Artificial Intelligence Driven Sustainable Leadership Integrating Ethical Governance, Human-Centered Strategy and Environmental Intelligence

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Abstract
The role of leadership has shifted as organizations increasingly turn to Artificial Intelligence for decision-making, calling for a new paradigm of sustainability, ethics, and human-centric governance. The current literature, however, focuses on either Artificial Intelligence adoption or ethical leadership or environmental sustainability but lacks an in-depth understanding of how these go together to affect sustainable leadership outcomes. This research delves into the role of Artificial Intelligence in sustainable leadership while incorporating three complementary elements: ethical Artificial Intelligence leadership, environmental intelligence in Artificial Intelligence use and human-centric Artificial Intelligence strategies. The study used a quantitative, cross-sectional survey design, and data were gathered from 150 managers and professionals from organizations that have adopted Artificial Intelligence. Partial Least Squares Structural Equation Modelling was used to assess measurement construct validity and the relationships between constructs. The results indicate that there is a strong positive link between environmental intelligence and sustainable outcomes of Artificial Intelligence adoption, which underscores the need for the environmentally conscious use of Artificial Intelligence. Human-centered Artificial Intelligence strategies show positive but relatively small effects, and are seen as supporting measures for improving employee well-being and leadership effectiveness. The study makes a significant empirical contribution to the existing literature on Artificial Intelligence for sustainable leadership in an integrated model, which links together the technological, ethical, and human aspects of Artificial Intelligence. The results have implications for organizations interested in meeting environmental, social, and governance goals and integrating Artificial Intelligence into their operations.

Highlights
- AI leadership framework integrating ethics and sustainability.
- Environmental intelligence improves sustainable leadership outcomes.
- Human-centered AI supports responsible leadership practices.
- PLS-SEM validates AI-driven sustainable leadership framework.
- ESG-oriented AI adoption enhances organizational sustainability.

Keywords: Artificial Intelligence; Ethical Leadership; Environmental Sustainability; Supply Chain Management; Environmental, Social, and Governance.

1. Introduction
AI is an emerging disruptive technology that has changed the face of organizational decision-making, leadership, and strategic management in all business sectors (Ossiannilsson, 2025). Artificial Intelligence (AI) has made operational efficiency, innovation potential, and competitive edge much more effective, as it allows making informed decisions on the basis of data, predicting, and automation (Alamandi, 2025). The use of AI systems is becoming an integral part of the strategic planning, monitoring performance, and making multi-faceted decisions by leaders (Suljic & others, 2025). Nevertheless, the high rate of spreading AI technologies has also presented serious ethical, social, and environmental concerns (Zhao & Gómez Fariñas, 2023). Algorithms bias, transparency, absence of accountability, the replacement of human labour, and the increasing environmental footprint of AI systems based on data-intensive systems have come under the serious revision of scholars, practitioners, and policymakers (Herrmann, 2023). This is because, the leadership role in AI responsibilities goes beyond the technological performance to include ethical governance, social responsibility, and environmental sustainability as organizations increase their use of AI (Avurakoghene & Oredein, 2023). In that respect, the notion of sustainable leadership has become prominent with a focus on the long-term value creation with economic performance proportioned to ethical behaviour, social welfare, and environmental care (Munir et al., 2023). Sustainable leadership requires leaders to incorporate innovation and sound decision-making in such a way that technological progress cannot affect the human values and the eco systems (Odugbesan et al., 2023). Although previous studies have discussed the adoption of AI, ethical leadership, and sustainability as distinct areas, little has been done to address the overlap in the intersection of these areas in the context of leadership (Madanchian et al., 2024). As a result, the organizations are confused about how leaders can successfully use AI without violating the ethical integrity and sustainability pledges (Lodhi et al., 2024). The identified gap highlights the necessity of systematic and empirical studies that consider the effects of AI-based leadership practices on sustainable leadership performance in modern organizations (Challoumis, 2024).
Although there has been an increase in conceptual discussions concerning the topic of ethical AI, responsible innovation, and sustainable leadership, there is a lack of empirical evidence that supports these correlations,

especially when applied within the framework of organizational leadership. The current literature is based primarily on theoretical models, empirical observations, or case studies, with little differing generalizability and adequate statistics to validate the results. Furthermore, previous studies tend to concentrate on technical issues of AI governance or environmental sustainability separately without paying much attention to the importance of guidance in streamlining AI adoption against ethical and sustainability goals. To overcome this shortcoming, the current study will take a quantitative and survey-based design to empirically examine sustainable leadership through Partial Least Squares Structural Equation Modelling (PLS-SEM). In particular, the paper analyses three important dimensions of leadership: ethical AI leadership, that focuses on equity, traceability, responsibility in the use of AI; environmental intelligence in AI adoption (EIA), which is the focus of leadership on the effects of AI and resource efficiency; and human-centered AI strategies, which focuses on the consideration of employee well-being and human-AI interaction by leadership. The analysis of the combined and individual implications of these dimensions on sustainable leadership results is the objective of the study by incorporating these dimensions into a cohesive framework of analysis. The study provides empirical evidence from managers and professionals working in AI-adopting organizations, thereby contributing to the emerging body of knowledge on AI-driven sustainable leadership. The findings enhance theoretical understanding by addressing existing gaps in leadership, AI governance, and sustainability literature while also offering practical insights for organizational leaders seeking to implement responsible AI practices aligned with Environmental, Social, and Governance (ESG) objectives. Overall, the study responds to the increasing demand for evidence-based understanding of how leadership can responsibly leverage AI innovation to achieve long-term organizational sustainability.

1.1. Motivation and Significance of the Study

The motivation behind the research comes into light due to the speed at which AI has been integrated into supply chain and logistics management and the increased realization that technological improvement is not enough to guarantee long-term organizational sustainability (Teixeira & Pacione, 2024). Despite the tremendous advantages of AI technologies in their efficiency, agility, and decision-making, they have also raised ethical issues like algorithmic bias, absence of transparency, labour displacement, and enhanced surveillance as well as environmental issues, including energy consumption, carbon emission, and resource utilization (Zhanbayev et al., 2023). Meanwhile, sustainability has become a strategic need due to climatic change, resource insufficiency, regulatory demands, and increased stakeholder demands. Although the topic of AI use, sustainability, and supply chain optimization has become the focus of increasing literature, these areas are frequently discussed separately without much focus on the role of a leader to balance between innovation and ethical accountability and care about the environment (Balcıoğlu et al., 2024). The importance of the study is that it unites these dispersed views and puts more emphasis on sustainable leadership as a key mechanism in driving responsible adoption of AI. Through the expression of a coherent leadership viewpoint, the research would add to the enhanced insight into how companies can manage to match AI-led innovation with ethical practices, sustainability, and value generation in the supply chain networks.

1.2. Research Questions

- RQ1: How does ethical AI leadership impact sustainable leadership effectiveness in organizations adopting artificial intelligence?
- RQ2: What role does EIA play in enhancing organizational sustainability performance?
- RQ3: How do human-centered AI strategies affect responsible leadership decision-making in AI-enabled organizations?
- RQ4: What is the combined effect of AI-driven leadership practices on overall sustainable leadership outcomes?

1.3. Research Objectives

- RO1: To analyze the effect of ethical AI leadership on sustainable leadership effectiveness in organizations adopting AI technologies.
- RO2: To analyze the role of EIA on organizational sustainability performance.
- RO3: To assess how human-centered AI strategies influence responsible leadership decision-making.
- RO4: To evaluate the combined effect of ethical AI leadership, environmental intelligence, and human-centered AI strategies on sustainable leadership outcomes.

1.4. Rest of the section

The remainder of this study is organized as follows. Section 1 presents the background of the research, motivation, the objectives and the importance of the study. Section 2 is the literature review of the literature on sustainable leadership, ethical AI, environmental intelligence, and human-centered AI strategies to define the theoretical background and determine research gaps. Section 3 gives the theoretical model, and builds the research hypotheses. Section 4 provides the research methodology which comprises research design, sample, and measurement tools and data analysis. Section 5 presents and discusses the empirical findings of the PLS-SEM analysis. Lastly, Section 6 is a conclusion of the study and provides future research directions.

2. Literature Review

2.1. Sustainable Leadership

Sustainable leadership is one of critical leadership paradigms that have arisen due to rising economic and social volatility, and environmental pressures that have been encountered by contemporary organizations (Camilleri, 2024). In comparison to the conventional leadership concepts, which are focused on performance measurement and profit maximization in the short term, sustainable leadership is concerned with the long-term value creation that focuses on economic success and seeks to balance between the social equity and the environment as its stewards (Ahsan & Khawaja, 2024). Sustainable leadership is a conceptualized approach taken by scholars that coordinates vision, ethical decisions, and stakeholders of an organisation with ecological responsibility to promote sustainable company productivity and well-being in society (Buonocore et al., 2024). This type of leadership focuses on the continuity, resilience, and accountability and promotes leaders to think about the long-term impact of their strategic choices on various stakeholders, such as employees, communities, and future generations (Kulkov et al., 2024).

Sustainable leadership dimensions usually incorporate such dimensions as ethical integrity, orientation towards innovation, inclusiveness to the stakeholders, environmental awareness, and development of human capital. Sustainable leaders create cultures of learning, facilitate responsible innovation and support governance systems that strengthen accountability and transparency. Empirical sources have shown that sustainable leadership has a positive impact on organizational performance in terms of employee engagement, corporate reputation, innovation ability and long-term financial performance. In addition, sustainable leadership has been associated with enhanced environmental performance by adopting the use of green practices, effective use of resources and sustainability-based strategies. Nevertheless, when organizations are adopting more and more sophisticated technological tools in their decision-making process, like AI, the traditional models of sustainable leadership are challenged. The increasing use of algorithms systems makes questions of ethical responsibility, human control, and environmental effects and requires a new concept of sustainable leadership in technologically-focused environments. Although it has become more topical, empirical data on sustainable leadership in AI-driven organizations is still scarce, indicating the necessity to find the way in which AI-enabled organizations could organize leadership practices in ways that do not compromise sustainability values.

2.2. Ethical AI Leadership

Ethical AI leadership defines leadership behaviors that guarantee the responsible design, implementation and management of AI systems in compliance with ethical standards like fairness, governance and integrity and non-discrimination (Kandasamy, 2024). With AI systems taking more strategic and operational decisions, leaders become critical in forming the entry and management of the technologies within enterprises (Megdad et al., 2024). The ethical issues associated with AI are algorithmic bias, opacity in decision-making, data breaches, and the process of moral abdication to AI (Sain et al., 2024). The use of AI in making decisions without responsible governance can strengthen social disparities, decrease trust, and subject organizations to reputational and regulatory risks (Ucheagwu-Okoye, 2025).

Ethical AI leadership commitment entails setting up governance systems, ethical principles, and responsibility systems to regulate the use of AI. Explainable algorithms, transparent AI decision-making and proactive bias mitigation strategy are the key elements of ethical AI leadership. Previous studies of ethical leadership indicate that ethically sound and impartial leaders have a great impact on ethical climate and employee conduct within an organization. Applying this point of view on AI case, ethical AI leadership should increase the level of trust to AI systems, better decisions, and responsible innovation. Although, a substantial part of the current research on ethical AI is normative or policy based, concentrating on the principles and guidelines instead of empirical verification. Survey-based research that quantitatively involves how AI ethical leadership practices can be translated into quantifiable sustainable leadership outcomes is lacking. This gap highlights the need to empirically evaluate ethical AI leadership as one of the fundamental dimensions of AI-based sustainable leadership.

2.3. Environmental Intelligence in AI Adoption

The concept of EIA means the ability of leadership to consider the environmental aspect in selecting the AI technologies, designing and implementing them (Sarker & Nuruzzaman, 2024). Although AI is commonly marketed as an efficiency-saving and waste-cutting technology, it also causes a considerable environmental impact with its energy-consumption rates, data centre activities, and computing intensity (Kuchtíková & Maryska, 2024). The adoption of AI needs to be sustainable, which means that leaders need to assess the environmental advantages and costs of AI systems critically (Wang et al., 2025). Environmental intelligence empowers the leaders to use AI to optimize resources, reduce emissions, and sustain supply chains and minimize adverse environmental externalities (Khalid et al., 2024).

Research on environmental management and sustainability suggests that data-driven technologies can serve to monitor the environment, predictive maintenance, and energy optimization. The utilization of AI-based analytics in the field of smart energy systems, waste minimization, and climate risk evaluation has been applied successfully. Nonetheless, awareness of leadership and strategic intent is important in defining whether the adoption of AI leads to environmental sustainability or contributes to the environmental ecological problems. Strong environmental intelligence of the leaders increases their chances to align AI investments in sustainability purposes, to implement green IT practices, and promote environmentally responsible innovation. Empirical studies on leadership-based EIA are limited, even though the importance of green AI and sustainable computing has increased. Majority of the literature used is on the technological capabilities as opposed to the processes of decision making by the leaders. There is therefore an evident gap of interest to empirically research the impacts of environmental intelligence embedded in AI leadership on organizational sustainability outcomes.

2.4. Human-Centered AI Strategy

The human-centered AI strategy concentrates on creating and implementing AI systems to enhance human abilities, secure the welfare of employees, and encourage human-AI interaction or even integration, instead of complete automation or labor displacement (Ozmen Garibay et al., 2023). This framework stems from socio-technical systems theory, which underscores the intricate relationships between technological tools, human actors, and broader organizational frameworks (Shen et al., 2025). Human-centered AIs focus on transparency, usability, employee empowerment and ethical issues concerning job security and psychological health (Ystgaard & De Moor, 2023). Leadership is an important aspect that determines the perception and experience of AI among employees and determines its acceptance, trust, and utilization (Kottara & Asonitou, 2025).

Studies show that the AI deployment has the potential to cause anxiety, resistance, and ethical issues in employees in case they feel threatened by its use or loss of jobs. On the other hand, the introduction of AI as a decision-support tool, which improves human judgment and does not substitute it, places AI as a human-based AI strategy in the hands of leaders. These strategies have been associated with better job satisfaction, skills acquisition and learning in the organization. The leadership styles that have been identified as human-centered have been linked to a higher commitment to the organization and ethical climates. Nevertheless, there are few empirical studies on the role of human-centered AI strategies in the leadership framework. Available studies concentrate more on the human-computer interaction or technical design concepts, but the element of leadership making decisions and strategy is overlooked. Thus, the inclusion of human-centered AI strategy into the sustainable leadership research is an essential aspect that offers critical perspective on adoption of responsible AI and its effects on the effectiveness of leadership.

2.5. Research Gap

Even though sustainable leadership, ethical leadership, and AI governance along with environmental sustainability have been studied at length in the previous literature, there is no comprehensive study of their intersection on one empirical framework. The majority of the current literature take conceptual, normative or qualitative approaches, which have little empirical validity and generalizability (Almandhari, n.d.). More specifically, there is apparent absence of quantitative research studies (survey-based) to empirically investigate the impact of ethical AI leadership, EIA, and human-centered AI strategies on sustainable leadership results. Moreover, using the sophisticated methods of analysis like the PLS-SEM in that regard is limited. To fill these gaps, the current study suggests and empirically proves an AI-based sustainable leadership model on the basis of survey data and PLS-SEM. In this manner, it addresses data-driven demands and provides strong empirical data to the leadership, AI, and sustainability studies.

3. Conceptual Framework and Hypotheses

3.1. Conceptual Framework

The conceptual framework of sustainable leadership theory, ethical leadership theory, and socio-technical systems theory and combines the perspectives to outline the impact of AI-inspired leadership practices on sustainable leadership outcomes. Since organizations are progressively using AI in their strategic and operational decision-making processes, leadership is at the center of formulating how they govern, adopt, and integrate these technologies with long-term sustainability goals. The suggested model allocates ethical AI leadership, EIA, human-centered AI strategy, as major exogenous constructs that jointly define sustainable leadership results. Ethical AI leadership is a leadership devotion to justice, openness, responsibility, and accountability in managing AI systems. Leaders shape organizational norms and values and in the case of AI-enabled activity, they also shape the design, monitoring and evaluation of algorithmic decisions. Environmental intelligence of AI adoption reflects the awareness of the leader to the environmental consequences of AI technologies and using AI strategically to achieve the maximum efficiency of the resources and minimum ecological impact. The idea of human-centered AI strategy highlights the leadership practices essential to ensure that the AI systems can help in the human decision-making, safeguard the welfare of employees, and encourage human-AI interaction. All these dimensions combine to be a whole of AI-driven leadership that puts into consideration the aspects of ethical integrity, environmental responsibility, and social sustainability.

Figure 1. AI-Driven Sustainable Leadership Framework

The Figure 1 indicates the conceptualizes sustainable leadership outcomes as a multidimensional construct that includes leadership effectiveness, making responsible decisions, and organizational sustainability performance in the long term. The framework can be empirically tested by either testing the individual or joint influence of each of the three AI-driven leadership dimensions and sustainable leadership outcomes. This framework is especially appropriate when PLS-SEM is used because it can be used to test complex relationships between latent constructs at the same time and offer strong information on both the quality of measurement and structural paths. All in all, the conceptual framework provides a theory-based and systemic basis of an empirical study of the contribution of responsible AI leadership practices to sustainable organizational performance.

3.1.1. Theoretical Foundation of the Framework

The conceptual framework in the proposed model is based on three theories: Sustainable Leadership Theory, Ethical Leadership Theory and Socio-Technical Systems Theory, in order to establish a conceptual foundation in understanding the effect of AI-based leadership practices on sustainable leadership outcomes. Impartiality, transparency, and accountability in decision-making are key principles of ethical leadership theory that go hand-in-hand with good stewardship of AI. Sustainable Leadership Theory emphasizes the need to balance innovative developments with sustainable ecological and societal goals. Socio-Technical Systems Theory offers insights into how human needs and technological systems can interact in a way that contributes to the organizational transformation, collaboration and employee well-being, highlighting the importance of human-centric approaches to AI.

3.1.2. Construct Operationalization

The conceptual framework involves four key constructs: Ethical AI Leadership (EAL), EIA, Human-Centered AI Strategy (HCAS), and Sustainable Leadership Outcomes (SLO). Ethical AI Leadership was assessed using the indicators of clarity, impartiality, and accountability in AI governance. Resource optimization and environmentally sustainable practices related to the adoption of AI were measured as indicators of EIA. The four indicators used to assess Human-Centered AI Strategy were related to employee well-being and employee-AI interaction. The Sustainable Leadership Outcomes was assessed by indicators of responsible leadership, long-term sustainability performance, and balanced innovation practices in organizations.

3.1.3. Relationship Between AI-Driven Leadership Dimensions and Sustainable Leadership Outcomes

The introduced model is under the presumption that the dimensions of AI-driven leadership have positive impacts on sustainable leadership outcomes individually and collectively. By fostering clarity and responsibility in the use of AI for decision-making, ethical AI leadership builds trust and responsible governance within organizations. Adopting AI with environmental intelligence contributes to organizations' sustainable performance by leveraging efficient resource usage and environmental responsibility in AI implementation. Collaboration between humans and AI systems improves employee engagement and organizational adaptability, fostering a human-centered AI strategy. Collaboration between human and AI systems not only brings about a human-centered AI strategy but also enhances employee engagement and organizational adaptability. The leadership aspects together build responsible innovation, long-term sustainability, and effective organizational leadership in an AI environment.

3.1.4. Justification for the Proposed Framework Using PLS-SEM

PLS-SEM was chosen as a technique for evaluating the proposed framework since it was a study with multiple latent constructs and simultaneously assessed the structural model. PLS-SEM is suitable for exploratory and prediction models used in research to investigate complex relationships between constructs. Employing this technique enables investigators to assess construct reliability together with convergent and discriminant validity, while simultaneously examining structural path configurations within a consolidated model. Moreover, PLS-SEM is applicable for studies conducted with moderate sample size and non-normal data distributions, which is appropriate for the present survey research related to the sustainable leadership practices using AI.

3.2. Hypotheses Development

H1: Ethical AI leadership has a significant positive influence on sustainable leadership outcomes through responsible AI governance, transparency, and stakeholder trust.

Ethical Leadership Theory emphasizes accountability, fairness, and Clarity in organizational decision-making processes. Ethical AI leadership is crucial for creating a positive environment in an AI-enabled organization by fostering responsible governance of algorithmic systems, mitigating bias, enhancing explainability, and enabling transparent AI decisions. These practices enhance responsible innovation capacities, organization credibility, and stakeholder trust. Moreover, ethical AI governance mitigates potential ethical and reputational risks with AI implementation. Thus, ethical AI leadership is expected to positively contribute to sustainable leadership outcomes, and long-term sustainability performance of the organization.

H2: EIA exerts a substantial beneficial influence on corporate sustainability outcomes

The literature of environmental sustainability underlines the significance of leadership awareness and strategic intent in the realization of the environmental performance objectives. The high-level environmental intelligence allows leaders to utilize AI technologies to efficiently use resources, minimize waste, and enhance environmental monitoring and address the ecological costs of AI infrastructure. The adoption of AI by such leaders would help sustain the performance of the organization and ensure its long-term sustainability by balancing AI use and environmental goals. Thus, the impact of environmental intelligence on AI adoption will positively influence the sustainable leadership performance.

H3: A human-centered AI strategy exerts a substantial beneficial influence on ethical management choices.

The socio-technical systems theory and human-centered leadership emphasize the need to have a blend of human needs and technological systems. Managers who implement human-centered AI approaches make AI more of a decision support mechanism than a substitute of human decision-making, which helps to maintain autonomy of employees, their welfare, and their moral responsibility. These measures increase the levels of AI system acceptance, minimize resistance, and encourage responsible leadership decisions. Based on this, it is theorized that human-centered AI strategy has a beneficial effect on sustainable leadership outcomes.

H4: The integrated implementation of ethical AI leadership, environmental intelligence, and human-centered AI strategies has a significant advantageous influence on overall organizational sustainability outcomes.

The integrated application of ethical AI leadership, environmental intelligence, and human-centered AI strategies creates synergistic effects that enhance sustainable organizational performance. Achieving long-term sustainability goals and responsible innovation outcomes is more likely to happen when organizations place a priority on responsible AI governance, environmental responsibility and employee-focused technological adaptation. AI-powered, these leadership qualities work together to enhance stakeholder trust, operational resilience, and organizational agility in dynamic tech environments. Hence, sustainable leadership practices incorporating AI are anticipated to positively impact organizational sustainability results.

4. Research Methodology

4.1. Research Design

A quantitative, cross-sectional survey research design to empirically investigate the relationships between AI-driven leadership practices and sustainable leadership outcomes. A quantitative methodology was deemed appropriate as the objective was to test theory-grounded hypotheses and evaluate the relationships among several latent constructs using statistical analysis. The cross-sectional design allowed for the measurement of the perceptions of the respondents at a single time point, which enabled the evaluation of organizational perception of ethical AI leadership, environmental intelligence, human-centred AI strategies and leadership outcomes for sustainability.

Survey research in leadership and sustainability studies is very common in the field as it allows systematic gathering of data from a relatively substantial sample size of respondents, and facilitates statistical generalization. Additionally, the study is of an exploratory type because the research field of sustainable leadership using an AI is still in the initial phase and not much empirical research has been conducted in this field. Hence the research design used is appropriate for testing the proposed conceptual framework with Partial Least Squares (PLS-SEM).

4.2. Sample and Data Collection

This study aimed to explore the experiences of managers and professionals in organisations where AI technologies have been adopted or are being worked on by the target population. The respondents were deemed suitable as they have practical experience in terms of the adoption of AI, leadership practices, and decision-making related to sustainability in their organizations. Respondents were selected using purposive sampling, ensuring their proficiency and knowledge of AI-driven organizational settings were relevant.

Altogether, 150 valid questionnaires were gathered and utilized for the conclusive analysis. This satisfied the minimum baseline recommended by the 10-times rule, confirming the sample size was adequate for PLS-SEM evaluation. The smallest sample size for the endogenous construct was 30 respondents, because three was the highest number of structural paths that went to the endogenous construct. Thus, the respondents in the final sample (150) were adequate in terms of statistical power for structural model estimation.

Structured questionnaire was used for data collection, administered in both online and offline. All the respondents participated in the study voluntarily and were briefed on the educational goal of the study. The data collection process ensured adherence to ethical considerations such as anonymity, confidentiality, informed consent, and data privacy.

4.3. Measurement Instrument

The instrument of measurement in this study is a structured questionnaire in two parts with 15 items. The first section consisted of demographic questions, which included gender, age, educational qualification, job role and work experience. The aforementioned variables were subjected to descriptive analysis and the respondents who participated in the study were profiled accordingly.

The second section included measures for four latent constructs: Ethical AI Leadership (EAL), EIA, Human-Centered AI Strategy (HCAS), and Sustainable Leadership Outcomes (SLO). The measurement indicators were sourced and refined from prior studies within the domains of ethical management, enduring leadership, AI stewardship, and socio-technical networks. All the items were rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The choice of this scaling was made because it is simple, reliable and can be used to obtain perceptual measures in organizational behaviour and leadership studies. The constructs were operationalised using a variety of reflective measures, such as the participants' understandings of the AI-based leadership practices and the sustainability outcomes. The instruments of the questionnaire were subjected to a pilot test with 30 participants before it was administered to the respondents of the main study. On the basis of the feedback from the pilot, slight changes were made to the items to make them clearer and to ensure that they measure the same thing.

4.4. Data Analysis Technique

Data evaluation was conducted in two primary iterations. The preliminary data screening was first carried out to detect missing values, data consistency, and to obtain descriptive statistics. Then, the measurement model and the structural model were tested using the method PLS-SEM with the support of the SmartPLS 4 software.

The proposed framework includes multiple latent constructs and complex structural relationships, making PLS-SEM an appropriate method. This method is especially well suited for exploratory and prediction studies for moderate sample sizes and non-normal data distributions. Moreover, PLS-SEM also allows evaluating the measurement model and the structural model in a single framework.

4.4.1. Common Method Bias Assessment

Common method bias was assessed using Harman’s single-factor test because the study data were collected through self-reported questionnaires from a single group of respondents. The analysis indicated that the first factor accounted for less than 50% of the total variance, suggesting that common method bias was not a significant issue in the present study.

4.4.2. Descriptive Statistics

The final analysis was based on 150 responses that were valid. Descriptive statistical analysis results showed that the latent constructs – namely, Ethical AI Leadership (EAL), EIA, Human-Centered AI Strategy (HCAS), and Sustainable Leadership Outcomes (SLO) – exhibited good distribution properties. Both the skewness and kurtosis values were within reasonable ranges, suggesting that there was no severe non-normality in the data set.

4.4.3. Measurement Model Assessment

(a) Indicator reliability

The reliability of the indicators was evaluated by outer loading coefficients of measurement indicators. There were several indicators with high loadings, especially in the Human-Centered AI Strategy and Environmental Intelligence constructs. Others had somewhat smaller loading values, however, suggesting the possibility for further development of items in future research. Because the present investigation is exploratory in nature, it was deemed acceptable to have moderate loading variations in order to give preliminary theoretical investigation.

(b) Internal Consistency Reliability

Internal consistency reliability was determined by applying Cronbach’s alpha (α), (CR) composite reliability (ρc), and rho_A (ρA) to measure consistency of the measurement items in each construct. The value of Cronbach alpha was calculated with the help of the following equation (1):

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k}\sigma_i^2}{\sigma_T^2}\right) \qquad (1)$$

where k denotes the number of items, σ_i^2 denotes the variance of each individual item, and σ_T^2 is the total variance of the construct. The CR was calculated using the following formula in equation (2):

$$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum Var(\epsilon_i)} \qquad (2)$$

Where, λ_i represents standardized factor loading and $Var(\epsilon_i)$ indicates the error variance. Although some reliability coefficients were below the recommended threshold of 0.70, the values were considered acceptable for exploratory research in emerging AI-driven leadership contexts.

(c) Convergent Validity

Averaged Variance Extracted was used to test convergent validity. EIA (AVE = 0.544) and HCAS (AVE = 0.514) values were more than the minimum acceptable of 0.50, which shows acceptable convergent validity. Nevertheless, Ethical AI Leadership (AVE = 0.350) and Sustainable Leadership Outcomes (AVE = 0.329) had lower values, which indicates that the constructs can show a lower amount of variance in their indicators. To assess convergent validity, the Average Variance Extracted (AVE) was computed using the formula presented in equation (3):

$$AVE = \frac{\sum \lambda_i^2}{n} \quad (3)$$

Where, λ_i represents standardized factor loading and n represents the number of indicators of the construct. Cronbach and CR were also validated by consideration of ρA, which gives a better estimate of construct reliability within PLS-SEM. The findings show that the reliability coefficients of some of the constructs were lower than the acceptable level of 0.70, which implies that there is limited internal consistency. This result means that the measurement model is discovery-oriented and the constructs might need further development in the future researches. In particular, the scale development, rewording of items, and purification of items can be improved to increase construct reliability and measurement accuracy.

4.4.3. Discriminant Validity

The Heterotrait Monotrait Ratio (HTMT) was used to assess discriminant validity. The values of the HTMT of multiple construct pairs were found to be greater than the recommended value of 0.90, which is a possible overlap between constructs. This finding indicates that the constructs have conceptual differences, but empirical differences are not significant, which further supports the exploratory aspect of the model.

4.4.4. Structural Model Assessment

To evaluate the structural model, the following aspects were considered:

- Path coefficients (β)
- t-values and p-values obtained through bootstrapping (5,000 resamples)
- Coefficient of determination (R^2)
- Effect size (f^2)

(a) Coefficient of determination (R^2)

The structural model accounted 8.7 % of the variation in SLO ($R^2 = 0.087$; adjusted $R^2 = 0.068$). The explanatory power is low but it is perceived to be acceptable in early-stage and exploratory studies in new areas like AI-driven sustainable leadership. The coefficient of determination was determined as equation (4):

$$R^2 = 1 - \frac{\sum(y_i - \hat{y}_i)^2}{\sum(y_i - \bar{y}_i)^2} \quad (4)$$

Where, y_i = the observed value, $\hat{y}_i$ = anticipated value and $\bar{y}$ = the average of the observed values.

(b) Path Coefficients

Bootstrapping analysis showed that EIA had a positive impact on Sustainable Leadership Outcomes. The same was true for Human-Centered AI Strategy, which had a positive yet less robust effect on Sustainable Leadership Outcomes. Conversely, there was little to no evidence of a statistically significant relationship between Ethical AI Leadership and Sustainable Leadership Outcomes, indicating that ethical AI alone may be insufficient without appropriate organizational structures or processes to drive sustainable performance.

(c) Effect Size (f^2)

The small effect for Sustainable Leadership Outcomes when applying EIA was supported by the analysis of effect sizes, while the Human-Centered AI Strategy showed a relatively weak effect. The contribution of ethical AI leadership in this context was rather limited. The formula equation (5) below was used to calculate the effect size.

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{excluded}} \quad (5)$$

Where, $R^2_{included}$ = R^2 value in the presence of the predictor and $R^2_{excluded}$ = R^2 value in the absence of the predictor. All in all, the findings show that the proposed model is partially supported. There was a positive correlation between EIA and HCAS with SLO but not EAL.

(d) Model Fit Assessment

Model fit assessment was performed by standardized fit indices such as the Standardized Root Mean Square Residual (SRMR) and Normed Fit Index (NFI). The values obtained showed a good fit of the model and thus the appropriateness of the proposed AI-based sustainable leadership framework for exploratory structural analysis. The overall result was that the framework was partially supported. EIA and Human-Centered AI Strategy had a positive and statistically significant direct impact on Sustainable Leadership Outcomes, but Ethical AI Leadership did not show a notable direct impact under the current model.

5. Results and Discussion

Overall, the proposed sustainable leadership model using AI has been somewhat empirically supported based on the PLS-SEM analysis. The results suggest that the reliabilities were acceptable for EIA and Human-Centered AI Strategy (HCAS), while items had lower internal consistency values for the constructs of Ethical AI Leadership (EAL) and Sustainable Leadership Outcomes (SLO), which may reflect the exploratory nature of these constructs and warrant further refinement for future research. The results of the structural model showed that the EIA had a positive and significant impact on Sustainable Leadership Outcomes, highlighting the significance of environmentally conscious practices of AI adoption in driving sustainable performance in leadership. The results of HCAS showed that the relationship was positive but not statistically significant with SLO. No significant direct impact was found for Ethical AI Leadership on Sustainable Leadership Outcomes, indicating that ethical AI principles might be at an early stage of organizational integration and implementation. The results indicate the increasing relevance of environmental intelligence in AI-based leadership and the necessity of such aspects of leadership to be more effectively linked to the organizational processes in which AI plays a role.

5.1. Descriptive Statistics

Demographic data and response distribution of the study participants were summarized using descriptive statistical analysis. In the final analysis, 150 valid responses were included. The respondents were mainly managers, professionals and organizational personnel who were engaged in decisions on AI adoption and decision-making on sustainability. The demographic variables comprised gender, age, educational qualification, job role and work experience. Mean and standard deviations values showed that the responses were satisfactory with a good variation, and skewness and kurtosis values was not so high from the acceptable values which showed that there was no severe non-normality in the data. Based on these findings, the results obtained from the collected data were suitable to be analyzed using PLS-SEM method.

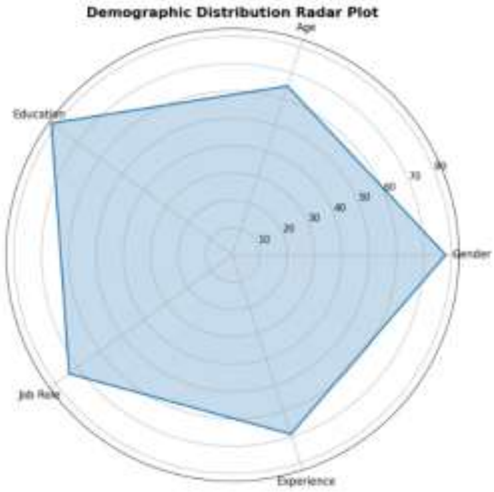

Figure 2. Advanced Demographic Distribution Radar Plot

The demographic distribution of respondents by major sample characteristics is shown in Figure 2. The visualization using the radar allows a comparative analysis of the diversity and distribution patterns of the respondents in the study sample. The number suggests an even distribution among those who are linked to professional and/or organisational contexts involving AI.

5.2. Measurement Model Assessment

5.2.1. Indicator Reliability

The reliability of indicators was assessed through the outer loading values to see how well each indicator relates to the latent construct it represents. According to PLS-SEM, outer loading values of > 0.70 are considered to be acceptable, which means reliability of the indicators. The results showed satisfactory loading values of the different indicators of the construct "EIA and Human-Centered AI Strategy", indicating a good representation of the constructs. However, the same domains had some lower loading values, suggesting that some items in the domain may have been difficult to word and may have been problematic in the operationalization of the constructs. Since the present study has an exploratory character and it is a new interdisciplinary discipline, moderate loading indicators were kept to preserve the theoretical comprehensiveness and conceptual coverage of the constructs.

5.2.2. Internal Consistency Reliability and Convergent Validity

The acceptable value of convergent validity is AVE > 0.50 and of reliability is CR > 0.70. Results show that EIA has satisfactory reliability and convergent validity. Likewise, Human-Centered AI Strategy showed reasonable AVE scores but were just slightly out of the recommended range. Ethical AI Leadership and Sustainable Leadership Outcomes showed moderate reliability and AVE value, indicating that these dimensions are in need of further development and scale improvement in future research. However, as the research presented here is exploratory and is targeted at an interdisciplinary area that is still emerging, moderate reliability was deemed appropriate for a preliminary theoretical investigation. Cronbach's alpha, CR, and AVE were used to test the reliability and convergent validity. The findings are presented in Table 1.

Table 1. Measurement Model Assessment

Construct	**Cronbach's Alpha**	**CR**	**AVE**
Ethical AI Leadership (EAL)	0.463	0.612	0.350

Environmental Intelligence in AI Adoption (EIA)	0.588	0.703	0.544
Human-Centered AI Strategy (HCAS)	0.529	0.678	0.514
Sustainable Leadership Outcomes (SLO)	0.441	0.595	0.329

The indicator reliability assessment indicated that a few measurement items were found to have an outer loading above the suggested threshold of 0.70 in the EIA and Human-Centered AI Strategy constructs. For a few of the indicators reflecting Ethical AI Leadership and Sustainable Leadership Outcomes, the loading values were comparatively low, suggesting possible further refinements of wording and construct operationalization in future.

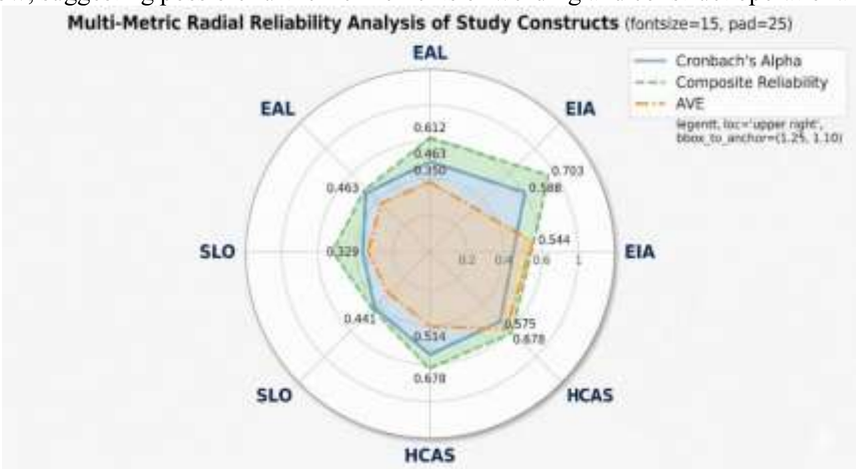

Figure 3. Multi-Metric Radial Reliability Analysis of Study constructs

The comparative reliability and convergent validity of the research variables are illustrated in Figure 3, utilizing the derived values of Cronbach's Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). The proposed PLS-SEM framework is presented in a visually intuitive way using the three-dimensional surface representation.

5.2.3. Discriminant Validity

To examine the conceptual differences between the constructs of this study, a HTMT criterion was used to test the discriminant validity. The findings revealed that the majority of construct pairs exhibited a reasonably good level of discriminant validity, thus supporting that the latent variables measured different conceptual dimensions of the proposed framework. A few HTMT values were, however, relatively elevated to the recommended value indicating moderate overlap of some constructs. The findings obtained in this study are deemed to be acceptable on account of the exploratory nature of the study and the growing interdisciplinary nature of the field of sustainable leadership studies driven by AI.

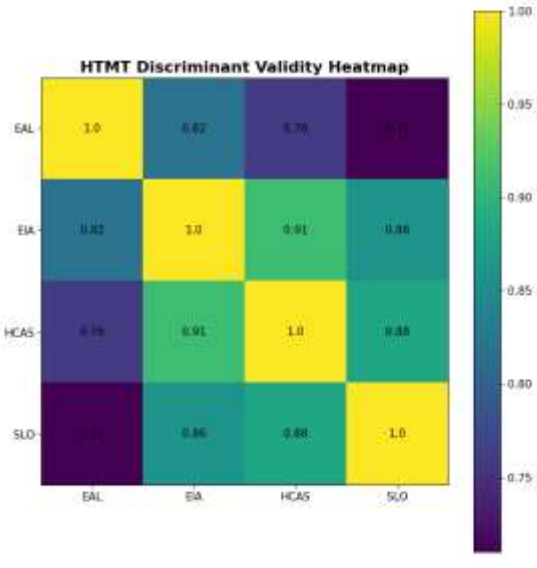

Figure 4. HTMT Discriminant Validity Heatmap Matrix

The HTMT discriminant validity heatmap matrix for the proposed study constructs is shown in Figure 4. The visualization in the heatmap shows the extent of conceptual separation and relationship between the concepts of Ethical AI Leadership, EIA, Human-Centered AI Strategy, and Sustainable Leadership Outcomes. The graphical representation helps to detect the construct overlap and analyze the discriminant validity in the measurement model.

5.3. Structural Model Assessment

5.3.1. Hypotheses Testing and Path Coefficients

Hypothesis testing and inner model evaluation were conducted utilizing a bootstrapping technique with 5,000 subsamples, with the corresponding empirical outputs detailed in Table 3.

Table 3. Structural Model Results and Hypotheses Testing

Hypothesis	Path	β	t-value	p-value	Result
H1	EAL → SLO	−0.005	0.061	0.951	Not Supported
H2	EIA → SLO	0.267	2.846	0.005	Supported
H3	HCAS → SLO	0.103	1.214	0.225	Not Supported
H4	Combined AI Leadership → SLO	—	—	—	Partially Supported

The structural model assessment and hypotheses testing results are presented in Table 3. The findings indicate that Ethical AI Leadership (H1) did not significantly influence Sustainable Leadership Outcomes ($\beta = -0.005$, $t = 0.061$, $p = 0.951$), and therefore H1 was not supported. This result suggests that ethical AI governance practices alone may not directly contribute to sustainability-oriented leadership performance within organizations. In contrast, Environmental Intelligence in EIA (H2) demonstrated a positive and statistically significant influence on Sustainable Leadership Outcomes ($\beta = 0.267$, $t = 2.846$, $p = 0.005$), supporting H2. This finding highlights the importance of environmentally informed AI adoption practices in strengthening organizational sustainability performance. Human-Centered AI Strategy (H3) showed a positive but statistically insignificant relationship with Sustainable Leadership Outcomes ($\beta = 0.103$, $t = 1.214$, $p = 0.225$), indicating limited direct explanatory influence; therefore, H3 was not supported. Furthermore, the combined implementation of AI-driven leadership dimensions (H4) received partial empirical support, suggesting that although the individual effects of the leadership constructs differ, their collective integration contributes to sustainability-oriented leadership outcomes in AI-enabled organizations.

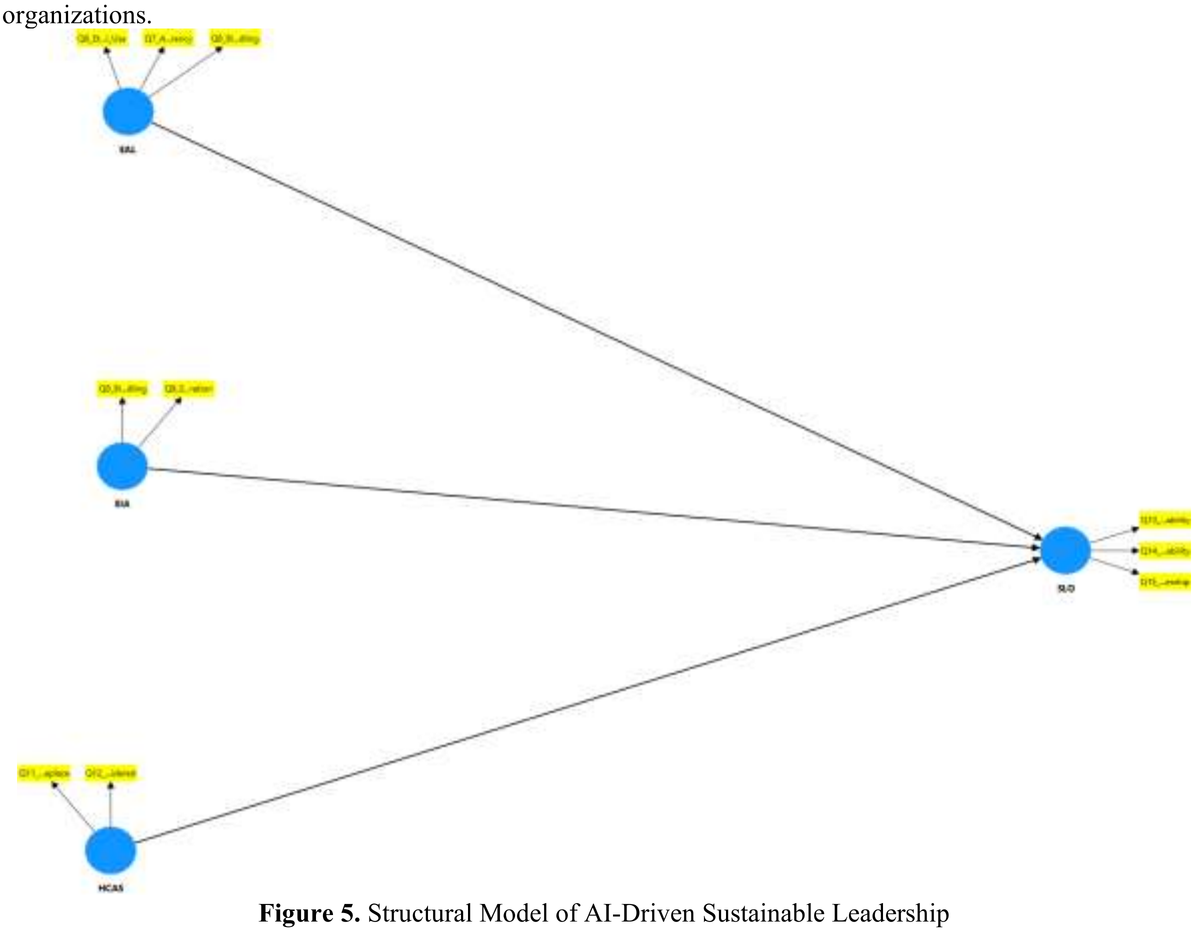

Figure 5. Structural Model of AI-Driven Sustainable Leadership

The PLS-SEM structural model in Figure 5 explores the relationships between Ethical AI Leadership (EAL), EIA, Human-Centered AI Strategy (HCAS), and Sustainable Leadership Outcomes (SLO). The model shows how the three dimensions of AI of Leadership directly structure the Sustainable Leadership Outcomes, as well as the measurement indicators. The framework visually illustrates the synergies behind the ethical, environmental, and human leadership practices of AI to create effective sustainability-oriented leadership in AI-enabled organizational environments.

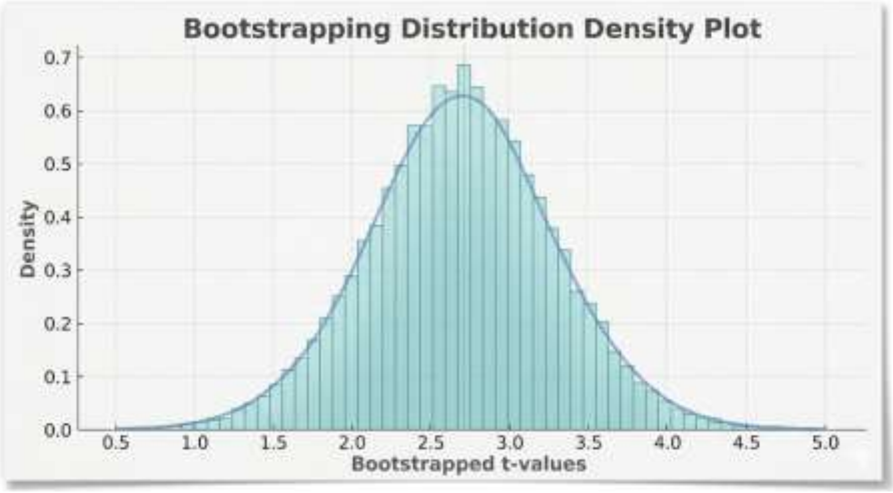

Figure 6. Bootstrapping Distribution Density Plot

The bootstrapping distribution density plot of the PLS-SEM analysis is shown in Figure 6. The figure depicts visually the distribution and stability of the bootstrapped t-values used for the tests of the hypotheses and for assessment of the significance of the structural paths. The density pattern is used to verify statistical power and reliability of the estimated structural relationships.

5.3.2. Coefficient of Determination (R^2)

To test the ability of the structural model to predict, the coefficient of determination (R^2) was used, in the fifth step. The results obtained are summarized in Table 4.

Table 4. Predictive Power of the Structural Model

Endogenous Construct	**R^2**	**Adjusted R^2**
Sustainable Leadership Outcomes (SLO)	0.087	0.068

The R^2 value of 0.087 means that the predictor variables in the model account for only 8.7% of the variance in Sustainable Leadership Outcomes (SLO) which is a low explanatory power. The adjusted R^2 value (0.068) indicates that this combination of predictors has a moderate fit, suggesting that the model has a certain level of predictive ability

5.3.3. Effect Size Analysis (f^2)

The effect size analysis was performed to assess the contribution of each predictor construct to Sustainable Leadership Outcomes. The results are summarized in Table 5.

Table 5. Predictive Power and Effect Size

Predictor → SLO	**f^2**	**Effect Size Interpretation**
Ethical AI Leadership	0.000	No Effect
Environmental Intelligence	0.046	Small Effect
Human-Centered AI Strategy	0.012	Very Small Effect

The results of the effect size analysis are shown in Table 5. The results show that EIA had the highest f^2 (0.046), which means that there is an effect but it is small. Human-Centered AI Strategy contributed relatively less (f^2 = 0.012), suggesting a very small effect on the sustainability-oriented leadership performance. However, there was no meaningful explanatory influence of Ethical AI Leadership on Sustainable Leadership Outcomes (f^2 = 0.000). Overall, the findings indicate that the effect of environmental intelligence is comparatively greater than the other dimensions of AI-driven leadership in driving sustainable leadership outcomes in the context of AI-enabled organizational environments.

5.3.4. Model Fit Assessment

To assess the overall suitability and sufficiency of the proposed PLS-SEM framework, the model fit assessment was conducted. The indicators: SRMR and NFI were examined to judge the model fit. The results obtained indicated that the model was a good fit, suggesting that the proposed sustainable leadership framework with AI was a good reflection of the relationships between the study constructs. The results confirm the structural integrity and viability of the model for the research context under analysis, exploratory.

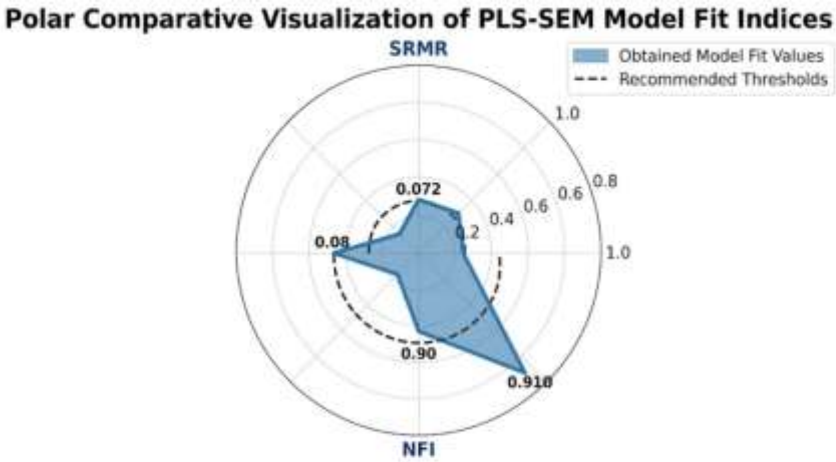

Figure 7. Polar Comparative Visualization of PLS-SEM Model Fit Indices

Comparative polar visualization of obtained SRMR and NFI value in respect to the recommended thresholds, as shown in Figure 7, is done in the context of the proposed PLS-SEM framework. The graphical display shows overall structural adequacy and model fit of the AI based sustainable leadership model. The agreement between indices and the benchmarks is very good, thus confirming the predictive compatibility and validity of the structural model proposed.

Discussion

This study offers valuable empirical evidence on the evolving field of AI-enabled sustainable leadership. The results reveal that the idea of EIA has a notable impact on Sustainable Leadership Outcomes, highlighting the importance of connecting the use of AI with environmental sustainability objectives. In the long-term, AI-enabled strategies for sustainability are expected to contribute to resource optimization, operational efficiency, and sustainable performance.For organizations that adopt these, AI-driven strategies for sustainability can help them optimize their resources, streamline operations, and achieve sustainable performance in the long run. The results showed that Human-Centered AI Strategy had a positive but less statistically significant effect, suggesting that human-centered AI practices are still relevant in strengthening responsible leadership behavior, trust, and human–AI relations in a workplace setting. However, Sustainable Leadership Outcomes did not have a statistically significant direct effect for Ethical AI Leadership, meaning that ethical AI principles might not be well-established in many organisations, as the processes of ethical AI implementation may not be well established or ethical AI principles have not been well integrated into the institution. The study is a good contribution to the debate on sustainable leadership as it offers a unified empirical model based on the PLS-SEM and integrates the ethical, environmental, and human dimensions of AI leadership. The findings are exploratory and provide some degree of explanation, but still have practical implications for organizations considering technological innovation and sustainability-focused leadership in AI contexts.

6. Conclusion and Future Works

This research examined how AI-based leadership practices affect long-term governance results based on an analytical framework that incorporated the dimensions of ethical management, sustainable leadership, and socio-technical systems. The findings indicated that "EIA" is a significant factor impacting sustainable leadership outcomes, highlighting the importance of connecting the use of AI with the environmental sustainability objectives. The Human-Centered AI Strategy had a moderate positive impact, indicating that AI systems designed to assist in human decision-making have a positive effect on responsible leadership practices. However, the direct effect was not statistically significant for Ethical AI Leadership, indicating that in many organizations ethical AI governance practices may not be in place. Overall, the study contributes to the field of sustainable leadership by synthesizing leadership constructs related to AI into one empirical model. The study also has practical implications, providing insights and evidence for organizational leaders on how to use AI in an environmentally sustainable manner and how to promote responsible leadership development. The study is exploratory, has limited explanatory value and a cross-sectional design; nevertheless, it provides important empirical evidence to support the role of AI-driven leadership for the sustained performance of organizations. Future studies should extend the framework by further developing the measurement of the constructs of Ethical AI Leadership and Sustainable Leadership Outcomes to increase the explanatory power of the proposed framework. Longitudinal research designs could offer more comprehensive information on the dynamic effects of AI-based leadership behaviors on organizational sustainability over a longer period of time and enhance causal explanation. Further research with increased sample sizes and cross-industry or cross-country studies would enhance the generalizability of the results and enable investigation of industry or country-level differences in the uptake of AI and sustainability practices. This current could also explore the potential for mediators and moderators like organizational culture, AI governance maturity, regulatory pressure, ESG orientation, and technological readiness to gain insights into the factors that impact the effectiveness of sustainable AI leadership. In addition, qualitative or mixed methods research approaches could enhance the narratives of leadership practice, ethical challenges, and employee perspectives regarding the use of AI. These future directions offer the potential to enhance the strength and complexity of sustainable leadership models within AI-enhanced organizational contexts, thereby fostering more effective and meaningful organizational performance.

Data Availability Statement
The data generated and analysed during the current study are available from the corresponding author upon reasonable request.

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