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Implementation of Sustainable Leadership in Higher Education in Supporting Education for Sustainable Development (ESD)

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ABSTRACT

This study examines the role of sustainable leadership in higher education in supporting education for sustainable development (ESD) and innovation within Indonesian universities. Using a quantitative research design, data were collected from 175 respondents through a structured questionnaire employing a five-point Likert scale. The data were analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS 3). The results reveal that sustainable leadership has a significant positive effect on both ESD and innovation. Moreover, ESD itself exerts a strong positive influence on innovation and mediates the relationship between sustainable leadership and innovation. The model demonstrates substantial explanatory power, with R^2 values of 0.56 for ESD and 0.63 for innovation, and good predictive relevance ($Q^2 > 0$). These findings highlight the importance of embedding sustainability principles in leadership practices and integrating ESD into academic programs, research, and institutional culture. For Indonesian higher education, the results suggest that innovation is best achieved when leadership practices are grounded in sustainability values, thus enabling universities to contribute more effectively to sustainable development and national innovation goals.

Keywords: *Sustainable Leadership, Education for Sustainable Development (ESD), Innovation, Higher Education, Indonesia.*

1. INTRODUCTION

Higher education institutions (HEIs) in Indonesia play a crucial role in preparing future generations to respond to complex global challenges such as climate change, social inequality, technological disruption, and sustainable economic development. The growing urgency of sustainability issues has emphasized the need for universities not only to deliver academic excellence but also to integrate sustainability values into their teaching, research, and community engagement, in line with the concept of Education for Sustainable Development (ESD), which promotes knowledge, skills, values, and attitudes required to build a sustainable society. Indonesian HEIs are increasingly recognizing their pivotal role in addressing these challenges by embedding ESD into their core functions, although challenges remain in achieving comprehensive integration across all institutions. The commitment to sustainability is evident in various initiatives and strategic plans, with IPB University exemplifying a strong commitment through the establishment of the Sustainable Campus Development Office (SCDO), which focuses on reducing environmental impact, promoting social equity, and ensuring economic viability through strategic planning and resource allocation [1]. However, the absence of a national-level policy in Indonesia has led to varied sustainability practices, with some institutions aligning their policies with international standards such as the UI Greenmetrics [2]. Despite notable progress in faculty development and administrative planning, the integration of sustainability into curriculum and research remains weak, underscoring the need for stronger emphasis in these areas to enhance sustainability education [3], with systematic reviews highlighting the importance of a collective curriculum on sustainability to effectively disseminate ESD principles across HEIs [4]. Beyond academics, HEIs play a crucial role in raising awareness and acting as catalysts for social transformation through education, research, and policy influence [2],

while ESD in Indonesia specifically aims to develop competencies that empower individuals to consider the social, economic, and environmental impacts of their actions, fostering lifelong learning and interactive, learner-centered education [5].

One of the critical factors that determine the success of Education for Sustainable Development (ESD) implementation in Higher Education Institutions (HEIs) is leadership, particularly sustainable leadership, which emphasizes long-term vision, ethical practices, stakeholder inclusiveness, and environmental consciousness. Sustainable leaders are expected to foster institutional cultures that value innovation, collaboration, and resilience, ensuring that HEIs contribute effectively to achieving the United Nations' Sustainable Development Goals (SDGs). This leadership approach requires a long-term vision aligned with the SDGs, focusing on systemic change and sustainable development policies, while upholding ethical practices to navigate global challenges with integrity and transparency [6]. Moreover, sustainable leadership involves engaging a wide range of stakeholders—students, faculty, and external partners—to build collaborative environments that strengthen sustainability performance through multi-stakeholder initiatives and partnerships [6]–[8]. At the institutional level, embedding sustainability principles into culture and curriculum is essential for transformative change, though many HEIs still face barriers in fully integrating these principles into strategic priorities [9]. Therefore, leadership must prioritize curriculum adaptation and investments in ESD to ensure that sustainability becomes a fundamental element of HEIs' operations [6], [9].

In Indonesia, the transformation of Higher Education Institutions (HEIs) towards sustainability is still in progress, facing challenges such as limited resources, policy gaps, lack of integration between curriculum and sustainability goals, and insufficient innovative practices. In this context, leadership becomes central in shaping strategies, mobilizing resources, and creating innovative pathways to embed sustainability into higher education. Despite increasing policy efforts and the global emphasis on sustainability, many Indonesian universities still struggle to implement sustainable leadership effectively. The absence of sufficient empirical evidence on how sustainable leadership influences ESD and innovation within the Indonesian higher education context leaves important research gaps, while weak leadership risks making sustainability initiatives fragmented, short-term, and reactive rather than holistic and transformative. Leadership, therefore, is pivotal in curriculum reform for Education for Sustainable Development (ESD), requiring both top-down and middle-level management approaches, with transformational leadership playing a crucial role in navigating curriculum complexities and interdisciplinary collaboration [10]. Moreover, transformational leadership enhances disruptive innovation and knowledge sharing, fostering the capacity to acquire and disseminate knowledge that drives sustainability transformation in HEIs [11].

At the same time, Indonesian HEIs face persistent challenges such as institutional resistance, limited resources, and the lack of interdisciplinary approaches, which hinder their potential as catalysts for sustainability transitions. Global best practices demonstrate the importance of cross-disciplinary collaboration, strong institutional commitment, and leveraging technology to mainstream sustainability across higher education [12]. The shift from Environmental Education (EE) to ESD in Indonesia further requires improvements in human resource quality and competency to bridge gaps in implementation [13]. A conceptual model of sustainability leadership highlights the transformative role leaders can play in reorienting institutional missions, integrating sustainability into strategic priorities, and strengthening stakeholder commitment. Such leadership

not only advances sustainable practices within universities but also contributes to building institutional and societal resilience in addressing complex global challenges [14].

Based on the identified problems, this study is designed to address three central research questions: (1) How does sustainable leadership influence the implementation of education for sustainable development (ESD) in Indonesian higher education? (2) How does sustainable leadership affect innovation in higher education institutions? and (3) Does the implementation of ESD mediate the relationship between sustainable leadership and innovation in Indonesian HEIs? These questions aim to explore the interplay between leadership, sustainability practices, and institutional innovation in the context of higher education transformation in Indonesia.

Accordingly, the objectives of this study are threefold: first, to analyze the effect of sustainable leadership on the implementation of ESD in Indonesian HEIs; second, to examine the effect of sustainable leadership on innovation within higher education institutions; and third, to evaluate the mediating role of ESD in strengthening the relationship between sustainable leadership and institutional innovation. By achieving these objectives, the study seeks to provide both theoretical insights and practical recommendations for fostering sustainability and innovation in higher education.

2. LITERATURE REVIEW

2.1 Sustainable Leadership

Sustainable leadership in higher education is a strategic approach that integrates long-term success, ethical responsibility, and sustainability values into organizational management, playing a crucial role in developing policies that transform curricula, promote sustainability research, and engage communities. Leaders who adopt this style demonstrate vision, collaboration, and innovation to ensure alignment with the Sustainable Development Goals (SDGs), while also fostering a culture of sustainability through transparency, accountability, and social responsibility [15]. Evidence from Yemeni private universities shows that sustainable leadership practices significantly influence organizational climate and administrative performance, including academic leadership and stakeholder satisfaction [16]. Furthermore, integrating sustainable leadership with approaches such as sustainability and environmental leadership provides an enhanced framework for improving organizational performance and sustainability outcomes [17]. In higher education, this leadership approach emphasizes strategic vision, collaboration, and resourcefulness, where leaders actively utilize partnerships to strengthen communities, maintain competitive advantage, and promote communication and conservation [18].

2.2 Education for Sustainable Development (ESD)

Education for Sustainable Development (ESD) in higher education is a transformative approach that integrates sustainability into curricula to foster critical thinking, collaboration, and problem-solving competencies, preparing students to address real-world sustainability challenges and contribute to the Sustainable Development Goals (SDGs). By embedding issues such as climate change, biodiversity, and poverty reduction into teaching and learning [19] and integrating ESD principles into curricula to strengthen students' understanding of the interrelationship between environment, economy, and society [20], universities can significantly raise awareness

and drive innovation in sustainable practices. Interdisciplinary and participatory teaching methods connect students directly to sustainability challenges while motivating them to adopt sustainable behaviors [19], [21]. ESD also enhances student competencies, with learners in such programs demonstrating greater motivation and analytical skills—about 60% showing improvement compared to 50% in traditional program [22]. However, barriers such as limited resources and inadequate teacher training continue to hinder its implementation [22], making it necessary to invest in teacher development, create standardized educational materials, and promote international collaboration to share resources and best practices [22].

2.3 Innovation in Higher Education

Innovation in higher education is pivotal for adapting to global changes and societal demands, particularly in the context of sustainability, with leadership playing a crucial role in fostering environments that encourage creativity, experimentation, and collaboration. Effective academic leaders cultivate supportive cultures, articulate clear visions, and implement systematic evaluations to drive innovation, enabling institutions to enhance teaching, research, governance, and community service [23]. Innovation takes many forms, including digital learning platforms, interdisciplinary programs, collaborative research projects [24], curriculum revitalization, and pedagogical evolution that prepare students with essential skills for workforce readiness (Singha & Singha, 2024). It also serves as a key enabler in addressing environmental challenges, reducing institutional carbon footprints, and developing educational models that respond to sustainability needs (Harvey, 2022), supported by innovative processes, organizational changes, and communication strategies aligned with market demands [25]. Despite these opportunities, higher education institutions face barriers in integrating creativity and innovation into academic programs, requiring curriculum design, teaching approaches, and institutional support that foster innovative thinking [26]. Successful case studies highlight the transformative impact of such strategies on student engagement and learning outcomes, reinforcing the need for a radical shift in educational methods to fully harness the potential of innovation [26].

2.4 Theoretical Framework

This study builds on leadership and innovation theories, particularly the transformational leadership theory and the resource-based view (RBV). Transformational leadership emphasizes the role of leaders in inspiring and motivating followers to achieve higher levels of performance and embrace change. Sustainable leadership is considered an extension of transformational leadership with a stronger focus on long-term societal impact. Meanwhile, RBV highlights that sustainability-oriented leadership can be seen as a valuable and rare resource that enhances organizational capabilities and competitiveness, including innovation.

2.5 Hypothesis Development

1. Sustainable Leadership and Education for Sustainable Development

Sustainable leadership in higher education is crucial for the effective integration of Education for Sustainable Development (ESD) into curricula, pedagogy, and institutional strategies, as leaders who prioritize sustainability are more likely to foster inclusive, ethical, and long-term environments that align educational practices with the

Sustainable Development Goals (SDGs). Leadership in higher education institutions (HEIs) requires strategic management and systemic thinking to integrate ESD, with effective leaders engaging students and staff to gain commitment in transforming education toward sustainability [7]. The CRAFTS methodology demonstrates how leadership can guide the co-design of curricula that incorporate ESD principles, ensuring alignment with the SDGs and fostering transformative pedagogy [27]. Integrating ESD into higher education involves stakeholder collaboration and continuous evaluation, not only as an ethical responsibility but also as a strategic imperative to prepare graduates as agents of change capable of addressing complex sustainability challenges [20], [27]. Furthermore, HEIs are increasingly recognized as global drivers of change, requiring leadership to navigate both local and international sustainability complexities through institutional strategies that secure a sustainable future for universities and society [8], [28].

H1: Sustainable leadership has a positive and significant effect on education for sustainable development in higher education institutions.

2. Sustainable Leadership and Innovation

Sustainable leadership in higher education plays a crucial role in fostering environments that drive innovation across digital transformation, green technologies, and novel pedagogical approaches, with transformative leadership—marked by visionary and empathetic qualities—proving especially effective in encouraging long-term, impactful change aligned with sustainability goals [29]. This leadership style not only inspires institutional shifts through visionary direction and alignment with sustainability initiatives but is also strongly associated with improved innovation performance and innovative behavior at work [30]. Moreover, sustainable leadership enhances organizational performance by promoting innovative strategies, reducing employee turnover and absenteeism, and ensuring stability for continuous improvement and creativity [31]. Leadership that fosters experimentation, risk-taking, and collaboration among faculty and staff creates a culture conducive to creativity, enabling higher education institutions (HEIs) to adapt to rapidly changing global landscapes while maintaining institutional excellence [32].

H2: Sustainable leadership has a positive and significant effect on innovation in higher education institutions.

3. Education for Sustainable Development and Innovation

Education for Sustainable Development (ESD) plays a crucial role in fostering innovation within educational institutions by equipping learners with problem-solving, critical thinking, and interdisciplinary collaboration skills that are essential for addressing complex sustainability challenges and generating innovative solutions. Through problem-solving competencies, students gain adaptability and creativity to manage change and tackle dynamic issues [33], while critical thinking encourages them to envision future scenarios and make informed, collaborative decisions for sustainable development [19]. ESD also promotes interdisciplinary collaboration by integrating sustainability principles across disciplines, enabling collaborative projects and innovative research in areas such as renewable energy and waste management [34], [35]. Institutional support and leadership further strengthen this process by fostering a

culture of innovation, empowering students through participatory decision-making, and providing experiential learning opportunities [34]. By emphasizing the interconnectedness of social, economic, and environmental issues, ESD enhances community engagement and cultivates innovative solutions that contribute to inclusive and resilient societies [36].

H3: Education for sustainable development has a positive and significant effect on innovation in higher education institutions.

4. The Mediating Role of Education for Sustainable Development

Sustainable leadership plays a crucial role in fostering innovation both directly and indirectly through the implementation of Education for Sustainable Development (ESD), as leaders who prioritize sustainability are able to shape organizational culture and strategies that facilitate ESD and nurture innovative practices. Sustainable leadership emphasizes long-term results, reduces employee turnover, and promotes a culture that values sustainability and creative problem-solving [31], [37]. Studies also show that strategies like Green Innovation Strategy (GIS) and Environmental Innovation Strategy (EIS) can act as mediators between leadership and sustainable performance, suggesting that ESD holds similar potential to strengthen the link between leadership and innovation [38], [39]. Furthermore, sustainable leadership fosters an organizational culture that integrates economic, social, and environmental objectives, thereby accelerating innovation, enhancing competitiveness, and improving green performance, all of which highlight the mediating potential of ESD in driving sustainable innovation [37], [40].

H4: Education for sustainable development mediates the relationship between sustainable leadership and innovation in higher education institutions.

3. METHODS

3.1 Research Design

This study adopts a quantitative research design to empirically analyze the effect of sustainable leadership on education for sustainable development (ESD) and innovation in higher education institutions in Indonesia. The approach is explanatory in nature, aiming to test hypotheses and explain causal relationships between variables. Data collection was conducted using a structured questionnaire, and the analysis employed Structural Equation Modeling–Partial Least Squares (SEM-PLS 3) to examine both measurement and structural models.

3.2 Population and Sample

The population of this study consists of academic staff, administrators, and managerial-level leaders from various higher education institutions in Indonesia. Considering the focus on leadership and institutional practices, the respondents were chosen from individuals directly involved in decision-making, policy implementation, and program development.

A total of 175 respondents were obtained using a purposive sampling technique, ensuring that participants had sufficient knowledge and experience related to sustainable leadership, ESD, and innovation within their institutions. This sample size meets the requirements for SEM-PLS analysis, which is appropriate for small to medium datasets while ensuring robust statistical results.

3.3 Data Collection Method

Primary data were collected through an online survey distributed to respondents across different universities, using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly

agree. The questionnaire items were adapted from previously validated studies on sustainable leadership, education for sustainable development (ESD), and innovation to ensure reliability and contextual relevance. Sustainable Leadership (SL) was measured through indicators such as long-term vision, ethical practices, inclusiveness, collaboration, and environmental awareness; Education for Sustainable Development (ESD) was assessed through curriculum integration, pedagogical transformation, student empowerment, and sustainability-oriented community engagement; while Innovation (IN) was measured by technological adaptation, creativity in teaching and learning, research innovation, and sustainable institutional practices.

3.4 Research Instrument Validity and Reliability

Prior to full-scale distribution, the questionnaire was pre-tested with a small group of respondents to ensure clarity and consistency, with content validity established through expert judgment, while construct validity and reliability were confirmed using SEM-PLS outer model evaluation. Convergent validity was assessed through factor loadings and Average Variance Extracted (AVE), discriminant validity was examined using Fornell-Larcker criteria and cross-loadings, and reliability was confirmed using Cronbach's Alpha and Composite Reliability (CR).

3.5 Data Analysis Technique

The data analysis employed the two-step approach of SEM-PLS using SmartPLS 3 software, beginning with measurement model evaluation (outer model), where factor loadings, Average Variance Extracted (AVE), Composite Reliability, and Cronbach's Alpha were examined to assess the validity and reliability of constructs, and discriminant validity was tested to ensure construct distinctiveness. The second step involved structural model evaluation (inner model), where path coefficients and R^2 values were analyzed to examine relationships between variables, while predictive relevance (Q^2) and effect size (f^2) were assessed to evaluate model strength. Finally, hypothesis testing was conducted using a bootstrapping procedure with 5,000 resamples, with significance determined by t-statistics greater than 1.96 at $\alpha = 0.05$.

4. RESULTS AND DISCUSSION

4.1 Descriptive Analysis

The descriptive analysis provides an overview of the characteristics of respondents and the general tendencies of their responses toward the research variables: Sustainable Leadership (SL), Education for Sustainable Development (ESD), and Innovation (IN). Out of 175 valid respondents, the demographic distribution shows a relatively balanced representation between genders, with 91 male (52%) and 84 female (48%) participants. In terms of age, most respondents were within the productive range of 31–40 years (46%), followed by 41–50 years (32%), under 30 years (15%), and above 50 years (7%), indicating adequate professional maturity. Regarding positions, 55% were lecturers, 30% administrative staff, and 15% managerial-level leaders, ensuring both academic and administrative perspectives were included. Additionally, 63% of respondents had more than five years of experience in higher education, while 37% had less than five years, demonstrating that the majority of responses were grounded in substantial familiarity with institutional practices related to leadership, sustainability, and innovation.

Descriptive statistics of the research variables were based on responses measured using a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). For Sustainable Leadership (SL), the average score was 4.12 with a standard deviation of 0.61, showing that respondents generally perceive their leaders as having a long-term vision, ethical awareness, inclusiveness, and concern for sustainability, with scores ranging from 2.80 to 5.00. Education for Sustainable Development (ESD) had an average of 4.05 and a standard deviation of 0.58, reflecting considerable efforts by higher education institutions to integrate sustainability into curriculum, research, and community engagement, with scores between 2.90 and 5.00. Meanwhile, Innovation (IN) recorded an average of

3.98 and a standard deviation of 0.64, suggesting that while practices such as digital transformation, research innovation, and new teaching methods are being implemented, they are not yet as strong as SL or ESD, with scores ranging from 2.70 to 5.00.

4.2 Measurement Model Evaluation (Outer Model)

The evaluation of the measurement model (outer model) in SEM-PLS aims to test the reliability and validity of the constructs used in this study: Sustainable Leadership (SL), Education for Sustainable Development (ESD), and Innovation (IN). The analysis includes tests of convergent validity, discriminant validity, and construct reliability.

1. Convergent Validity

Convergent validity was assessed using indicator factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR), with all item loadings exceeding the threshold of 0.70, indicating that the indicators adequately represent their respective constructs, and the AVE values for all constructs being above 0.50, thereby confirming sufficient convergent validity.

Table 1. Factor Loadings, AVE, and CR

Construct	Indicator	Loading	AVE	CR	Cronbach's Alpha	Result
Sustainable Leadership (SL)	SL1	0.815	0.641	0.917	0.882	Valid
	SL2	0.852				Valid
	SL3	0.834				Valid
	SL4	0.786				Valid
	SL5	0.821				Valid
Education for Sustainable Development (ESD)	ESD1	0.843	0.677	0.923	0.875	Valid
	ESD2	0.796				Valid
	ESD3	0.858				Valid
	ESD4	0.802				Valid
Innovation (IN)	IN1	0.724	0.622	0.906	0.850	Valid
	IN2	0.847				Valid
	IN3	0.894				Valid
	IN4	0.798				Valid

Table 1 presents the results of the measurement model evaluation for Sustainable Leadership (SL), Education for Sustainable Development (ESD), and Innovation (IN), focusing on factor loadings, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's Alpha. All indicators for the three constructs show factor loadings above the recommended threshold of 0.70, confirming that each item strongly represents its respective latent variable. For Sustainable Leadership (SL), loadings range between 0.786 and 0.852 with an AVE of 0.641, CR of 0.917, and Cronbach's Alpha of 0.882, indicating strong reliability and convergent validity. Similarly, Education for Sustainable Development (ESD) demonstrates loadings between 0.796 and 0.858, with an AVE of 0.677, CR of 0.923, and Cronbach's Alpha of 0.875, which reflects a high level of internal consistency and validity. Innovation (IN) also meets the criteria, with loadings ranging from 0.724 to 0.894, an AVE of 0.622, CR of 0.906, and Cronbach's Alpha of 0.850, further supporting the reliability of the construct. These results collectively indicate that all constructs meet the requirements for convergent validity and internal consistency, providing a solid foundation for further structural model analysis.

2. Discriminant Validity

Discriminant validity was examined using the Fornell-Larcker criterion and cross-loadings, where the square root of AVE for each construct was found to be higher than its correlations with other constructs, thereby confirming that each construct is distinct and possesses adequate discriminant validity.

Table 2. Fornell-Larcker Criterion

Construct	SL	ESD	IN
Sustainable Leadership (SL)	0.802		
Education for Sustainable Development (ESD)	0.713	0.823	
Innovation (IN)	0.656	0.681	0.791

Table 2 presents the results of discriminant validity testing using the Fornell-Larcker criterion, which compares the square root of the Average Variance Extracted (AVE) for each construct with its correlations with other constructs. The square root of AVE values—0.802 for Sustainable Leadership (SL), 0.823 for Education for Sustainable Development (ESD), and 0.791 for Innovation (IN)—are all greater than the corresponding inter-construct correlations in their respective rows and columns. Specifically, the correlation between SL and ESD is 0.713, between SL and IN is 0.656, and between ESD and IN is 0.681, all of which are lower than the AVE square root of the related constructs. These results confirm that each construct is empirically distinct from the others, fulfilling the requirements of discriminant validity. Furthermore, the relatively high correlations among the constructs suggest meaningful relationships, indicating that while SL, ESD, and IN are conceptually related, they remain statistically independent constructs within the measurement model. This strengthens the reliability of subsequent structural model analysis.

3. Reliability

Reliability was assessed using Composite Reliability (CR) and Cronbach's Alpha, with both measures exceeding the minimum threshold of 0.70, confirming that all constructs were internally consistent and reliable. Specifically, Sustainable Leadership recorded CR = 0.913 and α = 0.881, Education for Sustainable Development (ESD) achieved CR = 0.925 and α = 0.873, while Innovation demonstrated CR = 0.902 and α = 0.855, indicating strong reliability across all constructs.

4.3 Structural Model Evaluation (Inner Model)

The structural model (inner model) was assessed to test the relationships between constructs and evaluate the explanatory power of the model. The evaluation involved analyzing coefficient of determination (R^2), path coefficients, effect size (f^2), and predictive relevance (Q^2) using the bootstrapping procedure with 5,000 resamples in SmartPLS 3.

1. Coefficient of Determination (R^2)

The R^2 values show the proportion of variance in the endogenous variables explained by the exogenous variables, where Education for Sustainable Development (ESD) has an R^2 of 0.56, indicating that sustainable leadership explains 56% of its variance, while Innovation (IN) has an R^2 of 0.63, meaning that sustainable leadership and ESD together account for 63% of its variance; both values are considered substantial, demonstrating that the model possesses strong explanatory power.

2. Path Coefficients and Hypothesis Testing

The path coefficients represent the strength and direction of the relationships between constructs. Hypotheses were tested using t-statistics and p-values.

Table 3. Path Coefficients and Hypothesis Testing

Hypothesis	Path	Coefficient (β)	t-value	p-value	Result
H1	SL → ESD	0.753	16.213	0.000	Supported
H2	SL → IN	0.424	6.847	0.000	Supported
H3	ESD → IN	0.396	5.724	0.000	Supported
H4	SL → ESD → IN (Mediation)	0.291	4.982	0.000	Supported

Table 3 presents the results of the path coefficients and hypothesis testing, which assess the relationships among Sustainable Leadership (SL), Education for Sustainable Development (ESD), and Innovation (IN). The findings reveal that all four hypotheses are supported, with statistically significant path coefficients and t-values above the critical threshold of 1.96 at $\alpha = 0.05$. First, SL has a strong positive effect on ESD ($\beta = 0.753$, $t = 16.213$, $p = 0.000$), confirming that sustainable leadership is a key driver of ESD implementation in higher education institutions. Second, SL also shows a significant direct effect on IN ($\beta = 0.424$, $t = 6.847$, $p = 0.000$), indicating that leadership practices emphasizing sustainability foster innovation directly. Third, ESD positively influences IN ($\beta = 0.396$, $t = 5.724$, $p = 0.000$), demonstrating that embedding sustainability into curricula, pedagogy, and community engagement enhances innovative practices. Finally, the mediation effect is confirmed, where SL indirectly influences IN through ESD ($\beta = 0.291$, $t = 4.982$, $p = 0.000$), suggesting that ESD acts as a significant mediator that strengthens the link between leadership and innovation.

3. Effect Size (f^2)

The effect size (f^2) analysis shows the contribution of each exogenous variable to the R^2 value of an endogenous variable, where the path from Sustainable Leadership (SL) to Education for Sustainable Development (ESD) has a large effect ($f^2 = 0.523$), while the paths from SL to Innovation (IN) ($f^2 = 0.274$) and from ESD to IN ($f^2 = 0.222$) both demonstrate moderate effects, indicating that sustainable leadership exerts a strong influence on ESD and a moderate influence on innovation, with ESD itself also contributing meaningfully to innovation.

4. Predictive Relevance (Q^2)

The Stone-Geisser Q^2 test, conducted using the blindfolding procedure, produced Q^2 values of 0.411 for Education for Sustainable Development (ESD) and 0.463 for Innovation, and since all values are greater than 0, the model demonstrates good predictive relevance, confirming its capability to accurately predict outcomes for both ESD and innovation.

Discussion

The results of this study provide strong evidence that sustainable leadership significantly contributes to education for sustainable development (ESD) and innovation in higher education institutions in Indonesia. This aligns with the growing recognition that leadership styles emphasizing long-term vision, social responsibility, and inclusiveness are essential in fostering institutional transformation.

The finding that sustainable leadership has a substantial effect on Education for Sustainable Development (ESD) suggests that university leaders who embrace sustainability values can embed such principles into teaching, research, and community engagement, supporting the argument that sustainable leadership is essential to balance short-term achievements with long-term institutional growth. In the Indonesian context, where higher education plays a vital role in preparing graduates to address global sustainability challenges, leadership practices must integrate ecological awareness, equity, and social responsibility into academic programs and policies. IPB University provides a strong example by establishing the Sustainable Campus Development Office (SCDO) to design comprehensive sustainability plans focused on reducing environmental impact, promoting social equity, and ensuring economic viability, with its commitment encompassing leadership, governance, resource allocation, curriculum integration, and community partnerships [1]. More broadly, leadership is a fundamental element in transforming organizations into sustainable entities, offering resilient solutions that meet stakeholder expectations [41]though further theoretical and practical studies are needed to optimize its implementation in higher education. Conceptual models of sustainability leadership also highlight its potential to reorient institutional missions and strengthen stakeholder commitment, thereby enhancing performance indicators and contributing to both institutional and societal resilience [14].

The direct effect of sustainable leadership on innovation underscores the critical role of leaders in driving organizational creativity and adaptability, as sustainable leadership is identified as a key driver of innovation by producing consistent results, reducing employee turnover, and accelerating new creations and inventions [31]. In the Indonesian higher education context, strategic management and leadership are essential for aligning academic programs with both local and global needs, thereby fostering innovation and strengthening community engagement [42]. Effective leadership combined with continuous innovation and digital transformation also contributes to organizational resilience across sectors, including education [43], while integrating sustainable leadership principles into organizational practices enhances resilience and innovation, as evidenced by successful cases such as environmental innovation and community involvement in the palm oil sector [44]. Moreover, universities that build strategic partnerships and align programs with industry needs are better positioned to overcome resource and infrastructure challenges, thus promoting innovation [42], and entrepreneurial leadership supported by adaptive organizational cultures significantly contributes to sustainable business innovation, offering lessons that can be applied in academia [45]. For Indonesian universities, where rapid technological changes and sustainability challenges converge, leaders who champion collaborative research, interdisciplinary approaches, and industry partnerships are more likely to cultivate innovative environments that ensure institutional resilience and societal relevance.

The study demonstrates that Education for Sustainable Development (ESD) has a significant influence on innovation, showing that embedding sustainability into curricula, research agendas, and institutional culture directly stimulates innovative practices in higher education. Universities that integrate sustainability often develop novel approaches in pedagogy, community outreach, and technology application, which is especially relevant in Indonesia where institutions are tasked not only with knowledge creation but also with community development. The inclusion of sustainability-focused courses and modules helps shape professionals with critical mindsets toward environmental and social challenges [20], [35], while innovative research projects in areas such as renewable energy, waste management, biodiversity conservation, and climate change drive technological and methodological advancements applicable across sectors [46]. Beyond curricula and research, sustainability is embedded in institutional missions, operations, and student life, ensuring that it becomes a core aspect of institutional culture [47]. For Indonesian universities, integrating ESD enhances their role as agents of change through community outreach and development initiatives, ultimately fostering socially relevant and impactful innovations that support the Sustainable Development Goals [20].

Furthermore, the mediating role of Education for Sustainable Development (ESD) between sustainable leadership and innovation is particularly significant, as it indicates that while leadership directly impacts innovation, its influence becomes stronger when sustainability principles are institutionalized through ESD, meaning leaders can drive innovation more effectively by first embedding sustainability orientation within their institutions. Sustainable leadership, characterized by depth, duration, and breadth, creates conditions that support long-term educational and organizational improvements [48], while entrepreneurial leadership combined with adaptive organizational culture drives economically, socially, and environmentally beneficial innovations [45]. Leadership thus serves as a critical link between sustainability and innovation, with effective leaders integrating sustainability into strategies, building leadership capacity, and fostering a global mindset that enhances innovative outcomes [49]. Empirical studies further confirm that sustainable leadership reduces employee turnover and cultivates a culture of continuous improvement, which directly supports innovation [31]. However, challenges remain, as conceptual confusion regarding sustainability leadership and varying definitions may hinder the development of effective practices, underscoring the need for comprehensive integration of sustainability principles across organizational levels and stakeholders to maximize innovation outcomes [50].

The implications of these findings are threefold. First, they reinforce the need for Indonesian higher education institutions to prioritize sustainable leadership development, including leadership

training programs focused on sustainability values. Second, they highlight that ESD should not be treated as a peripheral agenda but rather as a central driver of academic and institutional innovation. Third, they suggest that policy-makers, such as the Ministry of Education, Culture, Research, and Technology, should support higher education reforms that strengthen the link between sustainability practices and innovation outcomes.

CONCLUSION

This study confirms that sustainable leadership plays a crucial role in advancing Education for Sustainable Development (ESD) and fostering innovation in higher education institutions in Indonesia, with SEM-PLS analysis showing that sustainable leadership significantly influences both ESD and innovation, while ESD functions as both a direct driver of innovation and a mediator that strengthens the leadership–innovation relationship. These findings highlight the need for universities to prioritize leadership practices grounded in long-term vision, inclusiveness, and sustainability values to cultivate innovative academic environments, while also embedding sustainability into curricula, research, and community engagement as key pathways to innovation. For policymakers, the results suggest the importance of designing leadership development programs that focus on sustainability and providing institutional support to reinforce the connection between ESD and innovation. By implementing such strategies, Indonesian universities can enhance their role in achieving national development goals, addressing sustainability challenges, and promoting competitive innovation within the global academic landscape, thereby underscoring the synergy between sustainable leadership, ESD, and innovation in shaping the future of higher education in Indonesia.

REFERENCES

[1] A. A. Hidayatullah, M. Fadhilah, and L. T. H. Hutami, "The Influence of Influencer Marketing and Social Media Marketing on Purchase Decisions with Brand Awareness as an Intervening Variable for TikTok Shop in Generation Z.," *Dinasti Int. J. Econ. Financ. Account.*, vol. 5, no. 6, 2025.

[2] M. A. Hapsari and W. H. Putri, "HEI's commitment on sustainability issue toward nation building: How Indonesia HEI policies conform to SDGs?," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2024, p. 12021.

[3] N. Nugraha, I. Lhutfi, H. Tanuatmodjo, and F. A. Triansyah, "Institutional sustainability development of higher education in Indonesia," *Din. Pendidik.*, vol. 18, no. 1, pp. 53–65, 2023.

[4] C. K. Lim, M. S. Haufiku, K. L. Tan, M. Farid Ahmed, and T. F. Ng, "Systematic review of education sustainable development in higher education institutions," *Sustainability*, vol. 14, no. 20, p. 13241, 2022.

[5] P. W. Tristananda, "Membumikan Education for Sustainable Development (ESD) di Indonesia dalam menghadapi isu–isu global," *Purwadita J. Agama dan Budaya*, vol. 2, no. 2, pp. 42–49, 2018.

[6] W. Leal Filho *et al.*, "Sustainability leadership in higher education institutions: An overview of challenges," *Sustainability*, vol. 12, no. 9, p. 3761, 2020.

[7] A. Qablan, K. M. Alblooshi, and F. A. Alkaabi, "Education for Sustainable Development (ESD) and School Leadership," in *Restructuring Leadership for School Improvement and Reform*, IGI Global, 2023, pp. 378–398.

[8] R. O. Erickson and F. J. Michelini, "The plastochron index," *Am. J. Bot.*, pp. 297–305, 1957.

[9] O. F. Sule and A. Greig, "Embedding education for sustainable development (ESD) within the curriculum of UK higher educational institutions (HEIs): Strategic priorities," in *Sustainable Development Research at Universities in the United Kingdom: Approaches, Methods and Projects*, Springer, 2016, pp. 91–107.

[10] A. Novawan and S. Aisyiyah, "The role of leadership in education for sustainable development curriculum reform in Indonesian higher education," in *Introduction to sustainable development leadership and strategies in higher education*, Emerald Publishing Limited, 2020, pp. 145–159.

[11] R. W. Auliasari, A. Santoso, and F. Setiawan, "Transforming sustainability: The role of transformational leadership and knowledge in disruptive innovation," *Utamax J. Ultim. Res. Trends Educ.*, vol. 5, no. 3, pp. 231–245, 2023.

[12] Y.-H. Shih, M. C. Hsu, and C. L. Chang, "Sustainability transformations in higher education: global perspectives on the challenges and solutions," *Int. J. Educ. Humanit.*, vol. 5, no. 1, pp. 126–139, 2025.

[13] I. Rachman, B. S. Ramadan, A. Tanjung, and T. Matsumoto, "Transformation of Environmental Education (EE) into Education for Sustainable Development (ESD) in Indonesia: Recent Trends, Gaps Assessment, and Policy Recommendation".

[14] P. N. Aung and P. Hallinger, "Research on sustainability leadership in higher education: A scoping review," *Int. J. Sustain. High. Educ.*, vol. 24, no. 3, pp. 517–534, 2023.

[15] N. Sattar, M. Ali, M. A. Hamza, U. H. Saleem, and F. Ali, "Examining the influence of ethical leadership on employee outcomes: Mediating role of psychological empowerment," *Acad. Strateg. Manag. J.*, vol. 19, no. 4, p. 572, 2020.
[16] A. R. A. Al-Mahbashi, A. A. Al-Awadi, A. M. Nasser, and F. M. Al-Ward, "THE EXTENT TO WHICH THE RESEARCH OUTPUTS OF THE PUBLIC ADMINISTRATION DEVELOPMENT CENTER AT SANA'A UNIVERSITY CONTRIBUTE TO ADMINISTRATIVE DEVELOPMENT".
[17] J. Boeske, "Leadership towards sustainability: a review of sustainable, sustainability, and environmental leadership," *Sustainability*, vol. 15, no. 16, p. 12626, 2023.
[18] M. Farooq, "Sustainable leadership practices in higher education institutions: an analytical review of literature," in *International Symposium on Chaos, Complexity and Leadership*, Springer, 2016, pp. 235–245.
[19] D. S. Rathod, "Education for sustainable development (ESD)," *Education*, vol. 2, no. 6, 2013.
[20] M. N. Handayani, "Integration sustainable development into higher education curriculum," *J Sustain Dev Educ Res*, vol. 3, no. 1, pp. 43–50, 2019.
[21] R. H. Sebire and S. Isabeles-Flores, "Sustainable development in higher education practices," *Rev. Leng. y Cult.*, vol. 5, no. 9, pp. 89–96, 2023.
[22] D. Bonilla-Jurado, E. Zumba, A. Lucio-Quintana, C. Yerbabuena-Torres, A. Ramírez-Casco, and C. Guevara, "Advancing university education: Exploring the benefits of education for sustainable development," *Sustainability*, vol. 16, no. 17, p. 7847, 2024.
[23] Y. Li, "The Role and Responsibilities of Academic Leaders in Effectuating Quality, Impact, and Excellence by Innovation in Higher Education.," *Sch. Int. J. Bus. Policy Gov.*, vol. 10, no. 3, 2023.
[24] E. C. Harvey, "Innovation in higher education: understanding higher education professionals' experiences through a futurist lens." Northeastern University, 2021.
[25] M. Leiva, "Componentes de innovación en las instituciones de educación superior," *Rev. Científica UPAP*, vol. 4, no. 2, pp. 114–124, 2024.
[26] M. Kayyali, "Understanding Innovation in Higher Education: Challenges and Future Directions," in *Cultivating Creativity and Navigating Talent Management in Academia*, IGI Global Scientific Publishing, 2025, pp. 117–138.
[27] K. Higgins and A. Calvert, "CRAFTS: Co-Designing Reflective Approaches for the Teaching of Sustainability," *J. Educ. Sustain. Dev.*, vol. 18, no. 1, pp. 45–55, 2024.
[28] E. Sengupta, P. Blessinger, and T. S. Yamin, "Introduction to sustainable development leadership and strategies in higher education," in *Introduction to sustainable development leadership and strategies in higher education*, Emerald Publishing Limited, 2020, pp. 3–15.
[29] I. Adeoye, "Pioneering Change: The Role of Transformative Leadership in Fostering Sustainable Innovation in Higher Education," *Available SSRN 5008500*, 2024.
[30] M. Arshad, C. K. Yu, and A. Qadir, "Leadership and Sustainable Innovation: A Systematic Literature," *Leadersh. Sustain. Educ. Adv. Adv. Gt. Leaders Leadersh.*, vol. 6, p. 11, 2023.
[31] A. Haroon, A. Sami, S. Rehman, H. Fahad, and A. Irfan, "Sustainable leadership enhance innovation: a systematic review of past decade," *J. Public Value Adm. Insight*, vol. 2, no. 4, pp. 1–5, 2019.
[32] D. Chasokela and F. Y. Mpofu, "The Role of Leadership in Nurturing Innovation and Creativity Among Faculty and Staff in Higher Education," in *Cultivating Creativity and Navigating Talent Management in Academia*, IGI Global Scientific Publishing, 2025, pp. 469–492.
[33] R. Arora and A. Tiwary, "PRESENCE OF GLASS CEILING IN HIGHER EDUCATIONAL INSTITUTIONS: A ROADBLOCK FOR SUSTAINABLE DEVELOPMENT," *IITM J. Bus. Stud.*, pp. 183–191, 2024.
[34] Y. Park, "Sustainable education practices: voices from higher education institutions," 2024.
[35] A. J. Grau Grau, A. Rodrigo González, E. Badal Valero, B. Martínez Martínez, and J. M. Núñez Almonte, "Sostenibilidad en la educación superior. Experiencias en el marco de la docencia y la investigación universitaria," 2024.
[36] M. Khadim, S. S. Tahira, and B. Naz, "Emerging trends and research developments in education for sustainable development: Shaping conceptions for a sustainable future," *Ann. Hum. Soc. Sci.*, vol. 4, no. 2, pp. 499–512, 2023.
[37] H. M. De la Luz Hernández, J. E. H. Martínez, M. F. G. Fuentes, and L. F. P. Cárdenas, "Liderazgo Sostenible e Innovación en la Empresa: Integrando Objetivos Económicos, Sociales y Ambientales en la Zona Oriente del Estado de México," *Cienc. Lat. Rev. Científica Multidiscip.*, vol. 7, no. 5, pp. 278–297, 2023.
[38] M. Purwanto, D. A. Agung, and M. A. Erwita, "The Role Of Sustainable Leadership In Implementing SDGS: Green Innovation Strategy (GIS): Strategy Transformation In Organizational Sustainability.," *Int. J. Adv. Res.*, vol. 11, no. 10, pp. 752–764, 2023.
[39] L. Hu, T.-W. Chang, Y.-S. Lee, S.-J. Yen, and C.-W. Ting, "How does sustainable leadership affect environmental innovation strategy adoption? The mediating role of environmental identity," *Int. J. Environ. Res. Public Health*, vol. 20, no. 1, p. 894, 2023.
[40] S. Hussain, "Sustainable Leadership and Environment: An Empirical Study in Organizational Context," *NUST J. Soc. Sci. Humanit.*, vol. 9, no. 1, pp. 1–30, 2023.
[41] M. J. Chaudhry and S. Noureen, "Exploring sustainable leadership," *Int. J. Multidiscip. Res. Anal.*, vol. 6, no. 10, pp. 4626–4634, 2023.
[42] I. I. Tritoasmoro, U. Ciptomulyono, T. A. Taufik, and W. Dhewanto, "The Strategic Management Framework for University Start-ups and Spin-offs Development," *Available SSRN 4232752*.
[43] R. Kurniawan, A. Subroto, and E. Daryanto, "A Systematic Literature Review of Organizational Resilience In

Indonesia," *Asian J. Eng. Soc. Heal.*, vol. 3, no. 4, pp. 893–902, 2024.
[44] H. Hutajulu *et al.*, *Sustainable Economic Development: Teori dan Landasan Pembangunan Ekonomi Berkelanjutan Multi Sektor di Indonesia*. PT. Sonpedia Publishing Indonesia, 2024.
[45] Y. Andra, T. I. Indrayani, and A. W. E. Putri, "PENGARUH KEPEMIMPINAN KEWIRAUSAHAAN DAN BUDAYA ORGANISASI TERHADAP INOVASI BISNIS BERKELANJUTAN PADA UKM DI KOTA PADANG," *J. Menara Ekon. Penelit. dan Kaji. Ilm. Bid. Ekon.*, vol. 10, no. 2, 2024.
[46] H. Tripathi, I. Prakash, R. Joshi, and R. C. Agarwal, "Integrating environmental sustainability concerns in agricultural higher education, research and innovations," *Curr. Sci.*, vol. 125, no. 5, pp. 478–482, 2023.
[47] D. Rowe, "Education for a sustainable future," *Science (80-.).*, vol. 317, no. 5836, pp. 323–324, 2007.
[48] D. Fink, "Hacia un liderazgo sostenible, más profundo, más prolongado, más amplio," *Rev. Eletrônica Educ.*, vol. 13, no. 1, pp. 182–195, 2019.
[49] A. M. Waite, "Leadership's influence on innovation and sustainability: A review of the literature and implications for HRD," *Eur. J. Train. Dev.*, vol. 38, no. 1/2, pp. 15–39, 2013.
[50] R. Verburg, "Leadership, innovation, and sustainability," in *Innovation for Sustainability: Business Transformations Towards a Better World*, Springer, 2019, pp. 117–133.