

Does gender matter? A moderation analysis of renewable energy and sustainability performance in Indonesian higher education institutions

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Abstract

This study aims to provide empirical evidence on the influence of renewable energy (RE) on sustainability performance (SP), while also examining the role of gender in this relationship. A quantitative research method employing a survey technique was used with university lecturers in Indonesia as respondents. 232 samples were measured using random sampling which was processed using the SmartPLS 4.0 application. The results found a significant influence of renewable energy on sustainability performance. However, gender was not found to moderate the effect of renewable energy on sustainability performance. This study confirms that the success of renewable energy strategies in improving sustainability performance in universities depends not only on technology and investment, but also on gender diversity. In the context of sustainability research, gender socialization theory provides a robust theoretical foundation to support the argument that gender equality is a vital prerequisite for achieving equitable, inclusive, and sustainable development for all. Thus, this study makes a significant contribution to the literature on renewable energy, sustainability, and gender, offering new insights into the development of more inclusive and sustainable higher education policies. The results also confirm the relevance of public policies that link the sustainability agenda to gender equality in the higher education sector.

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1. Introduction

Sustainability issues have become a global focus over the past two decades, accompanied by an increasing awareness of climate change, resource constraints, and demands for environmentally friendly practices across various sectors, including higher education. Furthermore, as centers of education, research, and community service, universities have a moral and strategic responsibility to promote sustainable development through environmentally friendly policies, innovation, and operational practices (Ahmad et al., 2022). As centers for the development of science and innovation, universities play a strategic role in supporting the implementation of the Sustainable Development Goals (SDGs), particularly Goals 7 (Affordable and Clean Energy) and 13 (Climate Action) (Montoya & Perea-Moreno, 2020). One concrete effort to support this agenda is the use of renewable energy sources, such as solar, wind, and biomass, to reduce carbon emissions and decrease dependence on fossil fuels (Bratt et al., 2021). The transformation towards renewable energy not only reflects a commitment to environmental sustainability but is also an important factor in improving the sustainability performance of higher education institutions (Almasri & Abu-hamdeh, 2024). Previous research has been mostly conducted in western countries, but in the Asian context there is still a literature gap on the role of renewable energy in supporting sustainability performance with gender as moderating variable, especially in higher education.

However, achieving sustainable performance through renewable energy is not solely dependent on technological aspects and institutional policies. Social and demographic factors, such as gender, also play a significant role. Previous literature indicates differences in perspectives and levels of concern between men and women regarding environmental and sustainability issues (Latif et al., 2020). Women generally exhibit more pro-environmental attitudes and tend to support green energy policies than men (Al-Rawashdeh et al., 2023). In the context of higher education, this gender perspective may moderate the relationship between the implementation of renewable energy and sustainability performance. Gender Socialization Theory posits that the differing social values and norms between men and women can shape patterns of concern for environmental issues (Bussey & Bandura, 1999). Theoretically, gender is expected to moderate the relationship between renewable energy implementation and sustainability performance.

Thus, gender-based analysis is highly relevant in explaining variations in the success of renewable energy implementation in higher education. Unfortunately, although numerous studies on renewable energy and sustainability have been conducted in the industrial and government sectors (Katre & Tozzi, 2018; Montoya & Perea-Moreno, 2020), particularly in the context of universities in developing countries, research examining the moderating role of gender in this relationship remains limited and has yielded inconsistent results (Mansour et al., 2024). Previous research conducted on companies in Europe (Issa, 2023), Africa (Babiker et al., 2025; Sarango-lalangui et al., 2023), and various countries (Almaqtari et al., 2024) found that gender diversity is able to moderate the influence of innovation on environmental performance. However, there has been little research on similar topics conducted in Indonesia, which has a very different culture. Therefore, this study aims to fill this gap by providing new empirical evidence on the impact of renewable energy on sustainability performance in higher education and examining whether gender, as moderating variable, plays a differential role in this relationship.

The novelty of this research lies in the integration of renewable energy issues and sustainability performance moderated by gender perspectives within the context of Indonesian higher education. Unlike previous research focused on the commercial sector, this study highlights the social and institutional dynamics within academic environments with distinct governance characteristics and sustainability objectives. Furthermore, the findings, which indicate that gender does not moderate the relationship between renewable energy and sustainability performance, provide an important theoretical contribution to gender socialization theory by highlighting that in egalitarian institutional contexts, gender differences are no longer a primary determinant of pro-environmental decision-making.

Practically, the results of this study contribute to policymakers in higher education by emphasizing the importance of renewable energy policies as a strategic instrument for improving sustainability performance, while also considering the potential for gender bias in their implementation. Universities can enhance their human resource capacity and energy management policies by adopting an inclusive and performance-based approach. Furthermore, it supports the gender equality agenda (SDG 5: Gender Equality) by emphasizing that the success of the green energy transition (SDG 7: Affordable and Clean Energy) is inextricably linked to gender participation and perspectives. Furthermore, this study supports social contributions by providing a foundation for the development of inclusive, sustainable campuses in developing countries.

2. Theory and Hypothesis Development

2.1. Theory

Gender Socialization Theory explains how differences in behavior, values, and roles between men and women are formed through social and cultural processes of socialization from an early age (Zampone et al., 2024). Gender socialization occurs when individuals learn the norms, expectations, and roles that society assigns to a particular gender. This process occurs through various socialization agents, such as family, school, mass media, and the social environment (Bussey & Bandura, 1999). According to this theory, men and women are not only biologically differentiated but also shaped by social experiences that instill values, preferences, and behaviors unique to each gender (Strzelecki & ElArabawy, 2024). For example, women are more often socialized to be caring, empathetic, and cooperative, while men tend to be taught to be competitive, rational, and achievement-oriented (Leigh et al., 2021).

In the context of sustainability, this theory implies that women are more likely to engage in pro-environmental behavior due to societal values that emphasize concern for social and environmental well-being (Al-Rawashdeh et al., 2023). In contrast, men, who are more often associated with rational and economic roles, may view environmental issues as secondary to organizational efficiency or profitability (Pandit & Paul, 2023). Zampone et al. (2024) found that women tend to exhibit higher levels of environmental concern than men because the values they internalize through socialization emphasize the importance of social harmony and environmental sustainability. This result explains why, in many studies, women's involvement in leadership is often associated with stronger sustainability practices (Pandit & Paul, 2023). Rana et al. (2025) noted that women tend to exhibit a more transformational leadership style, characterized by a value-oriented, empathetic, and morally motivated approach. This style supports the creation of a more sustainable organizational culture.

However, in the context of higher education institutions, which generally prioritize the principles of equality, meritocracy, and scientific values, the social influence of gender on sustainability behavior may be weakened (Fallon-Byrne & Harney, 2017). When decisions are made based on academic competence rather than gender characteristics, the moderating effect of gender becomes insignificant. This finding suggests a shift from the traditional social paradigm toward role equality in professional and academic contexts. Although Gender Socialization Theory has provided a robust framework for understanding gender differences in social and environmental behavior, it has not been without criticism. First, the theory is considered too deterministic because it emphasizes that social norms entirely shape individual behavior, while structural and contextual organizational factors are often ignored (Nketsiah et al., 2023). Second, the theory is not always relevant in

modern societies that increasingly emphasize gender equality and equal opportunities in the workplace, including in the higher education sector. Furthermore, this approach has been criticized for ignoring cross-cultural dynamics and individual variation. For example, in egalitarian cultures or in merit-based organizations, gender differences in pro-environmental behavior may not emerge significantly (Latif et al., 2020).

2.2. Hypothesis Development

2.2.1. Renewable Energy and Sustainability Performance

The concept of sustainability performance in higher education encompasses three main dimensions: environmental, social, and governance (ESG) (Salem et al., 2023). Sustainability is not only measured by energy efficiency and emission reduction, but also by the university's contribution to society, achievement of the Sustainable Development Goals (SDGs), and transparent governance (Ahmad et al., 2022). Previous studies have shown that the use of renewable energy can improve an institution's sustainability performance, both through resource savings, increased environmental awareness, and academic reputation (Katre & Tozzi, 2018). Thus, renewable energy is a crucial determinant in achieving sustainability performance in higher education.

Renewable energy is a crucial tool for promoting sustainability in higher education. The implementation of green energy sources, such as solar power, biomass, or energy-efficiency systems, has been shown to reduce carbon footprints, lower operational costs, and enhance the reputations of institutions as sustainable universities (Montoya & Perea-Moreno, 2020). Universities play a strategic role as living labs that integrate teaching, research, and sustainability practices, including the use of environmentally friendly energy (Shrestha, 2024). Although numerous studies confirm the crucial role of renewable energy, most of the literature focuses on technical aspects and institutional policies. However, social factors such as academic participation and demographic dimensions, including gender, can influence the successful adoption of green energy in higher education (Alghamdi & den Heijer, 2021).

Various studies have highlighted the positive impact of renewable energy initiatives in reducing greenhouse gas emissions and promoting sustainable practices within educational institutions. For example, Almasri et al. (2023) emphasize the economic feasibility and environmental benefits of energy-efficient and renewable energy systems in higher education facilities. The transition to renewable energy also brings economic benefits, including job creation, investment opportunities, and cost savings. The renewable energy sector has become a significant driver of economic growth, providing jobs in the manufacturing, installation, and maintenance of renewable energy systems (Yaprakli & Özden, 2021). Other research underscores the importance of renewable energy adoption in higher education as a means to achieve sustainability goals and contribute to environmental stewardship (Salem et al., 2023). The role of renewable energy in sustainability performance is multifaceted, encompassing environmental, economic, and social dimensions (Salem et al., 2023). Investment in renewable energy infrastructure can boost economic growth while reducing dependence on imported fossil fuels (Wang et al., 2020).

Literature shows that the use of renewable energy has a positive impact on achieving sustainability in various sectors, including higher education. The implementation of environmentally friendly energy sources, such as solar power, biomass, and energy efficiency, contributes to reducing carbon emissions, lowering operational costs, and enhancing an institution's reputation as a green campus (Montoya & Perea-Moreno, 2020). Within the Natural Resource-Based View (NRBV) framework, an institution's ability to manage natural resources sustainably is a crucial factor in achieving environmental, social, and governance performance (Hart, 1995; Hart & Dowell, 2011). Hannan et al. (2021) analyzed the alignment of renewable energy projects with SDG targets. They found positive synergies in areas such as affordable energy (SDG 7), climate action (SDG 13), and sustainable cities (SDG 11). Therefore, the first hypothesis can be proposed:

H1. Renewable energy has a positive impact on the sustainable performance of higher education institutions.

2.2.2. Gender as a moderating variable on the influence of renewable energy on sustainability performance

According to Gender Socialization Theory (Bussey & Bandura, 1999), gender differences influence how individuals perceive, respond to, and engage with environmental and sustainability issues. Gender issues in the context of sustainability have received attention in various social and environmental studies. According to Ruel et al. (2020), men and women develop different values and behaviors toward the environment as a result of social and cultural socialization processes. Women, in general, tend to demonstrate higher levels of environmental concern due to societal (Mansour et al., 2024) values that emphasize empathy, caring, and responsibility for social sustainability (Al-Rawashdeh et al., 2023). Within organizations, gender diversity is believed to strengthen strategic perspectives, enrich decision-making, and increase the effectiveness of environmental policies (Fallon-Byrne & Harney, 2017). Several studies have found that the presence of women in leadership positions can strengthen organizational commitment to sustainability initiatives (Pandit & Paul,

2023; Katsamakas et al., 2019). This result is because women are often more sensitive to the social implications of managerial decisions and are more likely to support environmentally based policies.

In the context of sustainability management in higher education, gender can serve as a moderating variable that influences the strength of the relationship between renewable energy implementation and sustainability performance. The presence of women in strategic positions or in decision-making is often associated with increased environmental awareness and support for green policies (Yaprakli & Özden, 2021). Several studies have found that gender diversity can strengthen the relationship between environmentally friendly practices and sustainability performance outcomes by increasing ethical and participatory perspectives (Zampone et al., 2024).

However, some studies have also shown inconsistent results. For example, Pareek et al (2023) found that the effect of gender on driving sustainability performance is not always significant due to gender-biased organizational culture and hierarchical structures. In the context of higher education institutions in developing countries, although women may have a higher awareness of sustainability issues, their influence in strategic decision-making is often limited (Rana et al., 2025). Previous research has shown that women tend to have higher environmental awareness than men. Previous literature indicates differences in perspectives and levels of concern between men and women regarding environmental and sustainability issues (Latif et al., 2020). These differences suggest that gender may act as a moderating variable, influencing the strength of the relationship between green energy strategies and sustainability performance. In the context of higher education, female lecturers may be more committed to sustainable practices, both in teaching, research, and institutional policies (Zampone et al., 2024).

Based on the theoretical framework and empirical evidence, gender is assumed to have the potential to strengthen (moderate) the relationship between renewable energy and sustainability performance. Universities with higher female involvement in energy management or sustainability policies are expected to generate a stronger impact from renewable energy implementation on sustainability performance. Therefore, the second hypothesis is proposed:

H2. Gender moderates the relationship between renewable energy and sustainable performance, such that the effect is stronger for female academics compared to male academic

3. Method

This study employs a quantitative approach with a survey design, aiming to investigate the relationship between renewable energy variables and sustainability performance, with gender serving as a moderating variable. The quantitative research design was chosen because it is suitable for testing causal hypotheses through numerical data analysis (Creswell & Creswell, 2018). This study employs a quantitative approach with a survey design, aiming to investigate the relationship between renewable energy variables and sustainability performance, with gender serving as a moderating variable. The population in this study was university lecturers in Indonesia. The sample consisted of lecturers who were willing to participate as respondents in this study. The sampling technique used was random sampling. The number of questionnaires collected and eligible for analysis was 232. This sample size is considered adequate for Partial Least Squares Structural Equation Modeling (PLS-SEM)-based analysis, because it exceeds the minimum requirement of the ten times rule (Hair et al., 2017). The data were processed using the SmartPLS 4.0 application.

The research instrument was a closed-ended questionnaire with a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). The instrument was divided into four main sections:

- a. Respondent characteristics: gender, age, work experience.
- b. Renewable energy: 5 items adapted from (Montoya & Perea-Moreno, 2020), which were also used in the UI GreenMetric ranking assessment. The assessment dimensions included the implementation of solar energy, biomass, energy efficiency, and green energy policies on campus.
- c. Sustainability performance: 6 items adapted from (Blasco et al., 2019), which were also used in the UI GreenMetric ranking assessment. The assessment covered the dimensions of sustainable infrastructure, water, waste management, transportation, renewable energy, and education.
- d. Gender: categorized based on respondent demographic data (1 = female and 0 = male) for analysis as a moderating variable.

The operationalization of the research variables can be explained as follows (Table 1):

Table 1. Operational Variables

Variable	Definition	Dimension	Indicator
Renewable Energy	Utilization of renewable energy encompasses institutional initiatives aimed at reducing dependence on fossil fuels and promoting energy efficiency and climate change mitigation (Hannan et al., 2021).	Commitment	Renewable energy as a priority
			Support for clean energy
		Energy system	Use of renewable energy systems
			Integration with daily operations
		Program	Energy efficiency program
			Energy-efficient building
		Education	Renewable energy curriculum
			Activities that support renewable energy
Sustainability performance	The institution's ability to integrate sustainability principles into academic, operational, and social policies (Blasco et al., 2019)	Sustainable infrastructure	Green open space
			Sustainability practices
		Renewable energy	Use of renewable energy
			Energy-saving policy
		Water	Water conservation practices
			Water use
		Waste	Waste sorting
			Reduced paper use
		Transportation	Restrictions on the use of motor vehicles
			Parking area that supports green mobility
		Education	Sustainable curriculum
			Student involvement in sustainability activities
Gender	Men and women develop different values and behaviors through a socialization process influenced by social norms and expectations (Bussey & Bandura, 1999).	Woman and Man	1 = woman 0 = man

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with the help of SmartPLS 4.0 software. The analysis steps included:

- Validity and reliability testing: The outer model was examined using loading factors, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's Alpha.
- Discriminant validity testing: Using the HTMT ratio.
- Structural model testing (inner model): including R^2 , f^2 , and path coefficient values.

Gender moderation testing: A moderation test was conducted to compare differences in the influence of renewable energy on sustainability performance based on gender. This study uses the product indicator approach technique and bootstrapping model to test the moderation effect in this study (Strzelecki & ElArabawy, 2024).

4. Results and Discussion

4.1. Result

The results of this study are presented in the following sections, including research data, instrument validity and reliability tests, model feasibility tests, and hypothesis tests, as outlined in Table 2.

Table 2. Basic Statistic

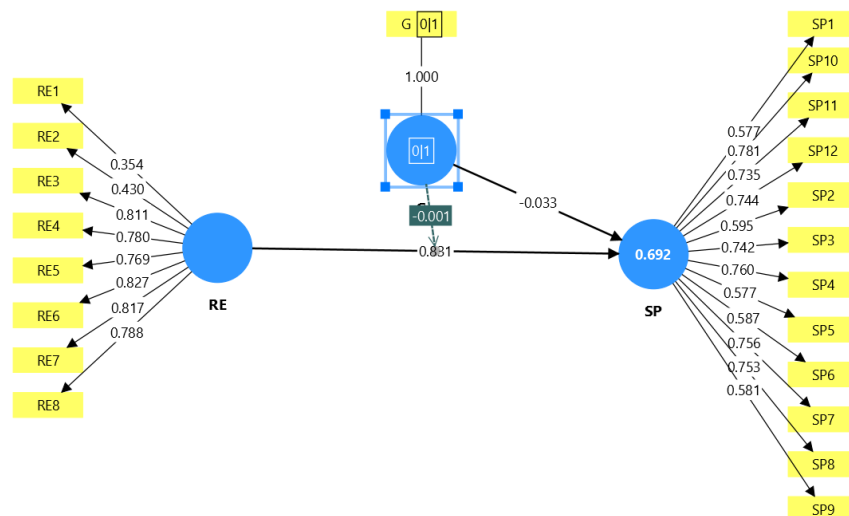
Variable	Mean	Median	Minimum	Maximum	Std Dev
Gender	0.59	1	0	1	0.5
Age	35.67	35	24	61	10.35
Tenure	8.78	5	1	35	8.33
Renewable energy	3.71	4	1	5	1.08
Sustainability performance	3.63	4	1	5	1.09

Table 2 shows that 59% of respondents were female, with an average age of 36 years and an average length of service of 9 years. The youngest respondent was 24 years old, and the oldest was 61 years old, with a median age of 35 years. Respondents worked for a minimum of 1 year and a maximum of 35 years, with a median value of 5 years. The Likert scale range in this study is 1 to 5 for the RE and SP variables. The RE variable has an average value of 3.71, and the SP variable has an average value of 3.63, indicating that the adoption of RE and SP in higher education is quite favorable. The data show that the standard deviation of all variables remains below the average value, indicating that the data is quite even. Meanwhile, the validity and reliability tests of the research instrument are presented in Table 3 below.

Table 3. Validity and Reliability Test

Variable	Cronbach's alpha	Composite reliability	AVE
Renewable Energy	0.857	0.892	0.518
Sustainability Performance	0.896	0.905	0.503

Table 3 shows that the Cronbach's alpha and composite reliability values for the research instrument exceed 0.7, indicating that the questionnaire is reliable. Furthermore, an AVE value of greater than 0.5 indicates that the questionnaire is valid. Therefore, this research questionnaire is suitable for representing the research variables of renewable energy and sustainable performance. In addition to the data above, the factor loading values that describe the convergent validity and reliability of the indicators in the following reflective measurements can also be described (Figure 1) :

**Figure 1. Factor Loadings**

Furthermore, a correlation test is needed between the variables, as shown in Table 4 below.

Table 4. HTMT Score

Variable	Gender	Renewable Energy	Sustainability Performance
Renewable Energy	0.117		
Sustainability Performance	0.109	0.791	
Renewable Energy*Gender	0.005	0.765	0.616

Based on the data in Table 4, all HTMT values are < 0.9, indicating that there is no autocorrelation between the variables. After the data meet the requirements, the research hypothesis is tested, as presented in Figure 2 and Table 5 below.

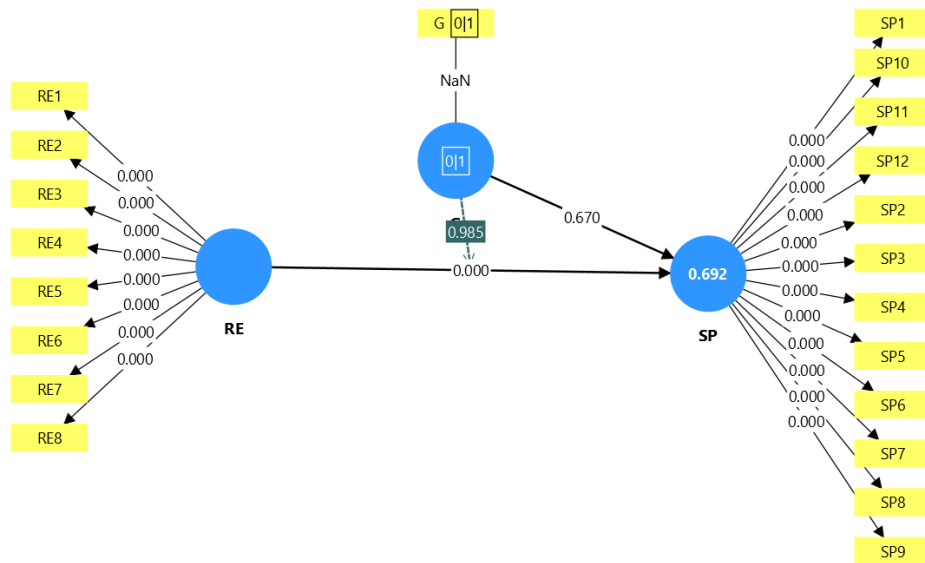


Figure 2. Bootstrapping Model

Table 5. Structural Model Result

Path	Coefficient	STDEV	T-value	P-value	Confidence interval		VIF	F2	R2	Result
					original	mean				
RE->SP	0.831	0.044	18.868	0.000	0.922	0.924	2.007	1.117	0.692	Accepted
G->SP	-0.033	0.078	0.427	0.670	0.108	0.131	1.006	0.001		Not accepted
RE*G->SP	-0.001	0.075	0.019	0.985	0.587	0.589	1.999	0.000		Not accepted

The data in Table 5 shows that renewable energy has a positive effect on sustainable performance. This result means that the higher the campus's support for renewable energy, the higher its sustainability performance. The significance value is also high, with a p-value of 0.000, α of 0.831, an F2 value of 1.117, and an R2 value of 69.2%. This score indicates that renewable energy plays a significant role in promoting sustainable performance in higher education. Meanwhile, gender does not affect sustainable performance, with a p-value of 0.985, $\alpha = 0.001$, and an F2 value of 1.117, indicating that this variable is unable to moderate the influence of renewable energy on sustainable performance. These results indicate that gender diversity actually contributes to better renewable energy and sustainability performance in higher education. Men and women have equal opportunities to play roles in supporting renewable energy and sustainability performance.

4.2. Discussion

4.2.1. Renewable Energy on Sustainability Performance

The results of this study indicate that renewable energy has a significant impact on sustainability performance in higher education institutions. This finding confirms that the higher the utilization of renewable energy in campus operations, the better the sustainability performance achieved by higher education institutions. This result suggests that the energy transformation from conventional sources to green energy not only impacts the efficiency of resource use but also strengthens the social and environmental dimensions of institutional sustainability (Al-Rawashdeh et al., 2023). These findings support the Natural Resource-Based View (NRBV) theory (Hart & Dowell, 2011), which emphasizes that natural resource management strategies, including the implementation of green energy, are important determinants of sustainable organizational performance. Indonesian universities have demonstrated that the consistent use of renewable energy significantly contributes to improving the environmental, social, and governance (ESG) dimensions of universities (Montoya & Perea-Moreno, 2020).

These findings are consistent with previous research, which confirms that the adoption of renewable energy directly contributes to improving organizational sustainability performance through reduced carbon emissions, increased energy efficiency, and long-term operational cost savings (Almasri & Abu-Hamdeh, 2024). In the context of higher education, the implementation of renewable energy, such as solar panels, energy-efficient lighting systems, and recycling-based water management, is a concrete indicator of an institution's commitment to green campus principles. Furthermore, these results also strengthen the argument that implementing green energy can improve an institution's reputation in the eyes of the public and stakeholders. Universities that actively engage in renewable energy programs are often perceived as having higher credibility in terms of social and environmental responsibility (Ahmad et al., 2022). Thus, renewable energy functions not

only as a technical instrument but also as a strategic driver for achieving long-term sustainability in the education sector.

In the context of higher education in Indonesia, the results of this study are significant. Universities face the challenge of balancing academic growth with a commitment to environmental sustainability. The implementation of renewable energy is one concrete way to reduce dependence on fossil fuels while strengthening the institution's image as a green campus (Xin et al., 2022). Furthermore, these results demonstrate that higher education institutions function not only as energy consumers but also as agents of social change, instilling sustainable values through their practices and curricula. With growing global concern about climate change, the role of universities in promoting the energy transition is becoming increasingly strategic (Han Nguyen et al., 2024).

4.2.2. Gender Moderation on Renewable Energy and Sustainability performance

The results of the second hypothesis suggest that gender does not moderate the relationship between renewable energy and sustainability performance, contrary to previous findings that indicate women tend to have a more pro-environmental attitude than men (Al-Rawashdeh et al., 2023; Latif et al., 2020). This finding aligns with a study by Fallon-Byrne & Harney (2017), which found that in an egalitarian academic environment, the influence of gender on decision-making is minimal because professionalism and meritocracy are more dominant than differences in demographic characteristics. Therefore, both men and women have a relatively equal commitment to implementing renewable energy and achieving sustainability goals in higher education. Sustainability issues in higher education have become an institutional agenda, so the adoption of renewable energy is viewed as a collective responsibility, not an individual preference. Therefore, gender becomes less relevant because all lecturers, both men and women, support the institution's green energy strategy (Alghamdi & den Heijer, 2021).

Social and cultural changes in academia may have narrowed the gender gap in environmental concerns. Recent research suggests that gender differences in pro-environmental attitudes are narrowing, particularly among professionals with higher education (Filho et al., 2020). This finding aligns with this study's finding that support for renewable energy is relatively evenly distributed among male and female respondents. The Indonesian context may provide additional explanation. In academic culture, the implementation of green energy policy is largely determined by institutional leadership and external regulations, so individual gender-based preferences do not significantly influence university sustainability outcomes (Shrestha, 2024).

From an empirical perspective, the results of this study align with those of Latif et al. (2020), who found that gender equality increases the effectiveness of environmental and green energy programs. In the context of higher education, this means that gender diversity among faculty and decision-makers can strengthen the implementation of renewable energy, for example, in the efficient use of electricity, the development of solar energy on campus, or the management of environmentally friendly transportation. Support for gender equality, particularly in renewable energy and sustainability performance, can also be influenced by institutional policies. Since the introduction of the SDGs, HEIs have sought to contribute, including those related to gender equality goals.

This research provides theoretical implications to contextualize gender socialization theory, which shows that there are no differences in the perspectives of men and women in supporting renewable energy and sustainability performance. The finding that gender does not moderate the relationship between renewable energy and sustainability performance suggests that human resources with a gender equality perspective can strengthen the effectiveness of environmental resource-based strategies. Thus, this research adds to the literature by demonstrating that sustainability is not solely the result of technological investment, but also the result of social diversity that supports the implementation of green strategies.

The practical implications of this research are intended for university administrators. The results emphasize the importance of considering gender perspectives in the planning and implementation of renewable energy policies. Universities that integrate gender equality into green energy management teams have the potential to achieve higher sustainability performance. For example, involving both female and male faculty members in decision-making regarding energy efficiency policies or solar energy development can result in more innovative and inclusive solutions. Furthermore, for governments and policymakers, these findings underscore the importance of energy and sustainability policies that align with the gender equality agenda. Funding or support programs for universities developing renewable energy should be designed with gender participation in mind, so that benefits are more equitable and have a broader impact.

The results of this study also have social implications by demonstrating that gender equality is a critical factor in driving the transformation towards sustainable higher education. Universities that can create an inclusive environment will be more effective in mobilizing support from the academic community for green

energy adoption, increasing environmental awareness, and strengthening their contribution to the SDGs, particularly SDG 5 (Gender Equality) and SDG 7 (Clean and Affordable Energy).

5. Conclusion

This study aims to analyze the role of gender in moderating the influence of renewable energy on sustainability performance in higher education institutions in Indonesia. The results show that renewable energy has a positive effect on sustainability performance, and gender does not moderate this relationship. These findings provide theoretical contextualize for gender socialization theory, which emphasizes collaboration between men and women on sustainability issues. In the context of sustainability research, this research provides a robust theoretical foundation to support the argument that gender equality is a vital prerequisite for achieving equitable, inclusive, and sustainable development for all parties. The practical implication of this study is the importance of higher education institutions integrating a gender perspective in the formulation and implementation of renewable energy strategies to achieve optimal sustainability performance. Furthermore, the results of this study also emphasize the relevance of public policies that link the sustainability agenda with gender equality in the higher education sector. This study provides empirical evidence that gender equality may neutralize gender-based differences in sustainability support.

Although this study yields significant findings, several limitations should be taken into consideration. The data collection method used was a self-reported questionnaire approach, which could introduce subjective bias from respondents. Furthermore, the cross-sectional study design, where data is collected over a single period, cannot capture the dynamics of changes in renewable energy behavior and strategies over time. Based on the limitations mentioned above, future research can address several areas aimed at rectifying these shortcomings. Future research should employ longitudinal methods to capture changes in renewable energy and sustainability policies over time, thereby providing a deeper understanding of their long-term effects. Mixed methods could be employed, including in-depth interviews or case studies, to explore gender perspectives in a more qualitative manner. Additional moderating or mediating variables, such as organizational culture, leadership support, or environmental literacy, should be developed to influence the relationship between renewable energy and sustainability performance. Furthermore, cross-examination could be conducted internationally by comparing research findings from universities in developed and developing countries to identify differences in gender influence patterns in supporting sustainability.

Author Contributions

All authors have equal contributions to the paper. Dwi Sulistiani: Conceptualization, Methodology; Validation; Formal analysis; Roles/Writing - original draft. Yona Octiani Lestari: Data curation; Writing - review & editing. Yuanda Kusuma: Software; Supervision; Visualization.

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Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

The datasets generated during and/ or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used in the preparation of this manuscript.

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