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Advancing Sustainable Entrepreneurship Technology through Campus Environmental Education, Green Accounting, and Sustainability Competencies

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ABSTRACT

Objective: This research aims to investigate the influence of Sustainability Education, Campus Sustainability, and Environmental Sustainability on Entrepreneurship for Sustainability among university students. It also examines the moderating roles of Sustainability Competencies and Awareness of Green Accounting in strengthening or weakening these relationships, providing a more comprehensive understanding of the factors that promote sustainable entrepreneurship in higher education. **Method:** A quantitative research design with a survey approach was employed. The participants consisted of 753 students from Universitas Riau, Indonesia, selected using a convenience sampling technique. Primary data were collected through an online questionnaire, and the proposed model was analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 3.0 to evaluate both direct and moderating effects among the variables. **Results:** The findings show that Sustainability Education, Sustainability Competencies, and Awareness of Green Accounting positively and significantly influence Entrepreneurship for Sustainability. Sustainability Competencies and Awareness of Green Accounting also strengthen the effects of other variables, while Campus Sustainability and Environmental Sustainability do not have significant direct effects. Moderation analysis indicated positive interactions for Sustainability Education and negative interactions for Campus Sustainability and Environmental Sustainability. **Novelty:** The novelty lies in integrating Sustainability Competencies and Awareness of Green Accounting as both direct predictors and moderating variables in explaining Entrepreneurship for Sustainability. This model offers a more comprehensive framework for promoting sustainable entrepreneurship in higher education.

INTRODUCTION

Entrepreneurship is a concept that has taken center stage globally and has become an attractive lifestyle and career choice, including for university students (Schumpeter & Swedberg, 2021). Zen Business found that 84% of Gen Z chose entrepreneurship as an attractive career path (Hyder, 2016), while 19.48% of Indonesian youth became entrepreneurs in 2022 (Sriwahyuni & Kurjono, 2023). A tracer study report from Universitas Riau noted that 24% of students expressed interest in becoming entrepreneurs, but only 8.61% of alums are active entrepreneurs (Isjoni et al., 2023). Indonesia currently has an entrepreneurship ratio of 3.47%, below the 4% target set for achieving the 2045 economic vision (Pusparini et al., 2024). With Indonesia's population reaching 278.69 million, increasing the number of entrepreneurs to 11.148

million is expected to strengthen the national economy and encourage business interest among potential entrepreneurs.

5 Entrepreneurship is important for economic progress, while sustainable business practices are necessary for long-term success (Shivhare et al., 2024). This condition gave birth to the concept of Sustainable Entrepreneurship. Entrepreneurship is recognized as playing a role in achieving Sustainable Development Goals (SDGs) through an attitude of commitment and awareness of sustainability aspects (Ashari et al., 2021). The educational paradigm has begun to shift from traditional universities to Entrepreneurial Universities (Ahari et al., 2021; Carmen et al., 2021). This has also caught the government's attention, prompting proactive measures to develop and inculcate entrepreneurial thinking, particularly through education (Ahari et al., 2021).

2 This research connects students' interest in entrepreneurship with the real challenge of encouraging university alumni actually to become active entrepreneurs. Tracer study data indicates a gap between the initial interest and the actual implementation of entrepreneurship after graduation. Moreover, the vision to increase the ratio of entrepreneurs in Indonesia to 4% of the population to achieve the economic target by 2045 highlights the need for a deep understanding of the factors that influence sustainable entrepreneurial success. 5 This research is expected to provide important insights for public policies and educational strategies that support sustainable entrepreneurial growth in Indonesia. The government has included entrepreneurship education in the curriculum. It has even designated it as a Key Performance Indicator (KPI) targeted by the Ministry of Education, Culture, Research and Technology (Momete & Momete, 2021).

In recent decades, many Higher Education Institutions around the world have implemented the Entrepreneurial University (EU) model (Audretsch, 2014), which has given rise to entrepreneurship education and university business incubators (Karahan, 2024). The EU faces criticism for being highly dependent on many contextual factors, with high costs being a prohibitive factor (Hayter & Cahyo, 2018; Meek & Gianiodis, 2023). EU is also perceived as focusing only on economic aspects (Trencher et al., 2014a; Trencher et al., 2014b). This criticism gave rise to the Sustainable Entrepreneurial University (Cai & Ahmad, 2023).

4 Research by Fanea-Ivanovici & Baber 2022) shows that Sustainable Entrepreneurial University is closely related to campus sustainability, environmental sustainability, and education sustainability. 4 In Sweden, sustainability competencies are a suggested model for realizing Sustainable Entrepreneurial University (Karahan, 2024). 4 A study by Venn et al. 2022) shows that formal and informal learning play an important role in competency development (including sustainability competencies). Sustainability competencies can be seen as a key educational goal for universities in producing graduates who can address complex sustainability issues (Barth, 2016; Molderez & Ceulemans, 2018).

Green Accounting practices are the norm in modern times and are business initiatives that are equivalent to sustainability initiatives (Tajane & Bhosale, 2023). Green Accounting adoption is one of the important factors in sustainable development (Dhar et

al., 2022; Dura & Suharsono, 2022). The Green Accounting model is considered a determinant of the entrepreneurial behavior of the younger generation (Bagiada et al., 2020). Based on the understanding of the Entrepreneurial University model, this study focuses on the importance of transformation towards a Sustainable Entrepreneurial University that integrates Campus Sustainability, Environmental Sustainability, and Education Sustainability. This study emphasizes that Entrepreneurship for Sustainability depends not only on these three aspects but also on Sustainability Competencies and Awareness of Green Accounting.

Sustainability theory (Hahn & Kühnen, 2023), the Triple Bottom Line (Elkington, 1997), stakeholders' theory (Freeman, 2010), and Planned Behavior theory (Ajzen, 1991) are integrated to provide a comprehensive understanding of how universities can be sustainable change agents in promoting sustainable awareness and action. The researcher highlights that there are still gaps in research on Entrepreneurship for Sustainability, as well as inconsistencies in some studies' results. Some studies ignore Sustainability Competencies, even though research indicates that Sustainability Competencies are an important factor in student involvement in sustainability activities. Bagiada et al. (2020) showed that Green Accounting is one of the determinants of the entrepreneurial attitude of the younger generation. This research is a development of research (Bagiada et al., 2020; Noor et al., 2024).

This study aims to analyze how Campus Sustainability, Environmental Sustainability, and Education Sustainability affect Entrepreneurship for Sustainability with Sustainability Competencies and Awareness of Green Accounting as moderation. The use of moderating variables is expected to address gaps in previous research. This research also contributes to the literature related to Entrepreneurship for Sustainability. The findings of this study can assist universities in designing more effective curricula and programs to produce sustainability-oriented entrepreneurs. The rest of the article outline is as follows: The theoretical review section describes the literature review, which includes the theoretical framework and hypothesis development, as well as the conceptual framework of this study. The following section describes the research methodology, followed by the results and discussion. Furthermore, the last section shows the conclusion, the importance of this research, and recommendations.

RESEARCH METHOD

Research Design

This study employs a quantitative research design with an explanatory (causal) nature, utilizing a cross-sectional survey approach. It aims to examine the causal relationships of Sustainability Education, Campus Sustainability, and Environmental Sustainability with Entrepreneurship for Sustainability, while considering Sustainability Competencies and Awareness of Green Accounting as moderating variables. Primary data were collected via online questionnaires and analyzed using the SEM-PLS method (Ashari et al., 2021; Ghozali, 2008). The research steps are shown in Figure 1 below.

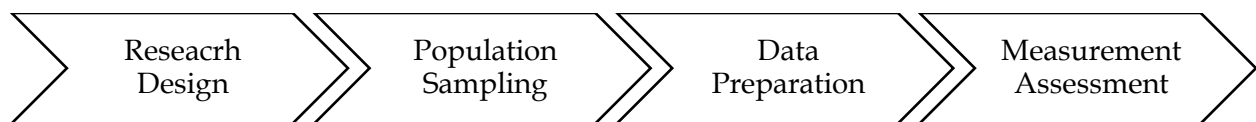


Figure 1. Research workflow

The research was conducted in four stages. The first stage involved designing the study by identifying the research problem, reviewing relevant literature, developing the conceptual framework, formulating the hypotheses, and adapting measurement indicators from previous studies to construct the research instrument. The second stage focused on determining the research population and sample, in which Universitas Riau students who had completed entrepreneurship courses were selected using a convenience sampling technique, followed by collecting primary data through an online questionnaire. The third stage consisted of data preparation, including screening incomplete responses, coding, and organizing the dataset to ensure its quality and consistency. The final stage involved evaluating the measurement model using SEM-PLS with SmartPLS 3.0 by assessing the path coefficients and p-values of the measurement instruments, ensuring that all constructs and indicators were suitable for subsequent analysis. The population in this study was all students at the Universitas Riau (UNRI) who had received entrepreneurship courses. The sampling selection method is non-probability sampling using the convenience sampling technique. The data in this study come from primary data obtained by distributing electronic questionnaires. The questionnaire is arranged in accordance with the measurement indicators using a 4-point Likert scale to avoid centered answers (Ashari et al., 2021; Baiada et al., 2020).

Operational Definitions and Variable Measurements

In this study, three variables were used, namely the dependent variable (Y), the independent variable (X), and the moderating variable (M). The following are operational definitions and variable measurements. The operationalization of variables is presented in Table 1.

Table 1. Operational definitions and variable measurements

Variable	Operational Definition
Campus sustainability	Internal campus practices are analyzed as part of the university's efforts towards sustainability (Dagiliūtė et al., 2018; Fanea-Ivanovici & Baber, 2022).
Environmental sustainability	University practices in preserving the environment (Fanea-Ivanovici & Baber, 2022; Demssie et al., 2019).
Education sustainability	Integration of sustainability in the academic curriculum or in any educational practice that is a manifestation of a desire to achieve sustainability literacy (Fanea-Ivanovici & Baber, 2022).
Sustainability Competencies	The integration of knowledge, skills, and attitudes that facilitate efforts to sustain the human and natural resources necessary for the social, environmental, and economic progress of current and future generations (Gupta et al., 2023; Lambrecht et al., 2013; Noor et al., 2024; Wiek & Kay, 2015)

Variable	Operational Definition
Awareness Green Accounting	A concept that integrates environmental costs and benefits in economic decision making (Bagiada et al., 2020). The author adopts green accounting variables from research (Tajane & Bhosale, 2023) which are updated with awareness. The indicators used are the level of awareness of green accounting practices, current status, implementation status, perceived benefits, and perceived barriers to adoption.
Entrepreneurship for Sustainability	The combination of the concepts of entrepreneurship and sustainable development (Ghozali, 2008). Future intentions to pursue and practice sustainable entrepreneurship (Fichter & Tiemann, 2019).

Data Analysis Techniques

Data were analyzed using the Partial Least Squares (PLS) model, which is a component- or variant-based SEM. PLS is a powerful analysis method because it does not rely on many assumptions. SEM-PLS was chosen because it is effective in testing complex models with many latent variables and indicators relevant to the research variables. Researchers used the Smart PLS 3.0 program application. To conclude, hypothesis testing was conducted using the t-test, and significance was assessed using the bootstrap resampling method. Moderation type testing was also carried out because this study involved 2 moderation variables (Ashari et al., 2021; Fichter & Tiemann, 2018).

RESULTS AND DISCUSSION

This study explores how campus sustainability, environmental sustainability, and education sustainability affect Entrepreneurship for Sustainability with Sustainability Competencies and Awareness of Green Accounting as moderation. In this study, 753 UNRI students responded to the questionnaire. After the data were obtained, they were tabulated according to the research needs. The tabulated results are then processed using the Smart PLS application, whose results are explained as follows.

Results

Descriptive statistics provide an initial description of the characteristics of the collected data, the results are presented in Table 2.

Table 2. The results of descriptive statistics.

Variable	N	Minimum	Maximum	Range	Mean	Std. Deviasi
Campus sustainability (X1)	753	6.00	16.00	10.00	12.7012	2.41663
Environmental sustainability (X2)	753	4.00	16.00	12.00	12.3825	2.50687
Education sustainability (X3)	753	8.00	16.00	8.00	13.1208	2.06928
Sustainability Competencies (M1)	753	8.00	24.00	16.00	20.6919	2.81772
Awareness Green Accounting (M2)	753	11.00	24.00	13.00	19.6056	2.58984
Entrepreneurship for Sustainability(Y)	753	5.00	20.00	15.00	16.8035	2.75143

The results showed that students from UNRI have a high level of awareness of Campus, Environmental, and educational sustainability. UNRI students have good Sustainability Competencies and Awareness of Green Accounting. Entrepreneurship for Sustainability has a mean of 16.80 (SD = 2.75), indicating a high interest in sustainable entrepreneurship. This finding shows the great potential of UNRI students in supporting sustainable development through entrepreneurship. The results of the measurement model analysis for all variables show high factor loadings (all above 0.5), Cronbach's Alpha above 0.7, Composite Reliability above 0.8, and Average Variance Extracted (AVE) above 0.5. All of them meet the recommended criteria and indicate each construct has high validity and reliability. Discriminant validity testing using the Fornell-Larcker criterion shows the square root value of the AVE for each construct is greater than the correlation between other constructs, indicating good discriminant validity. The HTMT values for all constructs were below the 0.90 threshold, supporting adequate discriminant validity. Collinearity analysis indicated that all VIF values were below the recommended threshold, so there were no significant collinearity issues in this model.

Evaluation of the structural model showed an Adj R² value of 0.484 for the Entrepreneurship for Sustainability construct, considered moderate by the standards. This suggests the model explains about 48.4% of the variability in the construct. Campus Sustainability, Environmental Sustainability, Education Sustainability, Sustainability Competencies, and Awareness of Green Accounting variables together have a significant contribution in explaining Entrepreneurship for Sustainability among UNRI students. Table 3 presents the results of the inner weights.

Table 3. Result for inner weights

	Path	Path Coefficient	T Statistics	P Values	Description
(H1)	CMS to Entrepreneurship for Sustainability	0.019	0.387	0.699	Rejected
(H2)	ENS to Entrepreneurship for Sustainability	0.032	0.593	0.553	Rejected
(H3)	EDS to Entrepreneurship for Sustainability	0.255	5.451	0.000	Accepted
(H1)	CMS to Entrepreneurship for Sustainability	0.019	0.387	0.699	Rejected
(H2)	ENS to Entrepreneurship for Sustainability	0.032	0.593	0.553	Rejected
(H3)	EDS to Entrepreneurship for Sustainability	0.255	5.451	0.000	Accepted
(H4)	AG to Entrepreneurship for Sustainability	0.273	6.547	0.000	Accepted

Path	Path Coefficient	T Statistics	P Values	Description
(H5) SC to Entrepreneurship for Sustainability	0.163	4.251	0.000	Accepted
(H6) CMS* AG to Entrepreneurship for Sustainability	-0.133	2.047	0.041	Accepted
(H7) ENS* AG to Entrepreneurship for Sustainability	-0.344	6.492	0.000	Accepted
(H8) EDS* AG to Entrepreneurship for Sustainability	0.455	5.994	0.000	Accepted
(H9) CMS* SC to Entrepreneurship for Sustainability	-0.187	3.550	0.000	Accepted
(H10) ENS* SC to Entrepreneurship for Sustainability	-0.182	3.266	0.001	Accepted
(H11) EDS* SC to Entrepreneurship for Sustainability	0.313	5.846	0.000	Accepted

The results of hypothesis testing showed that of the eleven hypotheses tested, nine hypotheses (H3-H11) were accepted with significant p-values below 0.05, indicating a significant effect of Education Sustainability, Awareness of Green Accounting, and Sustainability Competencies on Entrepreneurship for Sustainability, as well as the interaction between Campus Sustainability, Environmental Sustainability, and Education Sustainability with Awareness of Green Accounting and Sustainability Competencies. Two hypotheses (H1, H2) were rejected related to the direct effect of Campus Sustainability and Environmental Sustainability on Entrepreneurship for Sustainability, indicating that without moderation, these two variables do not have a significant effect on Entrepreneurship for Sustainability among UNRI students. In addition, four negative interactions were found, namely the interaction of awareness of green accounting and sustainability competencies on campus sustainability and environmental sustainability, respectively, and the rest were positive.

Discussion

This study shows that Sustainability Education, Awareness of Green Accounting, and Sustainability Competencies have a positive and significant direct influence on Entrepreneurship for Sustainability ($p < 0.005$). Based on the descriptive statistics results, the average scores for the three variables were 3.280, 3.448, and 3.267 out of a scale of 4, indicating that respondents agree on the importance of Sustainability Education in guiding them towards sustainable entrepreneurial practices. They also recognize the importance of Green Accounting in supporting sustainability and responsible business practices, and acknowledge that Sustainability Competencies are necessary for

sustainable entrepreneurship. This study demonstrates that Universitas Riau has successfully instilled values of sustainability and sustainable entrepreneurship in its curriculum, as reflected in the students' awareness and understanding of these three variables.

This finding demonstrates the effectiveness of university programs and initiatives in supporting and promoting sustainability, and reinforces the argument that higher education has an important role in shaping future sustainable entrepreneurial practices (Alonso-Almeida et al., 2015; Brinkhurst, 2011; Veiga Ávila et al., 2019). These findings are in line with the existing literature and strengthen the empirical evidence regarding the significant influence of these variables on Entrepreneurship for Sustainability as confirmed in research (Baiada et al., 2020; Dhar et al., 2022; Fanea-Ivanovici & Baber, 2022, Fichter & Tiemann, 2018; Noor et al., 2024; Ploum et al., 2018). Research by Hameed (2021) shows that education sustainability directly affects entrepreneurial intention. This is also in line with the concept of Planned Behavior theory (Ajzen, 2010), which posits that increasing students' awareness and competence regarding sustainability can foster positive attitudes, subjective norms, and behavioral control towards sustainable entrepreneurship, thereby strengthening their intentions and actions in this area.

Sustainability theory (Hahn & Kühnen, 2013) and TBL (Elkington, 1997) highlight the importance of balancing economic, social, and environmental dimensions in decision-making and organizational practices, including those at universities. Research by Fanea-Ivanovici & Baber (2022) shows that there are three aspects in the practice of sustainability in a university, namely campus, environmental, and education sustainability, which, according to them, has a positive effect on Entrepreneurship for Sustainability. In contrast to these studies, this study shows that Campus Sustainability and Environmental Sustainability are not significant in their direct influence on Entrepreneurship for Sustainability ($p > 0.05$).

The results of this study indicate that at UNRI, sustainable entrepreneurship among students still comes from internal motivation or students' intention to become entrepreneurs, not depending on Campus Sustainability and Environmental Sustainability, which may not be felt to exist. This finding suggests that, in addition to high student entrepreneurial intentions, programs and initiatives related to Campus Sustainability and Environmental Sustainability need to be improved to more effectively motivate and guide students towards sustainable entrepreneurial practices. Universities can encourage entrepreneurship for sustainability through internal organization and provision of support systems (Fichter & Tiemann, 2018; Solimun et al., 2017) and certainly through participation and collaboration (Dagiliūtė et al., 2018).

In contrast, the variables of Sustainability Education, Awareness of Green Accounting, and Sustainability Competencies show a significant effect, emphasizing that the educational aspects and competencies in sustainability are more accepted and recognized by students as important factors in building a sustainable entrepreneurial spirit. The success of sustainability transformation is faced with major obstacles, such as poor

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governance and policies, bureaucracy, lack of resources, and lack of leadership support (Adams et al., 2018; Veiga Ávila et al., 2019). In the context of Stakeholder Theory (Freeman, 2010), these findings indicate that to advance sustainable entrepreneurship, Universitas Riau needs to consider and meet the expectations of all stakeholders, including students, staff, and the community. A more holistic and collaborative approach in integrating sustainability into the curriculum and campus operations will enhance the positive impact on sustainable entrepreneurship.

This study also explores the moderating role of Awareness of Green Accounting (M1) and Sustainability Competencies (M2) in the relationship. Based on the test results, M1 and M2 not only moderate the relationships between the independent variables (X1, X2, and X3) and the dependent variable (Y) but also have a direct influence on Y. In other words, the two variables play a dual role, namely as direct predictors and as moderators. So, the variable Awareness of Green Accounting and Sustainability Competencies is a quasi-moderation variable. This study demonstrates that Awareness of Green Accounting and Sustainability Competencies are crucial and have a significant impact on Entrepreneurship for Sustainability at Universitas Riau.

The interaction of these two variables manifests in two directions: first, a positive and significant path coefficient when interacting with Education Sustainability, indicating that enhancing Education Sustainability, supported by these variables, can effectively promote Entrepreneurship for Sustainability among students. Second, a negative and significant path coefficient in interaction with Campus and Environmental Sustainability, suggesting that despite efforts in campus and environmental sustainability, this interaction has not effectively supported Entrepreneurship for Sustainability. This may be due to a mismatch between existing policies or practices and student needs. These findings underscore the necessity for reviewing and improving campus and environmental sustainability programs to align with the principles of Green Accounting and the Sustainability Competencies required by students.

This study emphasizes that Education Sustainability, Awareness of Green Accounting, and Sustainability Competencies play significant roles as predictors in promoting Entrepreneurship for Sustainability at Universitas Riau. At the same time, Campus and Environmental Sustainability do not have a direct influence. Awareness of Green Accounting and Sustainability Competencies has been shown to moderate the relationships among these variables significantly. Universitas Riau needs to strengthen its campus and environmental sustainability initiatives to make them more effective. This research clarifies the dual roles of moderating variables. It provides practical guidance for enhancing higher education programs to align with SDGs, consistent with existing literature that higher education plays a vital role in shaping sustainable entrepreneurship practices in the future.

CONCLUSION

Fundamental Finding: Education Sustainability, Awareness of Green Accounting, and Sustainability Competencies significantly and positively influence Entrepreneurship for

Sustainability, highlighting their crucial role in promoting sustainable entrepreneurship among students. Awareness of Green Accounting and Sustainability Competencies serve dual roles as both a direct predictor and a moderator, directly affecting Entrepreneurship for Sustainability and enhancing the influence of other variables. Sustainability efforts on campus and in the environment need to be improved to more effectively influence sustainable entrepreneurship, indicating that students' entrepreneurial intentions at Universitas Riau are driven by internal motivation. Positive and significant path coefficients are observed in the interaction of these moderators with Education Sustainability, while negative and significant coefficients are seen with Campus Sustainability and Environmental Sustainability. This highlights the need to enhance campus and environmental programs to align with sustainability principles. **Implication:** The theoretical implications of this study highlight the importance of Education Sustainability, Awareness of Green Accounting, and Sustainability Competencies in promoting Entrepreneurship for Sustainability. This research supports existing literature and emphasizes the need to integrate these aspects into university curricula. From a managerial perspective, Universitas Riau needs to strengthen its campus and environmental sustainability initiatives, review and enhance its sustainability programs, and ensure alignment with green accounting principles and Sustainability Competencies to maximize the positive impact on sustainable entrepreneurship. **Limitation:** This study uses a cross-sectional design, which cannot establish causal relationships, and its results may not apply to other universities. Data collected solely from students may introduce bias, and the quantitative approach may not fully capture the actual context. **Future Research:** Future research should adopt a longitudinal design, involve other universities, engage diverse stakeholder groups, and combine quantitative and qualitative approaches to achieve a more comprehensive understanding.

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AUTHOR CONTRIBUTIONS

Julita conceived the study, developed the conceptual framework, supervised the research process, coordinated the project, and led the manuscript preparation. **Muhammad Luthfi Iznillah** contributed to the research design, methodology development, and data analysis. **Susi Hendriani** contributed to the conceptual framework, literature review, and validation of the research instruments. **Ria Nelly Sari** contributed to data collection, data curation, and interpretation of the findings. **Riska Natariasari** contributed to statistical analysis, data visualization, and interpretation of the results. **Frini Karina Andini** contributed to the literature review, manuscript drafting, and language editing. **M. Yogi Riyantama** contributed to data collection, project administration, and manuscript revision. **Isjoni** contributed to the research methodology, academic supervision, and critical review of the manuscript. **Kiswanto** contributed to data validation, interpretation of findings, and manuscript review. **Diah Anugrah Dipuja** contributed to formal

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CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support in the research and writing stages of this article. Specifically, Grammarly was employed for correcting writing and grammar errors. All outputs generated with digital assistance were critically evaluated and revised to ensure academic rigor and ethical standards were upheld. The final responsibility for the manuscript rests entirely with the authors.

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