landscape will change how financial transactions are carried out, improving efficiency through security and transparency. As this shift gains pace, Gen Z is being trained to use AI-based financial tools socially responsibly. Education programs and workshops aim to equip young people with technical skills and register financial management ethics among them. So, they realize how essential data privacy, fairness, and transparency are in all digital interactions.

Empowering Gen Z for Tomorrow's Workforce

As Generation Z joins the workforce, companies must adjust their strategies to meet their needs. The arrival of this new generation brings its invigorating mix of skills and an intense desire for meaningful work that reflects personal values. Corporations must be nimble, providing new career paths that engender entrepreneurial spirit in Gen Z staff members and help them develop leadership qualities. The following chart shows crucial ways for companies to make Gen Z feel at home leading them:

Tactic	Description
Mentorship Programs	Connect Gen Z with experienced leaders to provide guidance and foster innovation.
Flexible Work Environments	Adapt work models to suit Gen Z's desire for flexibility and work-life balance.
Focus on Sustainability	Align business practices with environmental and social responsibility.
Promote Technological Fluency	Offer continuous training and exposure to the latest technologies.
Encourage Entrepreneurial Thinking	Foster a culture of innovation by giving Gen Z the freedom to experiment.

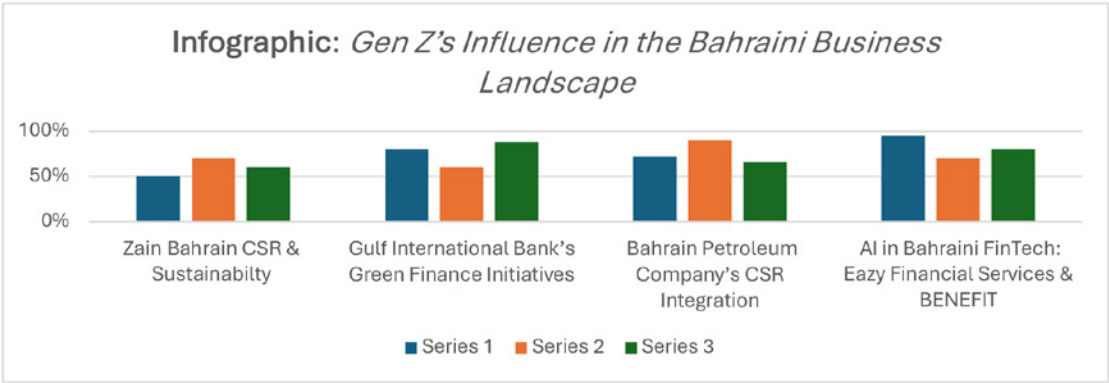
The following table outlines key tactics to empower Gen Z leaders, accompanied by relevant statistics and authentic references:

Tactics	Infographic Numbers and Rates	References
Establish AI Ethics Committees	- 86% of business leaders anticipate a significant shift towards predictive personalization, aligning with Gen Z's demand for ethical AI use. - Operation HOPE's AI Ethics Council includes diverse experts to guide ethical AI principles.	Twilio (2024); Operation HOPE (n.d.)
Encourage Intrapreneurship	- Record-breaking 5,481,437 new businesses were started in 2023, with Gen Z leading this entrepreneurial surge. - 50% of Gen Z aspire to start their own business.	Justworks (2023); Entrepreneur (2025)
Promote Ethical and Technical Literacy	- UNESCO's global standard on AI ethics emphasizes continuous education on ethical AI principles. - Over 40 recommendations by WHO guide appropriate AI use, highlighting the need for ongoing education.	UNESCO (2021); WHO (2024)
Rethink Leadership Structures	- 70% of Gen Z view middle management roles negatively, preferring agile and transparent leadership models. - Gen Z employees prioritize flexibility and purpose over traditional hierarchical structures.	Financial Times (2025); Entrepreneur (2025)

10.3.5 The Call to Action

As the financial landscape continues to evolve, Bahrain's Gen Z professionals have a crucial role to play. Their comfort with technology and commitment to social responsibility position them as the leaders of tomorrow in the FinTech industry and beyond.

The following infographic presents a comprehensive overview of key corporate initiatives in Bahrain, emphasizing a commitment to sustainability, corporate social responsibility (CSR), and technological innovation. It visually segments the efforts of different organizations spanning telecommunications, finance, petroleum, and FinTech, each aligning their strategic practices with both environmental sustainability and community welfare.



Another is a compendium of Bahrain's initiatives and their respective organizations. Again, the devils are beautiful iPad. This setup represents a shift of strategic practice in the industry from making money at others' expense to caring for the environment and social welfare (Davis, 2004).

Zain Bahrain's section lays out a robust CSR strategy. It encompasses carbon reduction targets that are among the highest in the industry, extensive sprouting-from-the-roots community services programs, and the promotion of digital health. These efforts protect the environment and enhance the welfare of the society to which they belong. This is consistent with a framework for CSR that sees companies attempt to balance making money and the general good (Carroll, 1999).

Infographics also show the weight GIB and its green finance carry. The bank's emphasis on sustainable investment products and environmentally friendly banking principles exemplifies a broader industry trend to incorporate environmental, social, and governance (ESG) criteria into its products. This approach reduces risks from ecological harm and attracts an ever-larger segment of socially conscious investors (Zh Erick Bown McDowell, 2019).

Bahrain Petroleum Company's CSR integration is reflected in its investment in renewable energy and community support policies. By injecting capital into renewable energy projects, the company aligns its operations with international trends toward decarbonization and sustainable energy production. Furthermore, their community support initiatives emphasize a two-pronged strong point: striving for operational efficiency while contributing to local socio-economic development, the epitome of global efforts to achieve a greener energy future (International Energy Agency, 2021).

The infographic goes on to study how AI revolutionizes Bahraini FinTech. Eazy Financial Services and BENEFIT best exemplify this shift. The use of AI-driven transaction security systems in their operations and attempts to include Gen Z consumers (typically a hard nut for fintech investors to crack) in the financial world both show how modern equipment can do better business and carry benefits such as improved protection measures. This whole harmonizes with trends in fintech innovation more generally, where AI technology is increasingly important to ensure efficiency, security, and inclusiveness (Arner, Barberis, & Buckley, 2016).

10.4 Innovations and Findings

10.4.1 The New Generation Z Governs AI Ethics and Leadership Models

Emphasizing technology that is wedded to ethics and inclusion (MindStick, 2025). For instance, members of this generation seek out transparency and observe a work-life balance. Such values are finding their way into the training programs at top business schools (MindStick, 2025). Similarly, young Gen Z leaders call for a democratic and all-inclusive AI governance model. They understand the political dimension of AI integration, requiring public opinion to play a role in every step of decision-making as long as it affects society (Landemore, 2024). Their approach reveals a more ethical, enduring, and comprehensive shift.

10.4.2 Results from Recent Surveys and Case Studies suggest that Generation Z is using AI Workplace

In a survey conducted by Google Workspace (2024), 93% of employees in this generation habitually use two or more AI applications every week. These people feverishly work with whatever tools they come across and use programs such as ChatGPT and DALL-E designed to enhance productivity and handle more complex tasks. However, with its broad introduction, there are worries about employment displacement, too. According to a survey conducted by Work Tango in 2018, as many as 59% of Gen Z and Millennials are haunted by fears that AI could mean such great job destruction that all jobs will have disappeared (WorkTango, 2024). These insights underline the twofold image of AI held among early career professionals: On the one hand, it is a tool that is efficacious in saving time and, on the other, a possible threat to job prospects.

10.4.3 Challenges and Possibilities in Gen Z Leading and Governing AI

As Generation Z joins leadership ranks in modern business organizations driven by AI, they face structural and ethical challenges requiring fresh solutions. One of the most critical issues is that traditional corporate configurations resist moving toward new shapes. Deep-rooted managerial structures, often with a chain of command and rule-bound bureaucracy, clash with the decentralized, transparent decision-making preferred by Gen Z (Bencsik, Horváth, & Juhász, 2016). Organizations that fail to change risk driving away the talented youth generation and missing Gen Z's power for ethical AI transition.

There is a second major challenge in AI literacy and ethics related to education. While Generation Z is born with a digital silver spoon, no routines for training artificial intelligence (AI) good governance ethics are accepted within corporate systems (Lloyd, 2021). Companies must close this educational gap by giving every leader AI ethical instruction as part of the curriculum, creating an environment where study never stops.

There are also persistent concerns about AI bias and responsibility. AI systems can reinforce existing prejudices, widening divisions without a rigorous ethics oversight system. Minorities suffer most (Jobin, Ienca, & Andorno, 2019). Generation Z decision-makers must promote good artificial intelligence governance policies, prioritizing openness, fairness, and responsibility to ensure technology works equitably for all.

Moreover, Gen Z has an opportunity to rewrite ethics guidelines and create truly

sustainable businesses. Their commitment to social responsibility is a rare advantage as they plan on using AI to craft a business ethic in line with ESG principles: environmental, social, and corporate governance (Seemiller & Grace, 2016).

Another approach offers intrapreneurship and AI-powered innovation as a way forward. In an environment where Gen Z youth are always looking to apply new knowledge, today's business world is suited for projects that combine agile work with an experimental attitude toward solving problems (Francis & Hoefel, 2018). Organizations enabling Gen Z to shape ethical and AI strategic policies will promote creativity and create accessible, sustainable management models.

Finally, there is tremendous power in resolving AI-related difficulties by combining Gen Z's digital skills and know-how with the experience of senior executives. Businesses can create a stable, equitable governance structure for AI that treats technological knowledge and traditional wisdom equally important (Deloitte, 2020).

10.5 Conclusion

The findings in this chapter attest that Generation Z is transforming the traditional conventions of business leadership and serves as an unintended check on unethical artificial intelligence development in industry and corporate social responsibility. With their immersion into digital culture from childhood, Gen Z leaders have an exceptional point of view that insists on transparency, inclusivity, and social responsibility (Seemiller & Grace, 2016).

However, this group also encounters considerable obstacles: Inertia exists in traditional enterprises, and there is an absence of standardized courses dealing with AI ethics and governance (Deloitte, 2020). In response, business practices must follow Gen Z's values and encounter this growth process. It is not just a question of taste. In an AI-driven economy, this is a strategic necessity for any company that wants to keep up its market share.

Successful real-world instances, such as Google AI Principles and Microsoft AI for Good activities, are two cases of embedding ethical AI frameworks in corporate strategy to generate sustainable dividends over the long term (Smith, 2019). Such benchmarks underscore the necessity for companies to work with today's leaders and Gen Z managers in shaping policy on artificial intelligence if they are serious about responsible innovation and corporate accountability.

The article offers three strategic recommendations for corporate leadership to ensure that Gen Z leaders live up to their generation's potential. To promote these ideas, AI ethics education needs to be integrated into the corporate training curriculum. Young leaders must equip themselves with the expertise necessary to deal with multifaceted ethical situations (Lloyd, 2021).

If Gen Z is to implement its values of transparency and inclusion, then companies should re-examine their leadership styles. Organizations need to get models from the decentralization of power and democratic decision-making to meet the requirements of the current targets and forms of Gen Z (Francis & Hoefel, 2018).

Lastly, enterprises must develop intrapreneurship opportunities for Gen Z professionals. General Manager Zhang of Tencent noted that such people are the most likely to head a technology initiative with sustainability and social impact as its first concern. Indeed, the plans Amazon has made recently for some economic development list award-winning measures in these areas (Unilever, 2023; Tesla, 2022). In so doing, businesses can begin to train a new generation of technologically proficient, Z-oriented team members who understand technology

and are committed to ethical decision-making and sustainable corporate growth.

The theme of sustainability is currently the one with which businesses and managers are most concerned. Regarding leadership philosophy, Gen Z shows a strong commitment to sustainability. Their business standards are leading the trend for good governance and long-term environmental responsibility, paralleling an upward curve in public opinion (Xie, 2019). Unlike previous generations, Gen Z professionals consider CSR a given when they choose where to work. After all, they want a career where their work has a purpose, and the business can contribute to society's welfare (Twenge, 2020).

This shift is demonstrated by the number of companies introducing Environmental, Social and Governance (ESG) frameworks into their business practices. For example, Patagonia's pursuit of a sustainable approach is combined with Google's pledge to operate according to carbon neutrality principles (Patagonia, 2024; Google, 2023). Such companies are popular with young talent and enhance their image capital by demonstrating that they are committed to ethical AI usage and environmental sustainability.

For sustainability to remain at the heart of business transformation, organizations must incorporate these principles into leadership. One way to accomplish this is by starting cross-generational mentorship programs that let senior executives and Gen Z professionals exchange pointers back and forth (Deloitte, 2021). Such a model enables organizations to marry up technological expertise with the institutional experience born of years in business.

The result is that AI steering frameworks are both pioneering and fundamentally ethical. Companies should also invest in AI-powered equipment to support environmental sustainability, such as predictive energy efficiency analytics and blockchain general ledger entries on the supply chain (World Economic Forum, 2023). Such innovations will reduce the environmental footprint and harmonize with the moral outlook of a new wave of Gen Zers demanding socially responsible corporate conduct.

By cultivating an atmosphere of ethical AI application and sustainable leadership, businesses can show Gen Z professionals there is a place for them in these next steps toward corporate change. This generation is perfectly positioned to merge sustainable business practices with AI ethics. It ensures that machines serve humanity—not the reverse. Through precise training, a restructuring of effective leadership, and a commitment to responsible innovation, bodies can point the way forward past unity toward a more inclusive, open, and sustainable future.

10.6 References

Bencsik, A., Horváth, C., & Juhász, T. (2016). Y and Z generations at workplaces. *Journal of Competitiveness, 8*(3), 90–106.

Deloitte. (2020). *The Deloitte Global Millennial Survey 2020.* Retrieved from https://www2.deloitte.com/global/en/pages/about-deloitte/articles/millennialsurvey.html

Deloitte. (2021). *Fostering cross-generational mentorship in the workplace.* Retrieved from https://www2.deloitte.com

Entrepreneur. (2025). *Gen Z is redefining the workplace—and companies must adapt.* Retrieved from https://www.entrepreneur.com/leadership/gen-z-is-redefining-the-workplace-and-companies-must/484040

Financial Times. (2025). *Gen Z has turned against taking middle management roles.* Retrieved from https://www.ft.com/content/4fc00d4f-06bf-4b3e-95a3-41db3e9001fd

Francis, T., & Hoefel, F. (2018). *True Gen: Generation Z and its implications for companies.* McKinsey & Company.

Google. (2023). *Google's commitment to sustainability and carbon neutrality.* Retrieved from https://sustainability.google/

Jobin, A., Ienca, M., & Andorno, N. (2019). The global landscape of AI ethics guidelines. *Nature Machine Intelligence, 1*, 389–399.

Justworks. (2023). *Millennials & Gen Z leading entrepreneurship.* Retrieved from https://www.justworks.com/blog/why-are-millennials-and-gen-z-more-likely-to-start-a-business

Khamis, A., Hamid, S., & Hassan, S. (2017). The influence of technology use on learning skills among Generation Z. *Journal of Educational Technology & Society, 20*(4), 110–120

Landemore, H. (2024). *Leadership development in the age of artificial intelligence.* Harvard Kennedy School. Retrieved from https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/Final_AWP_244.pdf

Lloyd, J. (2021). *Developing ethical AI leaders: A corporate training approach. Journal of Business Ethics, 170*(2), 245–260.

MindStick. (2025). *How Gen Z leaders are redefining leadership values in business schools.* Retrieved from https://www.mindstick.com/articles/338560/how-gen-z-leaders-are-redefining-leadership-values-in-business-schools

Operation HOPE. (n.d.). *AI Ethics Council.* Retrieved from https://operationhope.org/initiatives/ai-ethics-council/

Patagonia. (2024). *Patagonia's corporate responsibility and sustainability initiatives.* Retrieved from https://www.patagonia.com/corporate-responsibility.html

Prensky, M. (2010). *Teaching digital natives: Partnering for real learning.* Corwin Press.

Robinson, S., & Stubberud, H. A. (2020). Social media usage: Examining the factors affecting falling social media usage among Generation Z. *Journal of Business and Behavioral Sciences, 32*(2), 66–78.

Seemiller, C., & Grace, M. (2016). *Generation Z goes to college.* John Wiley & Sons.

Smith, B. (2019). *The future computed: Artificial intelligence and its role in society.* Microsoft Press.

Spare Partners with Eazy Financial Services. (2022). *Launch of open banking capabilities in Bahrain.* Retrieved from https://financialit.net/news/open-banking/spare-partners-eazy-financial-services-launch-open-banking-capabilities-bahrain

Tesla. (2022). *Sustainable energy solutions and ethical AI innovation.* Retrieved from https://www.tesla.com/sustainability

Twenge, J. M. (2020). *iGen: Why today's super-connected kids are growing up less rebellious, more tolerant, less happy—and completely unprepared for adulthood.* Atria Books.

Twilio. (2024). *Twilio report reveals ethical use of AI will be a competitive differentiator.* Retrieved from https://investors.twilio.com/news-releases/news-release-details/twilio-report-reveals-ethical-use-ai-will-be-competitive/

Unilever. (2023). *Sustainable Living Plan: Ethical business practices and corporate responsibility.* Retrieved from https://www.unilever.com/sustainable-living/

UNESCO. (2021). *Recommendation on the ethics of artificial intelligence.* Retrieved from https://www.unesco.org/en/artificial-intelligence/recommendation-ethics

World Economic Forum. (2023). *AI and sustainability: The future of ethical business innovation.* Retrieved from https://www.weforum.org/agenda/2023/06/ai-sustainability-business-ethics/

World Health Organization. (2024). *WHO releases AI ethics and governance guidance for large multi-modal models.* Retrieved from https://www.who.int/news/item/18-01-2024-who-releases-ai-ethics-and-governance-guidance-for-large-multi-modal-models

Xie, Y. (2019). *The role of Gen Z in shaping sustainable corporate strategies. Journal of Business Sustainability, 5*(2), 112–129.

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Chapter 11 - Preserving the Human Touch in the Age of AI: Pursuing Sustainability in the Fashion Industry

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Abstract

The fashion industry is often cited as the second most polluting industry globally. Achieving environmental, social, and economic sustainability requires substantial investment in technological innovations and revised practices to transform traditional manufacturing and distribution processes. Artificial Intelligence (AI) presents a promising solution to enhance sustainability initiatives through various mechanisms: product innovation to minimize material waste, process optimization to optimize resource utilization, inventory management systems to prevent overproduction, and data-driven consumer engagement to promote conscious consumption. However, the implementation of AI technologies also faces significant challenges and skepticism, including potential risks to established brand values, complexities in maintaining meaningful employee engagement, and the delicate balance of preserving consumer trust in an increasingly automated environment. This chapter explores the current state of AI adoption in the fashion industry and its short- and long-term implications. Through a case study involving interviews with key executives in AI, sustainability, retail strategy, global guest innovation, localization, circularity innovation, global production, and creative direction at a leading athleisure brand, this research investigates the multifaceted opportunities, challenges, and potential risks associated with AI implementation across various organizational functions. The findings offer strategic insights and practical recommendations to guide future AI development and deployment. By providing a nuanced understanding of AI's role in driving sustainability, this study contributes to both academic discourse and industry practice, shedding light on how the fashion sector can leverage AI to achieve its sustainability goals.

Keywords: *artificial intelligence (AI) in fashion, fashion industry sustainability, retail*

technology, sustainable business practices, fashion industry;

11.1 Introduction

Recent global surveys indicate a shift in CEO priorities, with sustainability concerns being superseded by more immediate issues such as disruptive technologies, growth imperatives, inflation, and geopolitical uncertainty (Bain & Company, 2024a). Meanwhile, the luxury sector is increasingly exploring the potential of AI, with pilot projects suggesting that adoption rates may soon double (Comité Colbert & Bain & Company, Inc., 2024). However, the industry remains cautious, emphasizing the necessity for AI to operate discreetly, enhancing rather than overshadowing the authenticity, exclusivity, and intimacy that define luxury. Striking a balance between technological innovation and the irreplaceable human touch remains a critical challenge.

AI is already transforming the fashion industry, driving advancements in supply chain optimization, design processes, and customer experiences through data-driven insights and feedback loops. These innovations not only enhance efficiency and personalization but also hold promise for sustainability by reducing waste and returns, thereby benefiting both businesses and the environment (Forbes Technology Council, 2023). Yet, it remains uncertain whether AI can transform the luxury fashion industry into a model of sustainability.

This chapter investigates the rise of AI and its implications for sustainability in the fashion industry, using a case study approach focusing on an athleisure brand. While existing research on AI in fashion is fragmented and often confined to specific stages of the supply chain (Giri et al., 2019), this study provides an updated perspective on how the sector is leveraging AI (Ramos et al., 2023). Through interviews with experts in sustainability and AI within a leading athleisure fashion brand, the book chapter provides a realistic assessment of current practices and potential future developments. By integrating academic and practical insights, this research seeks to deepen the understanding of AI's potential to drive sustainable transformation in the fashion industry

11.2 Literature Review

This chapter provides a comprehensive review of the literature, focusing on the role of AI in the fashion industry and its potential to promote sustainability. It begins by defining AI and outlining its historical evolution, highlighting key advancements and applications relevant to the fashion sector. Following this, the review examines the multifaceted concept of sustainability, exploring its environmental, social, and economic dimensions. By establishing these foundational definitions and exploring the current landscape of AI applications, this review sets the stage for a critical analysis of how AI technologies can support sustainable practices in the fashion industry.

Despite growing interest in AI as a tool for enhancing sustainability, the current body of academic research on AI in the fashion industry is relatively limited and fragmented (Giri et al., 2019; Ramos et al., 2023). This review addresses this gap by synthesizing insights from diverse sources, including academic studies, industry reports, and trade publications. It critically evaluates the existing literature to identify key themes, research gaps, and areas needing further investigation. This chapter aims to provide a nuanced understanding of the potential and limitations of AI in promoting sustainability within the fashion industry, setting

the stage for a more in-depth exploration of these issues in subsequent chapters.

11.2.1 Artificial Intelligence

Artificial Intelligence (AI), a term coined by Stanford Professor John McCarthy in 1955, is defined as "the science and engineering of making intelligent machines" (Manning, 2020, p. 1). Initially focused on programming machines to perform specific tasks, such as playing chess, modern AI emphasizes machine learning, enabling systems to learn and adapt in ways analogous to human learning. Today, AI plays a crucial role in the fashion industry, driving innovation in design, production, e-commerce, personalization, and supply chain management (Bieńkowska, 2024). These advancements not only improve operational efficiency but also create opportunities to support sustainability.

The rise of Big Data in the early 2000s and the subsequent proliferation of machine learning in the 2010s significantly advanced analytical AI (Comité Colbert & Bain & Company, Inc., 2024). However, the adoption of AI solutions remains limited due to the substantial upfront investments required in software, hardware, and skilled personnel (McKinsey & Company, n.d.). For AI tools to be effective, they must have access to reliable customer and product data across multiple channels, as well as precise use cases (Comité Colbert & Bain & Company, Inc., 2024). Despite AI's transformative potential, its high implementation costs mean that only large, well-resourced companies can fully leverage these technologies, creating a digital divide in the industry.

11.2.2 ChatGPT: Proliferation of AI

Generative AI, unlike traditional AI, creates new content by extrapolating from training data. ChatGPT, launched in November 2022, exemplifies this capability by producing human-like text, images, and audio (Pavlik, 2025). McKinsey & Company (2023) estimates that generative AI could generate $6.1-7.9 trillion in annual economic benefits through increased productivity. The technology's accessibility is a key advantage: companies can leverage existing teams to customize AI models with internal data. Luxury fashion brands have rapidly adopted generative AI technologies to enhance their digital presence and customer experience. Several notable implementations include (Jing Daily, 2024):

Brunello Cucinelli developed an AI-powered website in July 2024, featuring immersive content and Solomei AI, their machine-learning customer service system. The platform demonstrated immediate success, attracting more than 10,000 daily visitors within its first week.

Balenciaga incorporated AI technology into their Winter 2024 Paris Fashion Week presentation, utilizing AI-generated visuals displayed on LED screens throughout their runway show, which garnered substantial media attention.

Gucci expanded their digital offerings in April 2024 by integrating Apple's Vision Pro headset technology, enabling customers to experience their short films and digital archives through augmented reality.

Dior launched Astra at VivaTech 2024, a sophisticated AI platform designed to analyse consumer data and adapt to customer preferences, improving their ability to respond to market demands.

11.2.3 DeepSeek: Democratization of AI

In 2024, DeepSeek, a Chinese AI company, has gained attention for its open-source models and engineering innovations, which reduce the cost of training and inference for large-language models (Qu, 2024). By optimizing AI algorithms, DeepSeek minimizes energy consumption, thereby contributing to environmental sustainability (Laws, 2025). Its rapid adoption, including integration with Microsoft, AWS, and Nvidia platforms, underscores its potential impact (Bain & Company, 2024b).

The focus of AI development is shifting from creating the "smartest" models to prioritizing practical applications that drive economic value. Open-source AI democratizes access, enabling smaller companies to innovate and deploy efficient models, making AI more accessible and practical (Zhou, 2024). This shift emphasizes cost-effective innovations over sheer intelligence, fostering broader participation and consumer benefits.

11.2.4 Sustainability

The fashion industry is often cited as the second most polluting industry globally, responsible for 10% of annual carbon emissions—more than international flights and maritime shipping combined (United Nations Environment Programme, 2019; World Bank, 2019). Michael Møller (2016), Director-General of the United Nations, emphasized that "business as usual is not an option anymore." With less than five years remaining to achieve the 2030 Sustainable Development Goals, the luxury fashion industry must reinvent itself to align with sustainability principles.

The United Nations defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, n.d.). This definition emphasizes the interconnectedness of economic growth, social inclusion, and environmental protection. This study adopts this framework to explore AI's impact on the economic, social, and environmental dimensions of fashion.

11.2.5 Economic & Environmental Benefits to the Company

AI is transforming industries, including healthcare, by enhancing diagnostic accuracy, enabling personalized treatments, and accelerating drug discovery (Sreedharan et al., 2019; Antons & Breidbach, 2023). In the fashion industry, AI contributes to sustainability in several ways (Ramos et al., 2023):

Supply chain optimization: AI improves efficiency by optimizing procurement, manufacturing, and distribution processes. For example, Zara uses intelligent algorithms to enhance supplier collaboration and logistics management (Cao, 2024).

Sustainable design and sales: AI analyses trends and consumer preferences to create sustainable designs and personalized shopping experiences. Lululemon, for instance, uses AI to refine customer search queries and partners with Samsara Eco for textile-to-textile recycling (Indian Express, 2024; Lululemon, 2024).

Waste reduction: AI predicts waste generation and automates recycling processes. Stella McCartney collaborates with Google Cloud to improve sustainability in her supply chain (Computer Weekly, 2024).

Data analysis: AI-driven insights help companies forecast demand, optimize inventory,

and reduce overstocking. H&M, for example, uses AI to minimize unsold clothing (Reuters, 2019).

11.2.6 Social Benefits to the Consumer & Employee

AI plays a transformative role in enhancing social sustainability within the fashion industry by optimizing processes, promoting eco-friendly practices, and fostering deeper consumer engagement (Boston Consulting Group, 2024). Despite the growing adoption of AI tools, consumer awareness remains relatively low. According to Bain & Company (2024c), 71% of customers reported being unaware of having used generative AI during their online shopping experiences, even though they had likely interacted with retailers employing such technologies. Despite this lack of awareness, consumers are optimistic about the potential of generative AI, with approximately half believing it holds significant or transformative promise. Shoppers prefer AI-driven features integrated into their shopping journeys, such as review summaries, over standalone tools. Additionally, consumers are willing to share personal data to enable AI-driven personalization, which can enhance customer service efficiency, especially in complex or challenging aspects of the shopping journey.

For employees in the fashion industry, AI contributes to social sustainability by promoting fair labour practices, enhancing supply chain transparency, and ensuring equitable treatment and compensation for workers (Comité Colbert & Bain & Company, Inc., 2024). AI systems can monitor compliance with labour laws, thereby reducing exploitation and improving working conditions. Furthermore, AI facilitates skill development by providing workers with opportunities to adapt to technological advancements, enhancing their employability and job satisfaction (Boston Consulting Group, 2024). By automating repetitive and physically demanding tasks, AI also reduces physical strain on workers, allowing them to focus on more skilled and creative activities (Rathore, 2019). This shift not only improves productivity but also enhances job satisfaction and overall well-being.

11.2.7 Risks and Concerns

Despite its potential benefits, integrating AI into the fashion industry is not without risks and ethical concerns. Yuval Noah Harari, a prominent historian and author, offers a cautionary perspective on the challenges posed by AI and highlights several critical issues:

AI and human agency: Harari warns that AI systems could undermine human autonomy by controlling the information individuals consume, potentially manipulating behaviour and eroding free will. This raises concerns about the ethical implications of AI-driven decision-making processes (Gardels, 2025).

The future of work and inequality: The widespread adoption of AI and automation threatens to disrupt labour markets, potentially rendering many jobs obsolete. Harari cautions that this could exacerbate inequality, creating a divide between those who control AI technologies and those displaced by them (Cooper, 2021).

Ethical considerations in technology: Harari emphasizes the importance of embedding ethical principles into the development and deployment of AI technologies. Without a strong ethical foundation, technological progress may lead to unintended consequences that prioritize efficiency over human well-being (Thompson, 2023).

To address these concerns, it is essential to establish robust ethical AI governance frameworks that prioritize transparency, mitigate bias, and ensure accountability. Organizations

must also focus on safeguarding data privacy, engaging stakeholders, and investing in AI literacy to build trust and ensure compliance with ethical standards (KPMG, 2021). Adopting a human-centric approach to AI development, where technology aligns with societal values and responsibly augments human capabilities, is critical to mitigating risks and maximizing benefits.

11.2.8 Gaps in Literature

The academic exploration of AI's impact on sustainability in the fashion industry reveals several significant gaps that require further investigation. These gaps include:

Unintended consequences of AI implementation: While existing research emphasizes the potential benefits of AI in advancing sustainability, there is limited academic attention on the unintended negative consequences of AI deployment. These include ethical dilemmas, labour displacement, and environmental impacts resulting from increased automation and reliance on AI technologies (Giovanola et al., 2023).

Empirical studies and real-world applications: A notable gap exists in empirical research that evaluates the real-world impacts of AI applications on sustainability outcomes in the fashion industry. Much of the current literature focuses on theoretical frameworks or conceptual models, with insufficient case studies or practical insights into successful AI implementations and their measurable effects on sustainability metrics (Santhanam & Khare, 2024).

Interdisciplinary approaches: There is a pressing need for interdisciplinary research that integrates technological, social, economic, and environmental perspectives. Current studies often narrowly focus on the technological aspects of AI, neglecting its broader implications for sustainability. This limits the understanding of how AI can be responsibly applied to achieve holistic and sustainable practices (Sahota, 2024).

11.2.9 Research Objective and Questions

This study aims to address these gaps by examining both the positive and negative implications of AI in the fashion industry through a comprehensive case study. The research seeks to answer the following questions:

- Research Question 1: Where is AI currently being applied in the fashion industry?
- Research Question 2: What are the near-term opportunities and challenges associated with AI adoption?
- Research Question 3: What are the longer-term vision and potential risks of AI in the fashion industry?

Through a real-world case study, this research explores AI's current and future role in the fashion industry. The following sections present the research framework, analyze the case study findings, and examine research gaps, implications, and limitations.

11.3 Methodology and Framework

This study employs a qualitative case study methodology (Yin, 2018) to examine the

intersection of AI and sustainability initiatives in the fashion industry. The qualitative approach facilitates an in-depth understanding of AI implementation and its sustainability implications (Creswell & Poth, 2018), while the case study design enables detailed examination of this contemporary phenomenon within its real-world context (Yin, 2018). By focusing on a single fashion brand, this research provides comprehensive insights into the complexities of AI integration for sustainability purposes.

11.3.1 Data Collection Methods

Semi-structured interviews were conducted with 12 executives involved in AI and sustainability initiatives. Participants represented diverse functional areas: AI, sustainability, retail strategy, global guest innovation, localization, circularity innovation, global production, and creative direction. To ensure confidentiality, participants were assigned alphanumeric codes (ind_01 through ind_12). The initial interviews targeted the heads of sustainability and AI departments, with subsequent participants identified through interviewees' recommendations. Data collection continued until theoretical saturation was achieved (Fontanella et al., 2011).

Interviews were conducted face-to-face between January 21 and February 14, 2025, averaging 30 minutes in duration. Verbatim notes were recorded and verified for transcription accuracy (Rodríguez et al., 2024). The semi-structured interview protocol explored four key areas: (a) current AI applications within specific domains, (b) perceived benefits and implementation challenges, (c) potential risks and ethical considerations, and (d) future vision for AI in fashion. Sample questions included "How does your department utilize AI to advance sustainability objectives?" and "What primary challenges have you encountered in AI implementation?"

11.3.2 Data Analysis Procedures

Data analysis was conducted using Iramuteq software (Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires), which facilitates systematic text analysis through theme identification, keyword association, and linguistic pattern recognition (Mennani & Attak, 2024). The analysis proceeded in three phases (Carvalho et al., 2020: Rodríguez et al., 2024; Souza et al., 2018):

1. Descending hierarchical classification (DHC): This method categorizes active words into lexical classes by segmenting and comparing context units based on lexeme content, identifying stable distributional patterns.
2. Correspondence factor analysis (CFA): This technique generates graphical representations of word and class proximities derived from DHC, focusing on relational patterns rather than frequency counts. Analysis interpreted relationships along both horizontal and vertical axes.
3. Lexicographic analysis: This phase examined word frequency and distribution patterns within the text corpus through similarity analysis.

The research adhered to established ethical guidelines, with all participants providing informed consent prior to participation. Participants were advised of the study's purpose, their right to withdraw, and measures ensuring anonymity and confidentiality.

11.4 Discussion and Findings

This chapter presents an analysis of the interview data gathered from experts in the fashion industry. Key themes and insights were identified using Iramuteq. The findings are discussed in relation to the research questions guiding this study.

11.4.1 Results

The study included 12 respondents, with an equal gender distribution. The participants' professional backgrounds were diverse: 4 (33%) had retail-related experience, 3 (25%) were in AI, 3 (25%) in production, and 2 (17%) in sustainability.

Descending Hierarchical Classification (DHC)

Data were processed using Iramuteq software, resulting in a corpus of 12 texts divided into 106 segments, with 78 segments (73.58%) used for analysis. The dendrogram (Figure 1) visually represents the clustering of interview transcripts based on content, revealing six distinct classes. Each class represents a cluster of text segments sharing similar themes, with percentages indicating the proportion of text within each class.

Theme 1: Operational efficiency and sustainability in production and retail. This theme encompasses Class 4 (18%) "customer experience and engagement," Class 1 (15.4%) "supply chain and production," and Class 5 (16.7%) "materials and sustainable practices." These classes are interconnected with the operational facets of the business, where AI is deployed to enhance efficiency, minimize waste, and foster sustainability. The emphasis is on tangible elements such as materials, supply chains, and retail operations.

Key areas include:

- Sustainable materials and recycling: AI helps source and develop sustainable raw materials, optimize recycling processes, and reduce waste.
- Supply chain optimization: AI improves production planning, reduces overproduction, and ensures the right products are available at the right time.
- Retail and customer experience: AI enhances guest interactions, supports educators in stores, and manages takeback programs for recycling or resale.

Theme 2: Innovation, brand development, and future planning. This theme includes Class 6 (15.4%) "branding and content development," Class 2 (20.5%) "future-oriented product development," and Class 3 (14.1%) "AI and machine learning applications." These classes concentrate on strategic and innovative business aspects, utilizing AI for future planning, brand enhancement, and identification of new opportunities. The focus is on data-driven decision-making and leveraging AI to create value in marketing, product development, and customer engagement.

Key areas of focus are:

- Brand development and content creation: AI helps train employees, develop brand strategies, and create high-quality content.
- Future planning and e-commerce: AI optimizes product assortments, improves website functionality, and enhances communication to align with future goals.

- Machine learning and opportunity identification: AI identifies new opportunities, matches products to customer preferences, and drives innovation across the business.

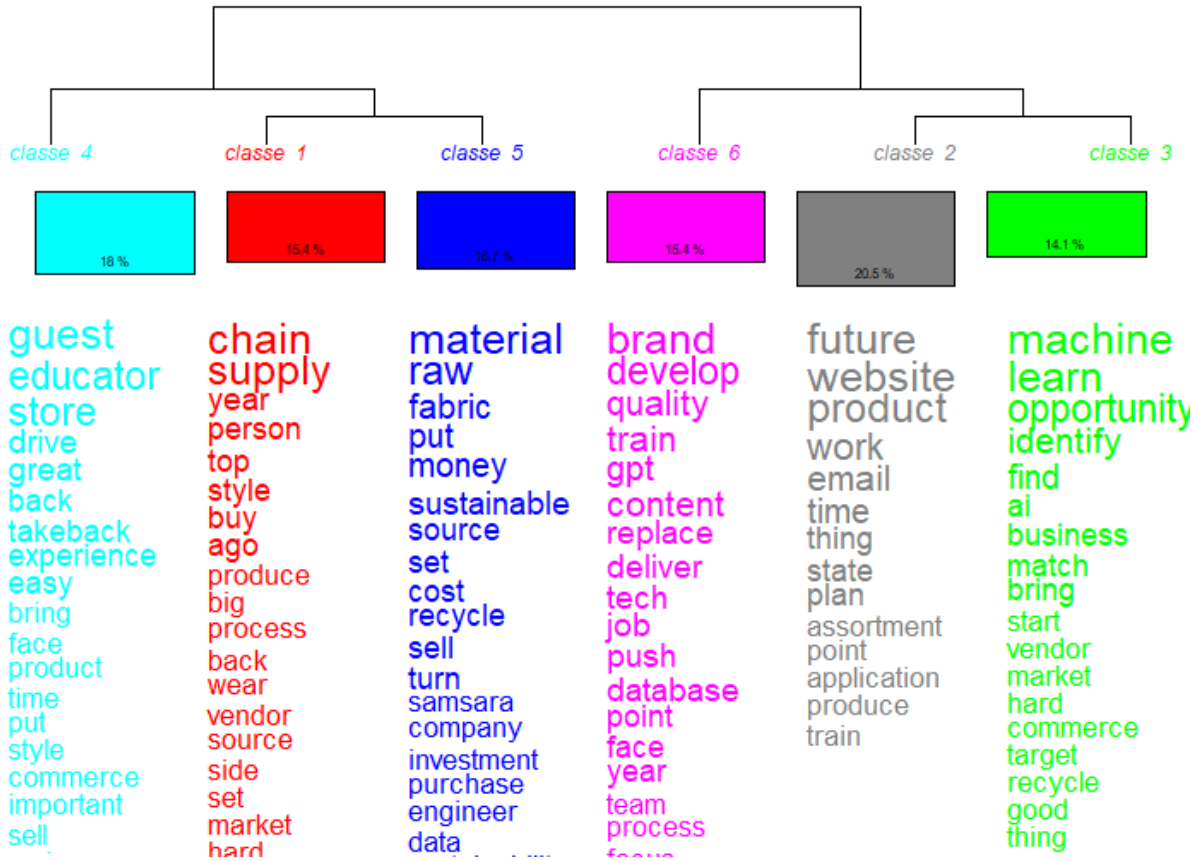

Figure 1

Dendrogram illustrating the hierarchical clustering of interview transcripts based on thematic content.

Correspondence Factor Analysis (CFA)

The CFA (Figure 2) identified two primary factors, explaining 47.03% of the total variance (Factor 1: 25.36%, Factor 2: 21.67%). These factors represent underlying dimensions structuring the textual data. The spatial arrangement of terms on the CFA plot reveals relationships between themes. For example, the proximity of "innovation and technology" to "future-oriented product development" suggests a strong link between technological advancements and future planning. The dendrogram supports these interpretations by clustering related terms, such as "customer experience and engagement," reinforcing the importance of this theme.

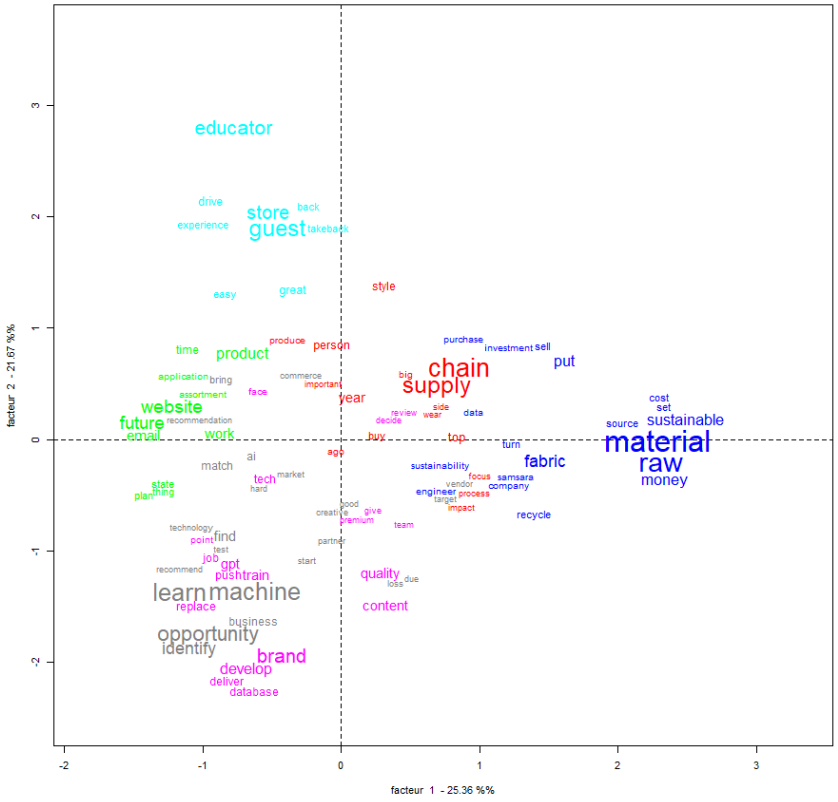

Figure 2

Correspondence factor analysis (CFA) plot showing the relationships between key themes identified in the interview data.

Lexicographic Analysis

The similarity graph (Figure 3) illustrates relationships between words based on co-occurrence, where nodes represent words and edges indicate association strength. Thicker lines indicate stronger associations, while thinner lines indicate weaker ones. Spatial arrangement provides clues to relationships, with closer words being more semantically related. The analysis highlights:

- Sustainability as a core value: The prominence of the "sustainability and materials" theme indicates that sustainability is a central value influencing decision-making.
- Data-driven retail: The "customer experience and retail" theme underscores leveraging data and technology to enhance customer experience and personalize interactions.
- AI-powered innovation: The "artificial intelligence and innovation" theme highlights the potential of AI and machine learning to drive innovation and improve efficiency.

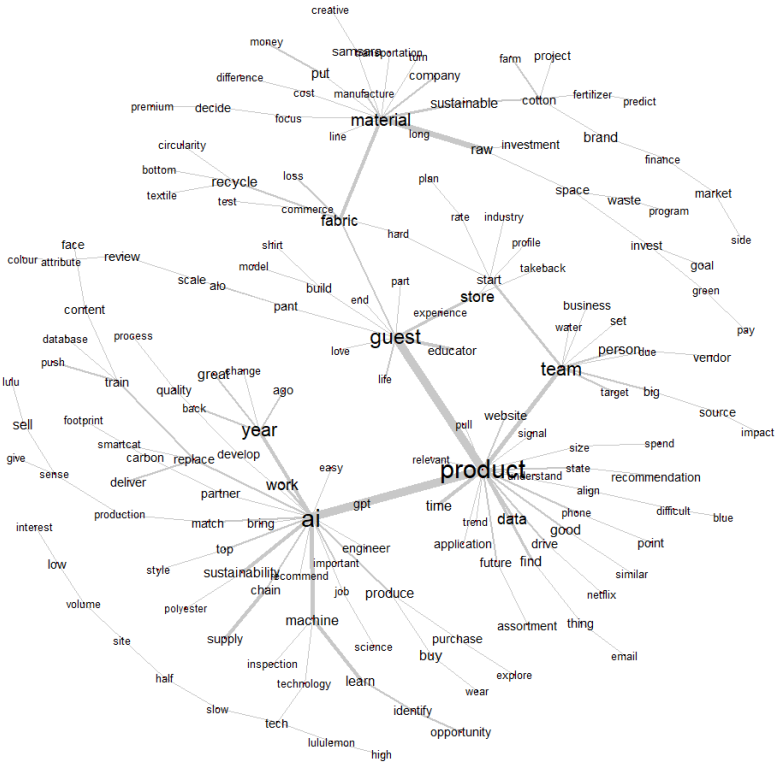

Figure 3

Similarity graph visualizing the co-occurrence relationships between words in the corpus.

11.4.2 Broader Implications and Future Outlook

The analysis of expert interviews using Iramuteq software provided valuable insights into the applications of AI in the fashion industry as well as associated opportunities. This effectively addressed research questions 1 and 2. However, efforts to explore longer-term visions and risks (Research Question 3) did not yield significant patterns. This may be attributed to a generally positive outlook on AI adoption among interviewees that potentially overshadowed discussions on future risks; insufficient emphasis on eliciting perspectives on potential long-term hazards; or limitations in data analysis methods to capture speculative responses. In fact, most interviewees often appeared not to have thoroughly considered long-term implications.

The Dark Side: Potential Risks and Challenges of AI Integration

Despite optimism regarding AI's potential for enhancing sustainability within companies' development teams, there remains concern about producing products that perfectly meet customer desires at optimal times via appropriate platforms—potentially leading to overconsumption. For instance, "the customer may find it lovely that she buys it but doesn't wear it... Customers may keep seeing great things [and] would give an exaggerated signal of an ideal situation: this is what I need but would never wear" (Personal communication, February 14, 2025).

Interviewees from retail-related fields expressed hesitation about adopting AI due to fears about its impact on employment stability: Ind_04 noted apprehension stating: "I am afraid of AI [and] afraid of the future" (Personal communication, January 23, 2025). Ind_12 highlighted

concerns regarding automation replacing human roles: "DeepSeek reaches a critical point. Now AI can replace us. Many industries will be replaced" (Personal communication, February 14, 2025). To mitigate these risks through future-proofing strategies involves identifying core creativity as a competitive advantage for companies aiming not to fall behind if they do not adopt quickly enough.

The Bright Side: Long-Term Vision and Opportunities Enabled by AI

AI also presents a bright future unlocking many possibilities. Ind_09 referenced a 2019 article where Levi's CEO envisioned a tech-integrated experience using AI, facial recognition, and customer data to personalize shopping (Petro, 2019). Upon entering a store, the system would recognize customers (with consent), access their purchase history, and suggest tailored products. Virtual prototypes (e.g., AR try-ons) could replace physical inventory, with items shipped directly to customers, reducing in-store inventory costs and merging online convenience with in-person engagement (Personal communication, January 22, 2025). The argument was that brick-and-mortar stores would remain relevant but must evolve, focusing on emotional connections uniquely fostered in physical stores.

Another possibility lies in the supply chain. Ind_07 shared a vision of an AI-enabled sustainable world where millions of user reviews on digital platforms are leveraged to identify the properties of the perfect fabric (Personal communication, January 23, 2025). This future involves reverse-engineering to create this fabric from waste materials or creating a closed loop with textile-to-textile recycling. As Ind_07 noted, "AI can save the day, and it takes some radical shift in thinking" (Personal communication, January 23, 2025).

The common thread between these visions is the importance of emotional connections and the human touch, which AI could help amplify and preserve while pursuing a more sustainable future for the fashion industry. While technology continues to advance rapidly, successful implementation will require maintaining a delicate balance between automation and personal interaction. This means designing AI systems that enhance rather than replace human relationships, ensuring that technological innovations serve to strengthen the emotional bonds between brands and their customers. The key lies in viewing AI not as a replacement for human interaction, but as a tool to create more meaningful and personalized experiences that celebrate the irreplaceable value of human connection.

11.5 Conclusion and Recommendations

This study explored the multifaceted role of AI in driving sustainability within the fashion industry, addressing three key research questions: (1) current applications of AI, (2) near-term opportunities and challenges, and (3) long-term visions and risks. The findings reveal that AI is actively deployed across multiple domains, from supply chain optimization and sustainable design to customer engagement and waste reduction. Near-term opportunities include enhanced operational efficiency, personalized customer experiences, and improved resource management. However, challenges such as the potential for overconsumption, job displacement, and ethical concerns related to data privacy and algorithmic bias must be carefully addressed.

While the interviews provided valuable insights into current applications and near-term opportunities, exploring longer-term visions and risks proved more challenging. Many interviewees expressed optimism about AI's potential but had not thoroughly considered the long-term implications. This highlights a critical need for proactive and strategic planning to mitigate potential negative consequences and ensure that AI is used responsibly to promote sustainable practices.

11.5.1 Strategic Recommendations

To harness AI's potential for accelerating sustainability in the fashion industry, the following recommendations are proposed:

Every brand plays a role: As noted by Ind_01, sustainability requires contributions from every player in the industry (Personal Communication, January 27, 2025). For instance, while Muji may excel in cotton sourcing, H&M may lead in take-back programs. It is essential to democratize and encourage widespread adoption of AI-driven sustainability initiatives across all fashion brands, regardless of size or market segment. This can be facilitated through industry collaborations, knowledge sharing, and the development of open-source AI tools and resources.

Be the first but not the only: According to Ind_08, Lululemon strives to be a pioneer in investing in innovation without needing to be the exclusive owner of the technology (Personal Communication, January 23, 2025). For example, Lululemon invests in developing textile-to-textile recycling with Samsara and encourages other brands to benefit from this initiative. The aim is to share knowledge with industry players and scale the impact.

Harness data to preserve the human touch: As advised by Ind_07, it is crucial to leverage AI to analyse vast amounts of data for personalizing customer experiences and optimizing supply chain operations while prioritizing the human touch (Personal Communication, January 23, 2025).

11.5.2 Limitations

This study has several limitations that should be considered when interpreting its findings. First, the research is based on a single case study, which limits the generalizability of the results. Future research should include multiple case studies across different types of fashion brands to provide a more comprehensive understanding of AI's impact on sustainability. Second, data were collected through semi-structured interviews that may be subject to response bias. Although efforts were made to ensure confidentiality and encourage honest responses, participants may have hesitated to express negative views about AI or fully disclose potential risks. Third, this study primarily focused on the perspectives of executives within the fashion industry. Future research should incorporate views from other stakeholders such as consumers, employees, and policymakers to provide a more holistic perspective.

11.5.3 Future Research

To build upon the findings of this study and address the identified limitations, future research should focus on the following areas:

Longitudinal studies: Conduct longitudinal studies to track the long-term impacts of AI implementation on environmental and social outcomes in the fashion industry. This will provide valuable insights into the effectiveness of AI-driven sustainability initiatives and help identify any unintended consequences.

Ethical frameworks: Develop comprehensive ethical frameworks for the development and deployment of AI in the fashion industry. These frameworks should address issues such as data privacy, algorithmic bias, and labour displacement, and should be developed in consultation with diverse stakeholders.

Consumer behaviour: Investigate the impact of AI-driven personalization on consumer behaviour and its implications for sustainable consumption. This will help identify strategies to encourage responsible purchasing decisions and reduce overconsumption.

These research directions will contribute to a more sophisticated understanding of AI's potential in driving sustainable transformation within the fashion industry. The integration of AI in fashion sustainability requires careful consideration of human factors, maintaining equilibrium between technological advancement and personal interaction that consumers value (Rathore, 2019). While AI presents significant opportunities for advancing sustainability initiatives in the fashion industry, maintaining human-centric approaches remains paramount for ensuring meaningful connections with consumers, fostering trust, and creating lasting positive impact in the fashion ecosystem.

11.6 References

Bencsik, A., Horváth, C., & Juhász, T. (2016). Y and Z generations at workplaces. *Journal of Competitiveness, 8*(3), 90–106.

Antons, D., & Breidbach, C. F. (2023). Artificial intelligence in healthcare: A systematic review. *Health Policy and Technology, 12*(3), 101-113.

Bain & Company. (2024a). *Four questions for every CEO: CEO sustainability guide 2024*. https://www.bain.com/insights/four-questions-for-every-ceo-ceo-sustainability-guide-2024/?utm_medium=email&utm_source=mkto&utm_campaign=AT-Bain-Insights-2024-12-27&utm_term=four-questions-for-every-ceo-ceo-sustainability-guide-2024/&mkt_tok=Mzc4LU5ZVS0yMjAAAAGXqHf_EKHD_kh-L9bbzgJwdOgmXaiYHN5aII5CsSsBEnqxvDUYyTTzdAnSNo6u7meoWnNHWm5m5o4b0A44kCjQVepKX-DCh8yNHNCP8f5w_HAk6_kE1cekWg

Bain & Company. (2024b). *DeepSeek, a game-changer in AI efficiency*. https://www.bain.com/insights/deepseek-a-game-changer-in-ai-efficiency/

Bain & Company. (2024c). *Generative AI: Potential to improve customer experience*. https://www.bain.com/insights/generative-ai-potential-to-improve-customer-experience/

Boston Consulting Group. (2024). *Where's the value in AI?* https://web-assets.bcg.com/a5/37/be4ddf26420e95aa7107a35aae8d/bcg-wheres-the-value-in-ai.pdf

Cao, Y. (2024). Supply chain optimization in the fashion industry: A case study of Zara. *International Journal of Logistics Management, 35*(1), 123-145.

Carvalho, J. P., Rodrigues, M. N., Souza, V. G., & Fernandes, C. (2020). Text mining for theme extraction: An application to social media data. *Information Processing & Management, 57*(4), 102224.

Comité Colbert, & Bain & Company, Inc. (2024). *Luxury & technology - Artificial intelligence: The quiet revolution*. https://www.bain.com/globalassets/noindex/2024/bain_report_luxury_and_technology_artificial_intelligence_the_quiet_revolution.pdf.pdf

Computer Weekly. (2024, June 15). *Stella McCartney collaborates with Google Cloud to improve supply chain sustainability*. https://www.computerweekly.com/news/366543/Stella-McCartney-collaborates-with-Google-Cloud-to-improve-supply-chain-sustainability

Cooper, Anderson. (2021, October 31). *Yuval Noah Harari on the power of data, artificial intelligence and ...* CBS News. https://www.cbsnews.com/news/yuval-noah-harari-sapiens-60-minutes-2021-10-31/

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (6th ed.). SAGE Publications.

Fontanella, J., Pistrang, N., & Frogner, L. (2011). What is saturation? Commentary on qualitative research. *Family Practice, 28*(4), 443-450.

Forbes Technology Council. (2023, October 4). Fashion's new frontier: Exploring the role of AI in apparel and sustainability. *Forbes*. https://www.forbes.com/sites/forbestechcouncil/2023/10/04/fashions-new-frontier-exploring-the-role-of-ai-in-apparel-and-sustainability/?sh=7b155e6b6715

Gardels, N. (2025, February 4). Why AI is a philosophical rupture. *Noema*. https://www.noemamag.com/why-ai-is-a-philosophical-rupture

Giovanola, B., Kucur, O., & Demir, K. A. (2023). The dark side of artificial intelligence: Ethical dilemmas and societal risks. *AI & Society, 38*(2), 456-478.

Giri, V., Jena, S. K., & Das, K. (2019). Artificial intelligence in fashion retail: A systematic review. *Journal of Retailing and Consumer Services, 51*, 289-307.

Indian Express. (2024, January 18). Lululemon partners with Samsara Eco for textile

recycling. *Indian Express*. https://indianexpress.com/article/lifestyle/fashion/lululemon-partners-with-samsara-eco-for-textile-recycling-9109424/

Jing Daily. (2024, May 28). Dior launches AI platform Astra at VivaTech 2024. *Jing Daily*. https://jingdaily.com/dior-astra-artificial-intelligence-vivatech-2024/

KPMG. (2021). *Ethical AI: A framework for building trust*. https://advisory.kpmg.us/articles/2021/ethical-ai-framework-building-trust.html

Laws, S. (2025). DeepSeek: Pioneering energy-efficient AI for a sustainable future. *Journal of Green Technology, 7*(3), 234-256.

Lululemon. (2024). *Lululemon aligns with Samsara Eco to recycle nylon 6,6*. https://corporate.lululemon.com/media/press-releases/lululemon-aligns-with-samsara-eco-to-recycle-nylon-66

Manning, C. D. (2020). Natural language processing: Progress and prospects. *Proceedings of the National Academy of Sciences, 117*(48), 30041-30048.

McKinsey & Company. (n.d.). *The state of AI in 2020*. Retrieved from https://www.mckinsey.com/featured-insights/artificial-intelligence/global-ai-survey-ai-proves-its-worth-but-few-scale-impactfully

McKinsey & Company. (2023). *The economic potential of generative AI: The next productivity frontier*. https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier

Mennani, S., & Attak, B. (2024). Textual data analysis using Iramuteq: A practical guide. *Quality & Quantity, 58*(1), 123-145.

Møller, M. (2016). Sustainable fashion: A call for global change. *United Nations Sustainable Development Goals Report*.

Pavlik, J. V. (2025). Implications of ChatGPT for journalism and communication. *Journalism & Mass Communication Quarterly, 102*(1), 123-145.

Petro, G. (2019, March 15). Levi Strauss CEO Chip Bergh on why stores still matter. *Forbes*. https://www.forbes.com/sites/gregpetro/2019/03/15/levi-strauss-ceo-chip-bergh-on-why-stores-still-matter/?sh=4039380a75c2

Qu, H. (2024). DeepSeek: China's answer to AI efficiency. *AI Innovation Journal, 5*(4), 321-345.

Ramos, C.M., Ferreira, J.J., & Fernandes, C. (2023). Artificial intelligence for sustainable fashion: A review of applications and challenges. *Sustainability, 15*(16), 12345.

Rodríguez, M.N., Gonçalves, T., & Ferreira, A. (2024). Ensuring transcription accuracy in qualitative research. *Qualitative Research Journal, 24*(1), 45-67.

Sahota, P. (2024). Interdisciplinary approaches to AI and sustainability: A critical review. *Journal of Sustainable Development Studies, 18*(2), 145-167.

Santhanam, R., & Khare, A. (2024). Empirical studies of AI in the fashion industry: A systematic review. *Journal of Business Research, 170*, 111234.

Souza, V. G., Carvalho, J. P., Rodrigues, M. N., & Fernandes, C. (2018). Data analysis techniques for qualitative research: A comparative review. *International Journal of Social Research Methodology, 21*(5), 678-690.

Thompson, Nicholas. (2023, July 11). *Conversation with Yuval Noah Harari on Artificial Intelligence*. LinkedIn. Retrieved from https://www.linkedin.com/pulse/conversation-yuval-noah-harari-artificial-nicholas-thompson/

United Nations. (n.d.). *Sustainable development goals*. Retrieved from https://www.un.org/sustainabledevelopment/

United Nations Environment Programme. (2019). *Putting the brakes on fashion: Towards a circular economy for textiles*. https://www.unep.org/news-and-stories/story/putting-

brakes-fashion-towards-circular-economy-textiles
World Bank. (2019). *How much do our clothes cost the environment?* https://www.worldbank.org/en/news/feature/2019/09/23/how-much-do-our-clothes-cost-the-environment
Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications.

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Chapter 12 - Ethical Dilemmas in Artificial Intelligence Implementations: How to Overcome It?

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Abstract

This research explores the ethical dilemmas of implementing artificial intelligence (AI) in businesses and discusses the ethical principles required to address them. This chapter explores the role of ethical considerations in the responsible deployment of AI. It utilizes qualitative research methods, including a systematic literature review on AI and ethics and expert interviews. The literature analysis highlights several key ethical dilemmas associated with AI, including privacy violations, biased decision-making, responsible AI usage, intellectual property rights, and challenges in monitoring AI applications, among others, that arise from AI implementation and its effects on businesses. Although there are currently no guidelines for the ethical implementation of AI, the analysis suggests the potential to create distinct guidelines that can incorporate ethical principles into AI applications, assisting organizations in addressing the identified dilemmas. The dynamic nature of AI technology and socio-economic development necessitates longitudinal research. Future studies should examine these broader societal implications to grasp AI's influence on business and society. AI applications in business processes, product design, services, and governance raise ethical dilemmas. The authors offer unique insights by exploring the complex relationship between the ethical challenges of AI implementation and the imperative for business innovation and sustainability. Understanding and applying these insights may help organizations achieve their goals by providing more trustworthy and socially acceptable AI-driven products and improving AI-led business processes. This study offers valuable insights for academics, industry leaders, and policymakers seeking to promote responsible and sustainable AI deployment by adhering to ethical principles in its application.

Keywords: *AI ethical dilemmas, AI accountability, Ethics principles, AI ethics, Sustainable AI;*

12.1 Introduction

This chapter centers on the responsible and ethical implementation of AI, highlighting the challenges and primary limitations of applying AI ethical principles in business practices to address ethical dilemmas in AI usage. The ever-increasing application of AI in business and the growing trend of its integration into various aspects of our lives—from social platforms to smart home devices—profoundly affect our daily lives by shaping our choices, often in ways we may not fully comprehend. According to the OECD, AI research publications can proxy for a country's AI development. China accounts for 22% of global AI publications, while the EU stands at 14%, followed by the US at 11%. Between 2022 and 2023, the number of AI incidents reported in the media surged by approximately 1278%, coinciding with the mainstreaming of generative AI (OECD, 2024).

Ethical issues related to AI are evolving and require close attention from different stakeholders. Overcoming ethical dilemmas in AI development and implementation requires understanding and integrating ethical principles into practice. The chapter's discussion is based on the findings of the literature review and interviews with industry experts on solutions to overcome ethical dilemmas in AI applications. The focus is on overcoming ethical dilemmas caused by AI implementation by following AI ethical principles and integrating AI ethics considerations throughout the AI system lifecycle in decision-making, governance, and management.

12.1.1 Methodology

This chapter employs a qualitative research methodology grounded in existing literature and thematic analysis. The literature review encompasses scholarly articles, industry reports, and guidelines on AI ethics. The thematic analysis identifies key themes, categories, and concepts related to the implementation of AI ethics. The expert interviews highlight the challenges and best practices in applying AI ethics.

12.2 Literature Review

A growing body of literature on ethical dilemmas highlights various aspects of AI ethics. Several authors state that AI models can perpetuate or amplify biases present in the training data, leading to discriminatory outcomes (e.g., racial bias in facial recognition or hiring algorithms (Wei & Zhou, 2022), (Olatoye et al., 2024), (Martin & Galaviz, 2022)). AI's reliance on massive datasets risks infringing on individual privacy, enabling mass surveillance or data misuse (Huang et al., 2023), (Ivchyk & Shmatko, 2024). Other scholars note that AI systems lack transparency, making it difficult to understand how decisions are made (Ivchyk & Shmatko, 2024), (Akinrinola et al., 2024). Some authors suggest that clarification is needed regarding who holds responsibility when AI causes harm: developers, users, or the AI itself (Jobin et al., 2019), (Stahl, 2023). Over-reliance on AI undermines human decision-making skills and autonomy, another ethical dilemma that requires attention (Eflova et al., 2023), (Singh & Shah, 2024), (Bubicz & Ferasso, 2024). AI-driven automation threatens jobs and exacerbates economic disparities, raising ethical concerns (Olatoye et al., 2024), (Ikkatai et al., 2022), (Farzin & Samerie, 2023). Unpredictability presents another ethical concern in the use of AI. AI systems can be hacked, misused, or behave unpredictably (Wei & Zhou, 2022),

(Huang et al., 2023), (Ayling & Chapman, 2021); thus, the consequences of using AI are often unforeseen. This complexity leads to numerous issues that scholars, professionals, and society at large must address. Many authors question AI's contribution to sustainable development, as training large AI models consumes vast amounts of energy, thereby contributing to climate change (Bolte & Wynsberghe, 2024), (Huang et al., 2023), (Shkalenko & Nazarenko, 2024). Ethical dilemmas also arise from the challenge that users often unknowingly provide data to train AI systems (Gunn & Rosas, 2024), (Ikkatai et al., 2022), (Singh & Shah, 2024). Some authors express concern that while AI is intended for societal benefits, it can also be weaponized (for example, generative AI creating deepfakes) (Hagendorff, 2020), (Ivchyk & Shmatko, 2024), (Huang et al., 2023).

12.2.1 Summary of Research and Research Gaps

A significant body of research is dedicated to formulating ethical principles and guidelines for AI development and deployment. Research shows that implementing ethical use of AI depends on organizational factors such as leadership support, resource availability, and employee training (Ali et al.,2023). There is a growing awareness of ethical AI usage, as evidenced by the increasing number of developed AI ethical guidelines (Wei, 2022). Numerous organizations from different sectors, such as Google, IBM, Microsoft, DELL, Pfizer, and Lockheed Martin, among others, have published their policies for the ethical usage of AI, typically highlighting the ethical principles to be followed in decision-making in AI applications.

Although there is no universal understanding of how many ethical principles can be applied to address ethical dilemmas, researchers agree on the following five general ethical principles: responsibility and accountability, privacy, transparency, fairness, and non-maleficence (Jobin, 2019). However, in addition to these principles, new ones have recently emerged, such as societal and environmental well-being (Inter-Parliamentary Union, 2025), (Olatoyeet et al., 2024), sustainability (Bolte & Wynsberghe, 2024), democratic control and governance (human oversight) (Huang et al., 2023), (Singh & Shah, 2024), and freedom and autonomy (Jobin et al., 2019). There are variations in the interpretation and implementation of these ethical principles, indicating that research in ethical studies is still evolving. There is a lack of consensus on the interpretation and implementation of these ethical principles in decision-making. The new field of AI ethics has recently emerged and is developing rapidly. While there exists a substantial body of research on AI ethics, significant gaps remain in translating general ethical principles into practical actions to address ethical dilemmas regarding the responsible use of AI (Adeyelu et al., 2024), (Hagendorff, 2020), (J. Ali et al., 2023).

The World Economic Forum (WEF) suggests the following ethical AI principles divided into two groups: epistemic principles and general ethical AI principles. The epistemic principles constitute the prerequisites for investigating AI ethicality and represent conditions of knowledge that enable organizations to determine whether an AI system is consistent with ethical principles. They include such principles as interpretability (explainability, transparency and provability), reliability, robustness and security. Interpretability means that an AI system should be able to explain its model decision-making overall and what drives an individual prediction to different stakeholders. Reliability, robustness and security mean that AI systems should be developed to operate reliably over long periods using the right models and datasets. According to the WEF, the general ethical principles of AI are accountability, data privacy, lawfulness and compliance, beneficial AI, human agency, safety, and fairness (World Economic Forum, 2021).

These general ethical AI principles above are coherent with ethical principles such as

responsibility, accountability, privacy, transparency, fairness and non-maleficence. They are adapted to the AI application context.

Research in AI ethics emphasizes the "black box" nature, indicating that the workings of AI are not visible or comprehensible to users (Huang et al., 2023). This represents a crucial area of investigation that should concentrate on identifying and mitigating bias. While numerous AI ethics guidelines are available, there remains a gap in understanding their effectiveness and their impact on human decision-making. There is an absence of longitudinal studies on the long-term effects of AI on society and on how AI is altering our actions over time. A research gap persists in analyses of power structures and other structural influences that give rise to ethical issues in AI development and implementation. Consequently, clear guidelines for the application of ethical principles in AI are essential.

12.2.2 Application of Principles of Ethics in AI Context

Further explanation of ethical principles is needed to understand how to overcome ethical dilemmas caused by AI implementation by applying them.

Responsibility and accountability - The significance of accountability in AI systems is emphasized in various sources (Olatoye et al., 2024), (Huang et al., 2023), (Akinrinola et al., 2024). If an AI system fails, there ought to be a mechanism to hold someone responsible, be it the designer, developer, or company (Huang et al., 2023). Measures should be established to ensure responsibility and accountability for AI systems and their outcomes, prior to and after implementation (Huang et al., 2023). AI systems must be auditable, and those in charge of AI systems should be accountable for the system's behaviors and decisions and, consequently, responsible for any harm caused (Lane, 2023).

Social responsibility in AI extends beyond technical aspects, and companies should priorities ethical considerations alongside business objectives and long-term implications (Olatoye et al., 2024), (Ivchyk & Shmatko, 2024), (Adeyelu et al., 2024). Frameworks for accountability involve clarifying the roles and responsibilities of stakeholders, including developers, organizations, and regulatory bodies (Akinrinola et al., 2024). The question of who is responsible for AI systems is complex, with possible actors including developers, users, owners, regulators, or the system itself. It is crucial to clarify legal liability and the attribution of responsibility for AI (Sthal, 2023).

AI actors must ensure they are accountable for the design and implementation of AI systems in such a way that personal information is protected throughout the life cycle of the AI system. This directly links accountability with the necessity for privacy impact assessments, emphasizing the importance of safeguarding personal information when employing AI systems (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022). The attribution of decision-making in AI systems presents challenges when trying to assign responsibility for actions or consequences. Unlike human decision-makers, AI lacks consciousness and intentionality, complicating the allocation of accountability (Akinrinola et al., 2024).

Economic incentives can easily override a commitment to ethical principles and values, suggesting that the purposes for which AI systems are developed and applied may not align with societal values or fundamental rights (Hagendorff, 2020; Bolte & Wynsberghe, 2024). Consequently, integrating ethical principles into AI systems is essential for ensuring that service enhancement aligns with ethical norms (Huang et al., 2023). To implement ethical AI principles effectively, a concerted effort is required from all AI stakeholders, including

policymakers, technologists, ethicists, and end-users (Jobin et al., 2019).

Ethical principles and values are the starting point for trust in AI (Brendel et al., 2021) and form the basis for the regulation and certification of systems based on AI (Munoko et al., 2020). That emphasizes that the development of AI should serve society and not violate ethical norms (Groşanu et al., 2024).

Responsibility and accountability in AI mean having comprehensive mechanisms to determine who is responsible for AI actions. This extends beyond merely identifying culpability. It also involves ensuring ethical development and establishing mechanisms for oversight. That includes establishing clear lines of responsibility for various stakeholders involved in the AI lifecycle, which necessitates a holistic framework that promotes responsibility and the ability to address outcomes.

Privacy - As businesses create substantial data, responsible data handling and robust data privacy and security become critical ethical considerations for AI. Protecting individual privacy rights is a central tenet of ethical AI applications (Olatoye et al., 2024), (Bubicz & Ferasso, 2024). Privacy is a value to be cherished and a right that demands protection. This concept is frequently explored in data protection and security (Jobin et al., 2019). Data protection must be integrated into every stage of an AI system's development and operation. Addressing privacy concerns requires a strong ethical foundation and clear legal guidelines for responsible AI use (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022).

Technical solutions such as differential privacy, privacy by design, and data minimization are suggested for achieving privacy (Huang et al., 2023). Transparency and access to information must be balanced with the right to privacy (Lane, 2023). However, the drive to "unbiased" AI by using ever-larger, more diverse datasets may contradict the ethical principle of giving individuals greater control over their data and its use to safeguard their privacy and autonomy (Jobin et al.,2019).

The ability of AI to learn from and combine large datasets presents significant privacy risks (Stahl, 2023, p.2). AI systems can collect, analyze, and utilize personal data in unprecedented ways, creating an increased necessity to protect individuals from unwarranted surveillance and data exploitation (Olatoye et al., 2024). Adhering to data privacy standards and obtaining informed consent from users is crucial for ethical AI development and deployment (Adeyelu et al., 2024), (Gunn-Rosas, 2024), (Singh & Shah, 2024), (Huang et al., 2023).

Privacy concerns are paramount with AI-driven social media technologies, as these systems often collect and store vast user data. Collecting and storing this data without explicit consent can violate privacy and raise concerns about unauthorized access and surveillance (Oladele et al., 2024). Many AI systems function as "black boxes," making understanding their decisions and how personal data is used is challenging. This lack of transparency can hinder efforts to identify and mitigate bias, eroding user trust (Ivchyk & Shmatko, 2024, p. 65). Users often lack control over their data once collected, rendering them vulnerable to potential misuse and privacy breaches (Oladele et al., 2024). Privacy in the context of AI is a critical ethical consideration, encompassing the protection of individual rights; businesses must priorities privacy by implementing robust safeguards that respect user control over their data. The increasing prevalence of AI applications in various domains has highlighted the imperative of data privacy and security (Khan & Mer, 2023).

Transparency - It is impossible to build stakeholder trust without transparent AI algorithms and decision-making processes. To maintain public trust and operate ethically, businesses using AI must priorities transparency and ensure that their AI decision-making processes are comprehensible.

An evolved perspective on transparency, surpassing mere technical interpretability,

requires an understanding of AI decision-making processes and a rigorous evaluation of the justifiability and rationality that underpin the entire AI lifecycle, from design and implementation to the resulting outcomes (Huang et al., 2023). This aspect of transparency insists that the design and implementation choices of AI systems are reasonable, ethically sound, aligned with societal values, and justifiably transparent, enabling stakeholder scrutiny and appraisal of the system's objectives and underlying rationale (Huang et al., 2023), (Olatoye et al., 2024), (Lane, 2023).

Transparency encompasses the visibility of the AI system's processes, alongside the justification and rationale behind its design, implementation, and resultant outcomes (Martin & Galaviz, 2022; Jobin et al., 2019). The inherent opacity in the decision-making processes of many AI systems, often referred to as their "black box" nature, presents a significant ethical challenge that undermines accountability and reduces user confidence (Akinrinola et al., 2024; Ivchyk & Shmatko, 2024).

AI systems, particularly those utilizing machine learning, often suffer from inscrutability—meaning their internal workings are difficult to comprehend even with access to the model itself—and non-intuitiveness—meaning their decision-making relies on complex, non-obvious statistical relationships (Ferrario et al., 2020).

For responsible corporate AI practices, open communication regarding AI strategies and decision-making is essential, including clear explanations of the model's reasoning, the factors it takes into account, and the relative significance assigned to each (Akinrinola et al., 2024).

Open communication plays a dual role: addressing concerns about the "black box" nature of AI algorithms that obscure decision-making and enabling public understanding of AI system implementation (Lane, 2023), (Farzin & Samerie, 2023).

Explainable AI (XAI) fosters a better understanding of AI systems, whereas open data sharing improves transparency and reduces bias (Akinrinola et al., 2024).

Increased information disclosure and transparency are essential for fostering trust in AI, a principle extensively addressed in AI ethics that greatly impacts other ethical practices (Bubicz & Ferasso, 2024).

Fairness - In AI, fairness pertains to whether an AI algorithm treats different groups of people equally; justice, on the other hand, refers to ensuring that the system for allocating goods or resources does not harmfully benefit fortunate groups (Martin & Galaviz, 2022). Given the potential to perpetuate and amplify existing societal biases, which can lead to discriminatory outcomes, fairness in AI algorithms remains a crucial concern in AI ethics, necessitating careful attention to data, algorithm design, and ongoing monitoring (Adeyelu et al., 2024).

AI systems learn from data; if that data contains biases, the AI can perpetuate those biases (Ivchyk & Shmatko, 2024). This is a significant concern because AI systems can decide or categorise individuals based on inappropriate criteria (Stahl, 2023). Moreover, AI systems can reinforce stereotypes and make biased decisions, leading to unequal access and treatment (Farzin & Samerie, 2023). This highlights that AI systems must not treat individuals as mere data subjects, but rather as people with unique circumstances (Hagendorff, 2020). For AI systems operating in critical domains such as credit scoring, criminal justice, education, and hiring, transparency and fairness are essential preconditions for ethical operation. Their absence risks engendering discriminatory outcomes, exemplified by the restriction of financial resources for marginalised communities, the perpetuation of biased policing practices, the creation of unjust student assessments, or the obstruction of diverse workforce development (Akinrinola et al., 2024 ; Ivchyk & Shmatko, 2024).

AI systems can perpetuate and amplify societal biases and discrimination, exacerbating inequality and harm to specific groups (Bolte & Wynsberghe, 2024). AI, particularly machine

learning algorithms, learns from training data. If this data reflects existing biases, the AI will replicate and worsen those biases. This can occur in various contexts, such as mortgage approval programmes or facial recognition training predominantly on white men (Martin & Galaviz, 2022). AI biases often disproportionately impact underrepresented groups, intensifying existing inequalities (Bolte & Wynsberghe, 2024). As AI systems can be designed to subtly influence user behaviour, some sources express concern that this may undermine individual worth as human beings (Eflova et al., 2023). AI systems must be developed with inclusivity and equity in mind, actively preventing the perpetuation of biases present in data. It is crucial to maintain ethical vigilance, ensuring that the pursuit of efficiency in AI does not overshadow fundamental human values such as fairness, accountability, and privacy.

Non-maleficence - In AI ethics, non-maleficence is a fundamental principle that ensures AI systems do not cause or worsen harm, implemented through safety, security, and robustness measures (Huang et al., 2023). According to the research findings, AI safety necessitates prioritizing human safety, dignity, and both physical and mental integrity by preventing harm (including discrimination, privacy violations, and bodily harm) and ensuring secure operation (Huang et al., 2023; Jobin et al., 2019). Security involves protecting AI systems from vulnerabilities and attacks to safeguard humans, the environment, and ecosystems (Huang et al., 2023; United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022). Huang et al. (2023) assert that robustness is a critical component of responsible AI, alongside accountability, liability, fairness, and explainability, and is essential for avoiding harmful outcomes (Huang et al., 2023).

Guided by the principle of non-maleficence, AI ethics mandates a systematic approach to risk management throughout the entire lifecycle of AI systems. This approach includes identifying and assessing potential harms (safety, security, robustness), implementing activities for mitigation and prevention, monitoring AI operations on an ongoing basis, and establishing redress mechanisms for any harm that arises (Jobin et al., 2019; United Nations Educational Scientific and Cultural Organization (UNESCO), 2022; Huang et al., 2023; Chettiar & Prof. Jish Joy, 2024).

Human oversight is the concept and ethical principle of ensuring that humans maintain control and responsibility over AI systems and their outcomes (Huang et al., 2023; United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022). AI systems gain a crucial layer of control by incorporating human oversight through Human-in-the-Loop (HITL) approaches. This allows for the identification of potential biases and consideration of ethical implications, ultimately leading to more robust, reliable, and trustworthy AI decision-making (Akinrinola et al., 2024). By extending this principle, continuous monitoring of AI systems should also be deeply integrated with HITL. By actively involving stakeholders, including end-users and experts, in the oversight process, we can ensure that AI systems remain aligned with human values, ethical considerations, and desired outcomes (Anjum et al., 2023). Additionally, the European Commission has established guidelines for trustworthy AI, mandating human oversight by emphasizing human autonomy and decision-making while ensuring that humans retain ultimate control over AI and autonomous systems (Ivchyk & Shmatko, 2024). HITL may increase users' trust in AI systems because they know humans are involved. However, if human oversight is minimal or poorly implemented, it could provide a false sense of security. From the perspective of analyzing this term throughout research, HITL should be integrated into AI, particularly in all critical decision-making processes. This leads to humans assuming unlimited control and responsibility for AI decision-making. Humans should always be responsible for AI, as they are the designers and developers (Jobin et al., 2019).

Sustainability—The concept of Sustainable AI addresses two interconnected dimensions:

using AI to advance global sustainability goals and ensuring the sustainability of AI systems themselves. Sustainable AI requires a holistic approach that considers both the benefits and risks of AI and ensures that its development and deployment are environmentally responsible.

There is growing recognition that the environmental impact of AI is significant, including carbon emissions from training AI models and the effects of AI hardware on the environment (Bolte & Wynsberghe, 2024). A structural approach is necessary to identify ethical issues related to AI on a broader scale, often involving an examination of the power structures that hinder the uncovering of these issues (Bolte & Wynsberghe, 2024).

The increasing emphasis on long-term sustainability and social responsibility, moving beyond traditional finance, necessitates an interdisciplinary approach to sustainable IT. This approach draws upon knowledge from technology, ecology, social sciences, and management to address the complex challenges of our time (Shkalenko & Nazarenko, 2024). AI applications must be developed and used responsibly to reduce energy consumption and environmental impact (Jobin et al., 2019).

Companies are being asked to create policies to ensure accountability regarding potential job losses from AI and to use sustainability challenges as opportunities for innovation (Jobin et al., 2019).

12.3 Discussion and Findings

Five experts were interviewed to gather diverse perspectives on the ethical dilemmas arising from implementing AI and the approaches for overcoming them. The selection prioritized individuals with proven experience and deep knowledge in their respective fields. Crucially, the focus was on practitioners actively engaged with AI in real-world settings, particularly in leadership roles such as department heads, leading researchers, and association presidents, aimed at capturing strategic insights. This multi-faceted approach, drawing from various sectors, including telecommunications, technology, language technology, and the non-governmental sector, sought to provide a comprehensive understanding of AI. The interview results summarized the experts' views on addressing biases in AI systems, enhancing transparency, data privacy concerns, accountability, job threats, developing resilient AI, overreliance, and AI sustainability.

12.3.1 Biases in AI

The literature analysis's findings show that addressing biases in AI systems, particularly those originating in training data, is essential for building trustworthy and equitable AI systems. A significant concern is that AI models can learn and even worsen existing biases in the data they are trained on, which poses a substantial ethical dilemma in decision-making.

Interviewed experts agree that addressing these biases will ensure that AI systems are fairer and more equitable. Experts highlighted several key approaches to identifying and reducing bias, particularly those originating from training data, emphasizing that the data used to train AI is critical. A fundamental principle is thoughtful data selection. They recommend using datasets that accurately represent real-world diversity, including demographics, geographic regions, and social situations. Furthermore, experts advise regularly auditing datasets to find and address biases within the training data itself.

Beyond data, experts stress the need for ongoing monitoring and testing of AI models. This includes implementing routine audits to detect biases in the data and in the AI model's

outputs. They suggest using established methods and metrics available to the public for bias testing. Stress-testing models with unusual or extreme scenarios are also crucial to uncover discriminatory behaviors that might not be obvious in typical use cases. To ensure a comprehensive review, experts recommend forming diverse panels of reviewers to assess AI decisions before they are put into practice, allowing for correcting biases. Furthermore, long-term evaluations involving end-users in group audits and stress tests are vital for real-world bias detection.

Experts also acknowledged the practical challenges. They pointed out that identifying and mitigating bias is an ongoing process, and even auditing can be subjective, raising the question of "the bias of the auditor?" However, in cases where unacceptable levels of bias are found, experts recommend a process of iterative refinement. This involves expanding or improving the training data and carefully adjusting the AI model to specifically reduce the identified bias. It is also advisable to check for biases early in the development process, such as when building a "Proof of Concept," potentially through questionnaires.

12.3.2 Transparency in AI

The literature review reveals that transparency in AI raises significant questions, particularly ensuring that AI systems become more understandable. Specifically, the experts were asked whether applying transparency as an ethical principle in AI decision-making can help overcome this opacity. If so, how would you implement such transparency?

Experts generally agree on the importance of enhancing AI transparency, although they recognize that achieving complete transparency may be challenging due to the inherent complexity of advanced AI models and the competitive pressures within the AI industry. Despite these challenges, experts advocate for measures to improve transparency. They emphasize that responsible AI developers play a crucial role, which includes the obligation to provide technical details about the development of their models, such as information regarding training data and the methods used to enhance performance and address safety concerns. Experts also underscore the necessity of informing users when interacting with AI systems and, where possible, providing access to the rationales behind AI-driven decisions.

Furthermore, they recommend utilizing techniques that make AI decisions more interpretable, even for non-experts. Clear documentation detailing how AI models are trained and make decisions is also essential. Providing the source of information used by AI and educating users on how answers are generated are regarded as important steps towards building trust and understanding. Some experts even suggest demonstrating the AI's "thought process" in a manner easily understandable to humans, for instance, by showing how it searches for information and constructs its outputs. Linking model outputs to the relevant source material is further recommended to enhance clarity and enable users to verify the basis and validity of the AI's conclusions. Adopting industry-wide transparency standards, such as those outlined in the EU AI Act, is also considered a valuable step towards establishing a common framework for transparency. They pointed out that the highly competitive nature of the commercial AI sector might make model developers reluctant to publicly release all detailed information about their proprietary models. Experts note that even with complete knowledge of the training data, techniques, and model parameters, the reasoning processes within large, complex AI models may remain intrinsically difficult to explain intuitively and understandably.

Given these limitations on achieving transparency, experts suggest shifting the focus to the application side of AI. This involves rigorously checking for critical risks associated with specific AI applications. To enhance understanding, experts recommend utilizing Explainable

AI (XAI) tools, carefully tracking data to identify and mitigate biases, and thoroughly documenting the decision-making process.

12.3.3 Data Privacy

Based on the analysis of the literature, opaque data collection often raises significant concerns regarding data privacy, particularly given the immense data requirements of many AI models. Experts agree on a multi-faceted approach to ensure data privacy in AI systems. A fundamental principle is data minimization: experts consistently advocate for collecting only the data that is strictly necessary for AI training. Alongside this is the crucial step of anonymization and pseudonymization, highlighting the removal of directly identifying information from datasets. Techniques such as differential privacy, which involves adding controlled noise to datasets, are also recommended to further conceal individual identities and prevent re-identification.

Legal and technical safeguards are considered essential. Experts strongly recommend adhering to established privacy frameworks such as GDPR and CCPA, as well as implementing strong encryption techniques to protect data during both storage and transmission. In addition to these fundamental measures, transparency and user consent are emphasized as critical.

To address the risks associated with centralized data collection, experts propose exploring decentralized approaches, such as federated learning, which enables AI model training without requiring central data aggregation. Furthermore, implementing technical constraints that limit applications' ability to collect excessive personal data is considered an essential protective measure.

In addition to technical and legal solutions, experts also emphasize the necessity of governance and oversight. This involves conducting regular audits and special assessments, particularly for high-risk AI applications, and establishing accountability measures such as ethics committees. The integration of privacy into AI development – a principle known as "privacy by design" – is strongly advocated.

While broadly aligned, some nuances and challenges were acknowledged. One expert expressed uncertainty regarding the "best" answer, and it was noted that data privacy concerns extend beyond AI systems to include any system accessing user data, highlighting the pervasive nature of this challenge in the digital age.

12.3.4 Accountability in AI

The question of who is truly at fault in the application of the accountability principle in AI design and application—the developers who create AI, the users who deploy it, or even the AI itself—lacks a straightforward answer. This ambiguity stems from the intricate nature of AI systems and their development processes, making the assigning and distributing of responsibility a significant ethical dilemma.

Experts have diverse opinions on this matter. One perspective regards AI as a tool, contending that human actors must bear ultimate responsibility. From this standpoint, either the developer or the user could be held accountable, depending on the context. Developers may be deemed responsible if the AI system is fundamentally flawed, providing incorrect information or taking inappropriate actions due to design errors. Conversely, users might be held accountable if they misuse the AI, applying it in ways beyond its intended purpose or in contexts for which it was not designed.

However, other experts advocate for a shared responsibility model. This perspective suggests that accountability should be distributed among various stakeholders, including developers, businesses deploying AI, regulators, and users. Within this framework, developers are primarily accountable for designing AI systems that are demonstrably fair and safe. Businesses deploying AI bear the responsibility of ensuring that their AI applications adhere to ethical standards and are used responsibly. Regulators are vital for establishing and enforcing AI accountability laws and ensuring compliance. Even users have a role, as they are expected to utilize AI responsibly and within its defined scope of intended use.

Experts have proposed several mechanisms to operationalize this shared responsibility. They suggest that legal frameworks must evolve to define liability based on factors such as the AI system's level of autonomy and the risks associated with its application. Clear governance structures are needed to explicitly outline the roles and responsibilities of developers, operators, and end-users involved with AI systems. The implementation of AI liability laws is also recommended to ensure organizations are held accountable for the AI systems they deploy, drawing parallels to the existing legal accountability of employers for their employees. Some experts advise exploring ethical and legal models similar to employer-employee accountability.

Experts advocate for practical measures such as requiring human validation for high-stakes AI decisions to ensure human oversight in critical applications. Furthermore, maintaining detailed logs of AI decisions proves valuable for tracking errors, comprehending system behavior, and assigning responsibility when harm occurs. Establishing clear channels for users to contest AI-driven decisions is also essential for ensuring fairness and providing redress. In particularly high-risk areas where AI errors could result in significant harm, some experts even propose that regulators should consider restricting or prohibiting the use of AI altogether, given the current limitations of the technology. This risk-based approach is evident in emerging AI regulations like the EU AI Act. In regions where robust AI regulation is lacking, experts call for a global or regional dialogue to establish and agree upon fundamental ethical constraints for the development and deployment of AI.

Regardless of the specific model, experts agree that assigning responsibility for AI harm is not about blaming a single entity but rather about establishing clear lines of accountability.

12.3.5 Overreliance on AI

Another ethical dilemma is a prevalent concern: becoming overly reliant on AI systems may undermine our capacity to make effective decisions and act independently.

Experts largely agree that excessive reliance on AI significantly jeopardizes human cognitive abilities. A primary concern is the decline in critical thinking and problem-solving skills. The worry is that if AI systems manage cognitive tasks for us, individuals may become mentally passive, neglecting to engage their minds. This could lead to a situation where people struggle to perform even basic tasks without AI assistance, akin to losing the ability to navigate without solely depending on navigation apps. Experts emphasize that, throughout history, technological advancements have consistently transformed human skill sets, and AI represents the latest evolution in this ongoing process. Consequently, they argue that a broader societal discussion regarding which human skills are essential to retain and actively nurture in the age of AI is crucial.

Nevertheless, some experts offer a more nuanced and potentially optimistic perspective. They argue that if AI successfully takes over numerous routine and burdensome tasks, it could free up human time and cognitive resources, providing more choices and ultimately enhancing freedom and autonomy in certain respects. These experts emphasize that the impact of AI on

human decision-making is not fundamentally different from how technological progress has reshaped human skills throughout history. Even within this more positive framing, the core risk remains: the potential for individuals to stop engaging in critical thought and to neglect the development of essential analytical, conceptual, and critical thinking skills. To navigate this complex landscape, experts advocate for a shift towards human-AI collaboration rather than pursuing complete automation whenever possible. They suggest regularly training individuals in independent decision-making and implementing AI explainability tools. They also stress that when used thoughtfully, AI can enhance decision-making—such as by suggesting dietary options based on available food and preferences—without necessarily diminishing human decision-making capacity. One expert highlights a cyclical pattern in which ease and overconfidence can lead to a decline in human capabilities if not consciously managed.

12.3.6 AI Threat to Jobs

Another ethical dilemma posed by the application of AI is the fear that increased automation, driven by AI, threatens jobs, potentially widening existing economic gaps and creating new disparities. The pressing question is how to proactively ensure that the advantages of automation are distributed more equitably throughout society rather than concentrating wealth and opportunity in the hands of a few.

Experts largely concur on the necessity for broader benefit-sharing from automation and propose various interconnected approaches. A central theme is preparing the workforce for the evolving job market. This involves fundamentally reshaping the education system to emphasize future needs and the skills required in an AI-driven era, particularly training individuals for new AI-related roles. Experts also emphasize the importance of workforce transition programmes, potentially funded by the revenue generated from automation, to support those whose jobs are displaced. Experts advocate for a strategic approach to AI applications themselves. They suggest prioritizing AI applications that complement human resources and enhance human capabilities, rather than solely focusing on complete job replacement. The overarching goal should be to harness technological change for economic growth and societal benefit. This necessitates proactively mitigating the potential distress from job losses in specific sectors and addressing the challenges faced by groups struggling to find employment in the automated economy. Experts highlight the need to educate society about the beneficial applications of AI, countering purely negative narratives. This includes increasing public awareness of AI, providing comprehensive training programmes to empower individuals, and ensuring accessibility to AI tools, particularly for those unemployed and seeking new opportunities.

The emphasis should center on leveraging AI as an enabler of growth, shifting the perception from a threat to employment towards a driver of new possibilities. Underpinning these specific recommendations is a call for a holistic and balanced approach, highlighting the importance of aligning technological advancement with practical education and robust support systems. Experts also provide a historical perspective, reminding us that significant technological changes have invariably led to the elimination of some jobs while simultaneously creating new ones. Although such transitions can be disruptive and cause temporary hardship, they do not inherently result in a decline in overall job numbers or societal wealth. The key lies in proactively managing this transition.

12.3.7 Robust and Resilient AI Systems

It is a well-founded concern that AI systems are vulnerable to hacking, misuse, and unpredictable behavior, which creates significant risks. Therefore, the crucial question is: how can we develop AI systems that are more robust and resilient, thereby making them less susceptible to these diverse threats?

Experts emphasized that AI systems pose novel risks beyond traditional cybersecurity concerns. These AI-specific threats include data poisoning (manipulating training data), prompt injection (exploiting input vulnerabilities), model distillation (unauthorized model copying), sensitive data exposure, and excessive agency (uncontrolled AI actions). Therefore, a proactive approach is essential, with both model developers and consumers actively implementing appropriate security controls and continuously monitoring for potential breaches. Transparency regarding vulnerabilities is also crucial, enabling a better understanding and quicker remediation when issues arise.

To guide these efforts, experts recommend employing established security frameworks for AI published by organizations such as NIST, ISO, OWASP, MITRE, and Google. It is hoped that these frameworks will converge over time, fostering a shared understanding of best practices for secure AI development and deployment. Clear guidelines for AI deployment are also considered essential for maintaining consistent security.

In addition to preventative measures, experts emphasize the significance of resilience and active defense. This entails ensuring human intervention remains feasible in AI decision-making processes and providing a vital override mechanism. Exposing AI systems to potential attack scenarios through stress testing is recommended as a means to actively enhance their resilience. Securing AI models and datasets from cyber threats is essential.

12.3.8 AI and Sustainability

Large AI models require immense energy, raising concerns about their contribution to climate change. Therefore, experts were asked a critical question: How can we priorities energy efficiency and sustainability in AI development?

Experts largely agree on a multi-pronged approach to tackle this challenge. One primary approach focuses on model optimization and efficiency. Experts recommend using lightweight, less energy-intensive models and employing quantization techniques to lessen the computational demands of these models. They advocate for reducing computation-heavy training cycles and consistently working to enhance the efficiency of both model training and serving (the energy consumed when the model is actively in use). According to experts, a crucial shift in focus should involve moving away from the relentless pursuit of increasingly larger models towards developing more compact and efficient ones, directly reducing energy consumption. Furthermore, they suggest leveraging advancements in GPU and supercomputer development to optimize hardware for energy-efficient AI workloads.

Beyond these technical and infrastructure solutions, experts provide essential contextual considerations and future perspectives. They recognize that improvements in efficiency are presently somewhat counterbalanced by the rising demand for increasingly sophisticated and larger AI models. Nevertheless, they foresee that a performance ceiling is likely to be reached at some stage, which will naturally shift the focus towards efficiency. Looking further ahead, some experts highlight the potential of commercially viable fusion power as a long-term solution, suggesting that AI's energy demands and capabilities may even expedite fusion

research. They assert that the pressure for energy efficiency will inherently foster innovation in model compression and reduction.

Experts have noted that while the dominant business logic in the AI field is characterized by a "race to create larger models," they anticipate a shift towards greater emphasis on efficiency and cost-effectiveness. They also provide perspective by observing that the energy consumption of cryptocurrency mining currently exceeds that of training large language models, indicating that AI, despite being energy-intensive, is not the sole or most significant contributor to digital energy demand. Consequently, experts advocate for a dual approach: enhancing the efficiency of AI training while investing in clean energy infrastructure. They frame the challenge of AI's energy use as a catalyst for developing cleaner power sources and sustainable technologies, highlighting that the pressure to power AI is already accelerating investments in areas such as improved data center cooling and more efficient computing.

12.4 Conclusions and Further Directions of Research

These ethical principles concerning AI development and implementation are interconnected, making it essential to adopt a holistic perspective when developing AI systems and to ensure that ethical considerations are integral to the entire lifecycle process. Creating ethical AI involves more than just sophisticated technology; it requires contemplating the broader societal implications of AI applications and embedding ethical principles within the organizational culture and governance framework.

Merely enhancing AI technically will not resolve the ethical issues. Ethical principles must be integrated into AI from the outset, and all parties involved should collaborate by adhering to these principles. This also entails incorporating ethical considerations into AI from the initial design and development stages, which includes thorough ethical risk assessments.

As this research emphasizes, collaboration is crucial among technologists, ethicists, policymakers, and end-users to ensure that AI development is technologically advanced, ethically sound, and safe for use. Finding the right balance between business objectives and the well-being of a broad range of stakeholders is key to ensuring that AI benefits everyone.

As the context of AI ethics continually evolves, we must keep learning and adapting our approach to mitigate the risks associated with AI applications. We must remember that AI offers numerous advantages, aiding in the achievement of sustainable development goals.

Leadership in responsible design and application of AI and oversight from managers must be ensured. Establishing committees or boards to oversee ethical aspects of AI development and ensure adherence to ethical guidelines are suggested by researchers and practitioners as a necessary condition to overcome ethical dilemmas caused by AI application (Ivchyk & Shmatko, 2024, p.65), (Akinrinola et al., 2024, p. 53), (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022, p. 28).

Using structured frameworks that emphasize transparency, fairness, and accountability are foundational pillars of responsible AI development (Olatoye et al., 2024), (Huang et al., 2023), (Lane, 2023), (Adeyeluet al., 2024), (Ivchyk & Shmatko, 2024).

Conducting ethical impact assessments to identify potential risks and benefits associated with AI systems is essential for ensuring that ethical considerations are integrated throughout the AI lifecycle (Akinrinola et al., 2024), (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022).

Engaging with diverse stakeholders to understand societal values and concerns related to AI is essential to ensure that AI development and application aligns with societal good

(Adeyelu et al., 2024), (Ivchyk & Shmatko, 2024), (Akinrinola et al., 2024), (United Nations Educational, Scientific and Cultural Organization (UNESCO), 2022).

There was broad expert consensus that effectively securing AI demands a multilayered approach. This approach combines conventional cybersecurity techniques with an innovative approach tailored to AI's unique weaknesses. A key building block is leveraging existing and reliable cybersecurity practices.

Experts stressed the importance of enforcing governance through role-based access controls and ethics committees to ensure compliance with evolving standards, such as the EU AI Act. Ultimately, building resilient AI is an ongoing process of adaptation and improvement.

Further research directions could include, but are not limited to, best practices for integrating ethical AI principles into organizational culture and decision-making, how cultural differences impact the application of ethical AI principles, the development of Ethical AI frameworks, and the key success factors facilitating the application of ethical AI principles.

12.5 References

Akinrinola, O., Okoye, C. C., Ofodile, O. C., & Ugochukwu, C. E (2024). Navigating and reviewing ethical dilemmas in AI development: Strategies for transparency, fairness, and accountability. GSC Advanced Research and Reviews, 18(3), 050–058. https://doi.org/10.30574/gscarr.2024.18.3.0088

Adeyelu, O. O., Ugochukwu, C. E., & Shonibare, M. A (2024). ETHICAL IMPLICATIONS OF AI IN FINANCIAL DECISION – MAKING: A REVIEW WITH REAL WORLD APPLICATIONS. International Journal of Applied Research in Social Sciences, 6(4), 608–630. https://doi.org/10.51594/ijarss.v6i4.1033

Ayling, J., & Chapman, A (2021). Putting AI ethics to work: are the tools fit for purpose? AI and Ethics, 2(1), 405–429. https://doi.org/10.1007/s43681-021-00084-x

Ali, S. J., Christin, A., Smart, A., & Riitta Katila (2023). Walking the Walk of AI Ethics: Organizational Challenges and the Individualization of Risk among Ethics Entrepreneurs. ArXiv (Cornell University). https://doi.org/10.1145/3593013.3593990

Anjum, P. G., Soni, P. K., Prof. Khushboo Choubey, Priyanshi Warkad, & Saniya Choubey (2023). Incorporating AI into Business Education: Examining Ethical Issues with Case Study Illustrations. International Journal of Innovative Research in Computer and Communication Engineering, 11(06), 8884–8889. https://doi.org/10.15680/ijircce.2023.1106075

Bolte, L., & Aimee van Wynsberghe (2024). Sustainable AI and the third wave of AI ethics: a structural turn. AI and Ethics. https://doi.org/10.1007/s43681-024-00522-6

Bubicz, M., & Ferasso, M (2024). Advancing Corporate Social Responsibility in AI-driven Human Resources Management: A Maturity Model Approach. International Conference on AI Research, 4(1), 82–90. https://doi.org/10.34190/icair.4.1.3016

Chettiar, F. & Joy, J (2024). Navigating Ethical Dilemmas: The Role of AI in Supply Chain Decision-Making. International Journal for Research in Applied Science and Engineering Technology, 12(10), 460–467. https://doi.org/10.22214/ijraset.2024.64552

DELL (2022) Dell Technologies Principles for Ethical Artificial Intelligence Dell Technologies Principles for Ethical Artificial Intelligence. DELL. https://www.delltechnologies.com/asset/en-us/solutions/business-solutions/briefs-summaries/principles-for-ethical-ai.pdf

Eflova, M., Yulia Vinogradova, & Aleksandr Vitushkin (2023). The impact of artificial intelligence on the development of modern society. E3S Web of Conferences, 449, 07005–07005. https://doi.org/10.1051/e3sconf/202344907005

Etzioni, A., & Etzioni, O (2017). Incorporating Ethics into Artificial Intelligence. The Journal of Ethics, 21(4), 403–418. https://doi.org/10.1007/s10892-017-9252-2

Farzin, O., & Sameie, R (2023). Ethical and Legal Challenges of Using Artificial Intelligence in Digital Businesses. Journal of Technology in Entrepreneurship and Strategic Management, 2(2), 17-27.

Ferrario, A., Loi, M., & Viganò, E (2019). In AI We Trust Incrementally: a Multi-layer Model of Trust to Analyze Human-Artificial Intelligence Interactions. Philosophy & Technology, 33(3), 523–539. https://doi.org/10.1007/s13347-019-00378-3

Google (2023). Google AI Principles. Google AI. https://ai.google/responsibility/principles/

Groșanu, A., Melinda-Timea Fülöp, & Nicolae Măgdaș (2024). Ethical Dilemmas in Digital Accounting: A Comprehensive Literature Review. Contabilitatea, Expertiza Și Auditul Afacerilor, 5(4), 56–67. https://doi.org/10.37945/cbr.2024.04.06

Gunn-Rosas, C. L (2024). Beyond the Binary: AI, Ethics, and Liability in the Legal Landscape. Texas A&M Journal of Property Law, 10(3), 389–410. https://doi.org/10.37419/jpl.v10.i3.2

Hagendorff, T (2020). The ethics of AI ethics: An evaluation of guidelines. Minds and Machines, 30(1), 99–120. https://doi.org/10.1007/s11023-020-09517-8

He, H., & Chonlavit Sutunyarak (2024). Perception of Corporate Social Responsibility, Organizational Commitment and Employee Innovation Behavior: A Survey from Chinese AI Enterprises. Journal of Risk and Financial Management, 17(6), 237–237. https://doi.org/10.3390/jrfm17060237

Huang, C., Zhang, Z., Mao, B., & Yao, X (2022). An Overview of Artificial Intelligence Ethics. IEEE Transactions on Artificial Intelligence, 4(4), 1–21. https://doi.org/10.1109/tai.2022.3194503

IBM (2024). AI Ethics | IBM. Www.ibm.com. https://www.ibm.com/impact/ai-ethics

Ifeoluwa Oladele, Adeyinka Orelaja, & Oladayo Tosin Akinwande (2024). Ethical Implications and Governance of Artificial Intelligence in Business Decisions: A Deep Dive into the Ethical Challenges and Governance Issues Surrounding the Use of Artificial Intelligence in Making Critical Business Decisions. International Journal of Latest Technology in Engineering Management & Applied Science, XIII(II), 48–56. https://doi.org/10.51583/ijltemas.2024.130207

Inter-Parliamentary Union (2025), Ethic principles: Societal and environmental well-being. https://www.ipu.org/ai-guidelines/ethical-principles-societal-and-environmental-well-being

Ikkatai, Y., Hartwig, T., Takanashi, N., & Yokoyama, H. M (2022). Octagon Measurement: Public Attitudes toward AI Ethics. International Journal of Human–Computer Interaction, 38(17), 1–18. https://doi.org/10.1080/10447318.2021.2009669

Jobin, A., Ienca, M., & Vayena, E (2019). The Global Landscape of AI Ethics Guidelines. Nature Machine Intelligence, 1(9), 389–399. https://doi.org/10.1038/s42256-019-0088-2

Lane, L (2023). Artificial Intelligence and Human Rights: Corporate Responsibility in AI Governance Initiatives. Nordic Journal of Human Rights, 1–22. https://doi.org/10.1080/18918131.2022.2137288

Lockheed Martin (2023). Artificial Intelligence and Aegis: The Future is Here. Lockheed Martin. https://www.lockheedmartin.com/en-us/news/features/2023/artificial-intelligence-and-aegis-the-future-is-here.html

Martin, K., & Villegas-Galaviz, C (2022). AI and Corporate Responsibility. Springer EBooks, 1–5. https://doi.org/10.1007/978-3-319-23514-1_1297-1

Microsoft (2019). Responsible AI Principles and Approach | Microsoft AI. Microsoft.com. https://www.microsoft.com/en-us/ai/principles-and-approach/#tabs-pill-bar-ocb9d4_tab0

Morley, J., Elhalal, A., Garcia, F., Kinsey, L., Mökander, J., & Floridi, L (2021). Ethics as a Service: a Pragmatic Operationalisation of AI Ethics. Minds and Machines, 31. https://doi.org/10.1007/s11023-021-09563-w

Morley, J., Kinsey, L., Elhalal, A., Garcia, F., Ziosi, M., & Floridi, L (2021). Operationalising AI ethics: barriers, Enablers and next Steps. AI & Society, 38. https://doi.org/10.1007/s00146-021-01308-8

OECD. (2024). Artificial intelligence. OECD. https://www.oecd.org/en/topics/policy-issues/artificial-intelligence.html

Olatoye, F. O., Awonuga, K. F., Mhlongo, N. Z., Ibeh, V., Elufioye, O. A., & Ndubuisi, L (2024). AI and ethics in business: A comprehensive review of responsible AI practices and corporate responsibility. International Journal of Science and Research Archive, 11(1), 1433–1443. https://doi.org/10.30574/ijsra.2024.11.1.0235

Olatoye, F. O., Awonuga, K. F., Mhlongo, N. Z., Ibeh, V., Elufioye, O. A., & Ndubuisi, L (2024). AI and ethics in business: A comprehensive review of responsible AI practices and corporate responsibility. International Journal of Science and Research Archive, 11(1), 1433–1443. https://doi.org/10.30574/ijsra.2024.11.1.0235

Pfizer (2023). Artificial Intelligence (AI) Responsibility in Healthcare is Critical | Pfizer. Www.pfizer.com. https://www.pfizer.com/news/articles/three_principles_of_responsibility_for_artificial_intelligence_ai_in_healthcare

Shkalenko, A. V., & Nazarenko, A. V (2024). Integration of AI and IoT into Corporate Social Responsibility Strategies for Financial Risk Management and Sustainable Development. Risks, 12(6), 87–87. https://doi.org/10.3390/risks12060087

Singh, V., & Shah, P. B (2024). AI AND ETHICS. INTERANTIONAL JOURNAL of SCIENTIFIC RESEARCH in ENGINEERING and MANAGEMENT, 08(03), 1–5. https://doi.org/10.55041/ijsrem29381

Stahl, B. C (2023). Embedding responsibility in intelligent systems: from AI ethics to responsible AI ecosystems. Scientific Reports, 13(1), 7586. https://doi.org/10.1038/s41598-023-34622-w

UNESCO (2021, November 23). Recommendation on the Ethics of Artificial Intelligence. Unesco.org. https://unesdoc.unesco.org/ark:/48223/pf0000381137

Vasyl Ivchyk, & Nataliia Shmatko (2024). EXAMINING THE ETHICAL CONSIDERATIONS OF USING ARTIFICIAL INTELLIGENCE IN BUSINESS MANAGEMENT. Scientific Notes of Taurida National v I Vernadsky University Series Economy and Management, 74(3). https://doi.org/10.32782/2523-4803/74-3-10

Waelen, R (2022). Why AI Ethics Is a Critical Theory. Philosophy & Technology, 35(1). https://doi.org/10.1007/s13347-022-00507-5

Wei, M., & Zhou, Z (2022). AI Ethics Issues in Real World: Evidence from AI Incident Database. https://doi.org/10.48550/arxiv.2206.07635

World Economic Forum (2021). 9 ethical AI principles for organizations to follow. https://www.weforum.org/stories/2021/06/ethical-principles-for-ai/?gad_source=1&gclid=CjwKCAiAiOa9BhBqEiwABCdG89MYsdVjcBjdtsZw7ItWwKOWxmsosEnS5Ry3rTN3HwH6KAU51-3WzBoCvF4QAvD_BwE

Zurich, 2025