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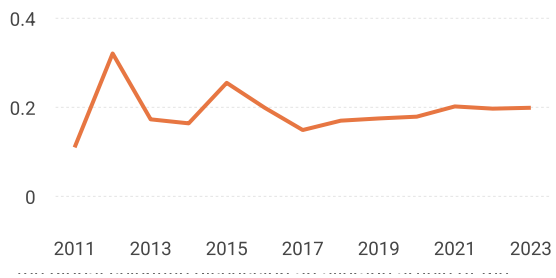

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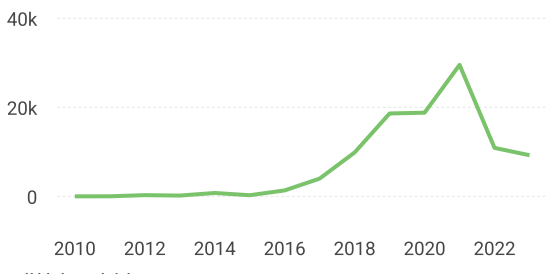

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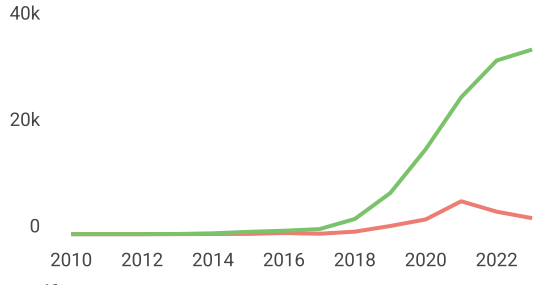

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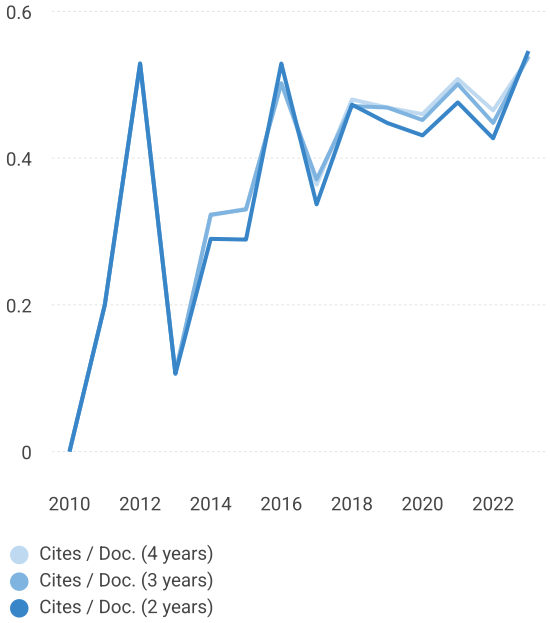

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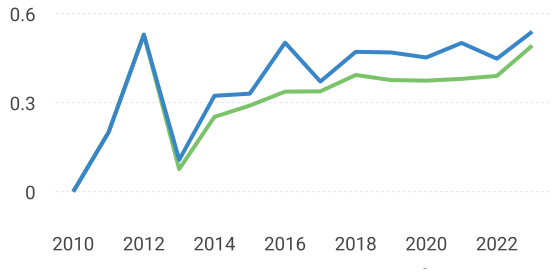

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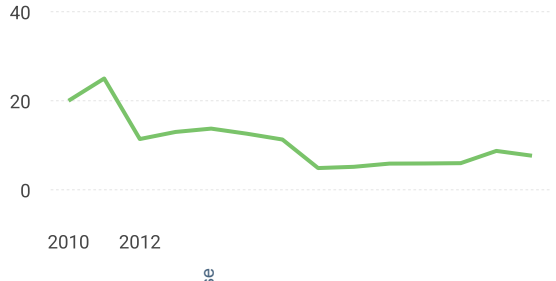

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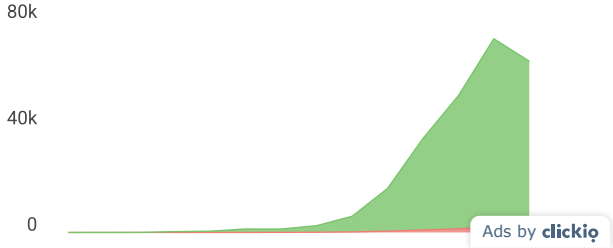

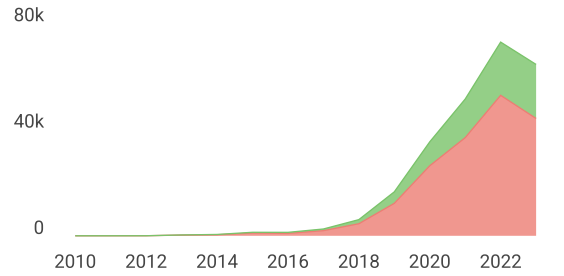

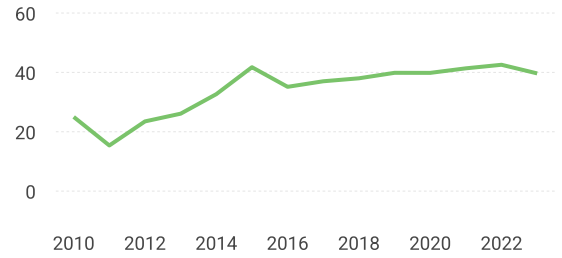

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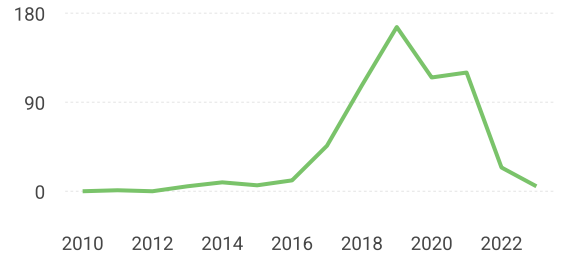

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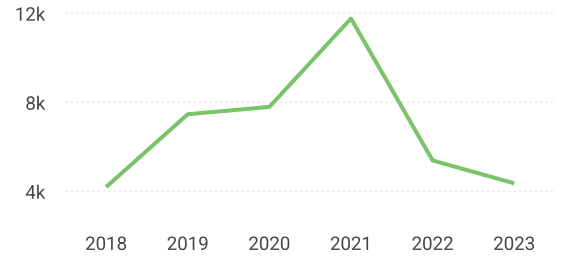

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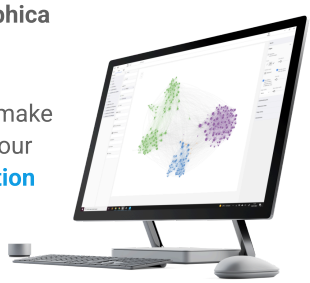

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Development of green SMEs: Integrating green entrepreneurship and innovation for environmental sustainability

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Abstract. Micro, Small, and Medium Enterprises (MSMEs) are vital to Indonesia's economy, contributing significantly to income generation across sectors. These enterprises, often small or micro-scale, are owned and managed by entities meeting specific size criteria. This study in Bangka Belitung Province aims to assess Green SME adoption among MSMEs and propose policies for sustainable practices. Using quantitative methods, the study collected numerical data to analyze relationships between variables. Research instruments were rigorously validated, with validity coefficients exceeding 0.300 and reliability surpassing 0.600. Through purposive sampling, 50 actively engaged MSMEs were selected, with data collected via questionnaires, observations, and documentation. Structural Equation Modeling (SEM), specifically Partial Least Squares Path Modeling (PLSPM), was used for its ability to handle complex relationships. Findings show that Green Entrepreneurship and Innovation significantly enhance environmental sustainability in MSMEs, promoting carbon-neutral activities and resource efficiency. Sustainable Business practices under the Green SMEs framework reduce operational costs and prioritize environmental conservation, shaping a model integrating environmental principles into business strategies. Policy recommendations include incentivizing green practices, training for sustainable methodologies, and supporting green innovation. These steps are crucial for enhancing MSME resilience and sustainability while advancing environmental goals in Bangka Belitung and beyond.

1. Introduction

MSMEs are crucial for Indonesia's economic development, providing significant employment opportunities and contributing to local and national income [1,2]. Despite their economic benefits, many MSMEs contribute to environmental degradation due to a lack of awareness about sustainable practices [3]. Therefore, integrating environmental sustainability into MSME operations is essential to mitigate negative environmental impacts.

Green MSMEs, focusing on environmentally sustainable practices, can achieve economic success while being environmentally responsible. These practices include waste reduction, energy efficiency, and sustainable raw materials [4,5]. Green MSMEs also contribute to broader economic benefits by improving operational efficiency, reducing costs, and enhancing market competitiveness [6–8]. Additionally, they align with the United Nations' Sustainable Development Goals (SDGs), promoting environmental protection, social well-being, and sustainable economic growth [9,10].

This research focuses on Green MSMEs in Bangka Belitung Islands Province, addressing the integration of sustainable business practices and environmental sustainability within the MSME sector. The primary research question is: "What is the overview of Green Entrepreneurship, Green Innovation, Sustainability Business, and the development model of Green MSMEs in Bangka Belitung Islands Province?" The study also explores how green entrepreneurship and business impact sustainability and the development model of green MSMEs.

2. Literature Review

2.1. Green Entrepreneurship

Green entrepreneurship refers to establishing and operating businesses prioritizing sustainability and economic and social benefits. This concept emphasizes eco-friendly practices such as reducing, reusing, recycling, and repairing [11]. Entrepreneurs in this domain integrate sustainable practices into their business models, considering financial success and their operations' environmental and societal impact [12]. Green entrepreneurship promotes long-term sustainability, innovation, and stakeholder engagement to balance economic, environmental, and social goals, aligning with the Sustainable Development Goals (SDGs).

2.2. Green Innovation

Green innovation, or eco-innovation, involves developing new products, services, processes, and organizational practices that reduce environmental impact [13,14]. This approach encourages businesses to adopt and innovate methods that enhance environmental sustainability while maintaining profitability. Green innovation encompasses waste management, energy efficiency, sustainable sourcing, and the creation environmentally friendly products and services. Businesses must remain competitive and environmentally responsible, driving sustainable development and addressing global environmental challenges.

2.3. Sustainability Business

Sustainability business models are designed to meet short-term financial needs without compromising future generations' ability to meet their needs [15]. These models balance social, environmental, and economic factors, emphasizing ethical practices, resource efficiency, and long-term viability. Key elements include minimizing environmental impact through waste reduction, energy efficiency, and sustainable material use (Environmental Responsibility), ensuring profitability while maintaining ethical and sustainable practices (Economic Viability), and prioritizing employee well-being, community development, and fair labor practices (Social Welfare). They also focus on intergenerational equity (Long-term Perspective), embrace change and continuous improvement (Adaptability and Innovation), and emphasize open communication and reporting on sustainability efforts (Transparency and Accountability). Sustainable business models contribute to a more equitable and sustainable global economy, aligning with the SDGs and addressing critical environmental and societal challenges.

2.4. Green Micro, Small, and Medium Enterprises (MSMEs)

Green MSMEs integrate sustainable practices into their operations, contributing to environmental conservation, economic development, and social welfare. These enterprises exhibit high flexibility and resilience, adapting to market changes and economic turbulence [16,17]. In Indonesia, MSMEs are governed by Law Number 20 of 2008, which defines and supports these enterprises (Hakim et al., 2021). Key aspects of Green MSMEs include incorporating eco-friendly methods in daily operations (Sustainable Practices), balancing economic, environmental, and social aspects (Holistic Approach), and enhancing community well-being and ethical practices (Social Responsibility). They also promote eco-friendly

initiatives and compliance with environmental regulations (Environmental Stewardship), contribute to goals related to environmental protection, social well-being, and sustainable economic growth (Alignment with SDGs), and adapt to environmental challenges while protecting investments (Resilience). Green MSMEs play a crucial role in achieving a sustainable economy in Indonesia, aligning with green entrepreneurship and sustainability business principles and addressing environmental issues while fostering economic inclusivity.

2.5. Conceptual Framework

To identify the factors influencing the development of Green MSMEs, this research examines the concepts of Green Innovation, Sustainability Business, Green Entrepreneurship, and the Green MSMEs Development Model. Within this framework, the study explores how green innovation and sustainable business practices can transform MSMEs into environmentally conscious enterprises, positively impacting environmental and economic sustainability.

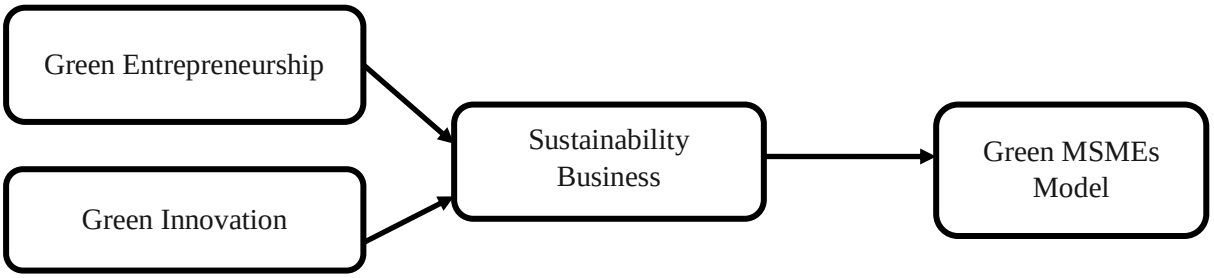

Figure 1. Conceptual Framework

3. Research Methodology

3.1. Research Approach and Methodology

This research employs a quantitative methodology, which involves gathering and analyzing numerical data to determine the correlations between variables. A quantitative approach is essential for quantifying the impact of Green Entrepreneurship and Innovation on Sustainability Business and the Green MSME Model.

3.2. Instrument Validity and Reliability

To ensure the robustness of the research findings, the study assesses the validity and reliability of the research instruments. Validity refers to whether the instruments measure what they intend to measure, while reliability assesses the consistency of measurements. The validation process reveals that all research items possess a validity coefficient exceeding 0.300 and a reliability coefficient surpassing 0.600, indicating that these instruments effectively measure the research variables.

3.3. Population and Sampling

This research focuses on MSME practitioners in the Bangka Belitung Islands Province, recommended by the Department of Cooperatives and MSMEs, who meet the Green MSME criteria. The study involves 50 actively engaged Micro, Small, and Medium Enterprises (MSMEs) in the Bangka Belitung Islands Province, selected using purposive sampling, a non-random method chosen to ensure relevant respondent characteristics.

3.4. Data Collection Methods

Two primary methods are employed for data collection. The first is the use of questionnaires, which are structured surveys used to gather quantitative data from respondents. This approach facilitates uniform data gathering and streamlines evaluating and contrasting the outcomes.

Documentation and observation are part of the second approach. Documentation may involve reviewing previously published records or reports, while observations usually involve the researcher gathering data directly from the source. These techniques offer a thorough understanding of the investigated variables.

3.5. Data Analysis Approach

Instead of testing particular hypotheses, the research uses a descriptive analysis approach, summarizing and interpreting data. This approach provides an overview of the connections between sustainability business, green innovation, green entrepreneurship, and the green MSME model.

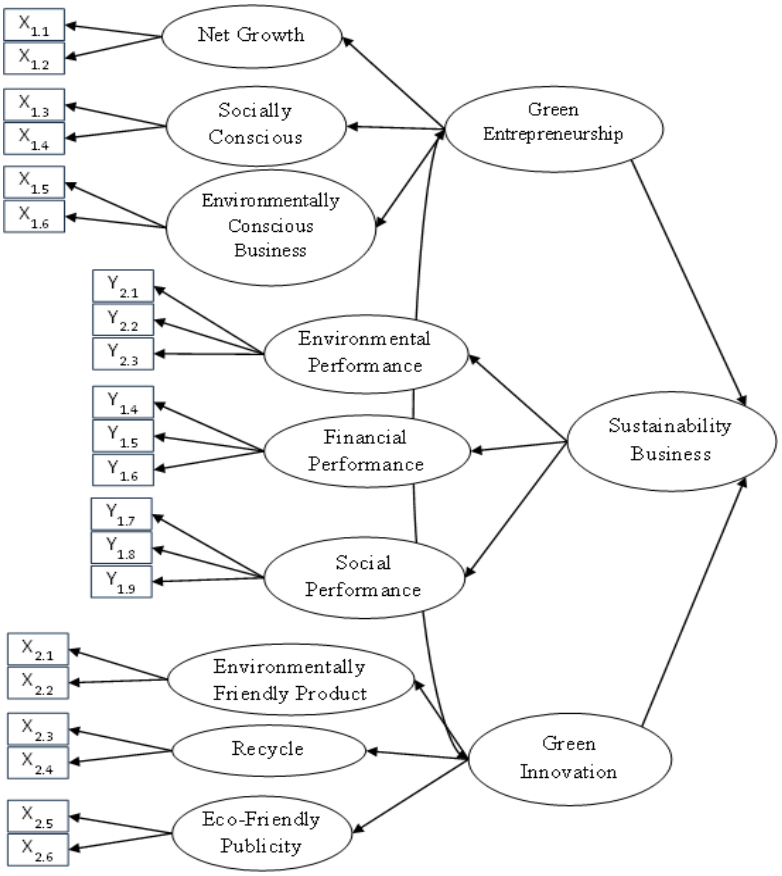

Figure 2. Submodel 1: The Influence of Green Entrepreneurship and Green Innovation on the Green MSME Model as a Mediating Variable

Figure 2 shows how Green Entrepreneurship (ξ1) and Green Innovation (ξ2) affect the Green MSME Model (η1). In this model, the relationship between the variables is depicted through equations:

$$\eta_1 = \gamma_{1.1}\xi_1 + \gamma_{1.2}\xi_2 + \zeta_1. \quad (1)$$

The explanation of each component in this equation is as follows:

1) Variable η1: The dependent variable measured in this model is the Green MSME Model concept that measures how green entrepreneurship and green innovation are applied in the context of MSMEs to support environmental sustainability.
2) Coefficients γ1.1 and γ1.2: These coefficients describe how much influence Green Entrepreneurship (γ1.1) and Green Innovation (γ1.2) have on the dependent variable,

which is the Green MSME Model (η1). Suppose the value of this coefficient is positive and significant. In that case, it indicates that an increase in green entrepreneurship and innovation will positively impact the implementing of the green MSME model. Conversely, if the coefficient is negative, it indicates an opposite relationship.

3) Variables ξ1 and ξ2: These two independent variables represent the dimensions of Green Entrepreneurship (ξ1), which includes environmentally friendly business initiatives, and Green Innovation (ξ2), which involves implementing innovations that support environmental sustainability. Both are considered to influence the dependent variable, which is the Green MSME Model (η1).
4) Residual (ζ1): This error term (ζ1) represents other factors that also influence the dependent variable (Green MSME Model) but are not included in this model. This means the model does not fully explain all the factors that might affect the outcome. Such factors could include external aspects such as government regulations, market dynamics, or technological capacity that are not explicitly explained in the equation.

Figure 2 shows how Green Entrepreneurship and Innovation play an important role in developing the green MSME model. However, other factors beyond these two variables influence the results but are not captured by the model. This model's random factors (residuals) suggest that the relationship between the independent and dependent variables may be more complex than the two main variables suggest.

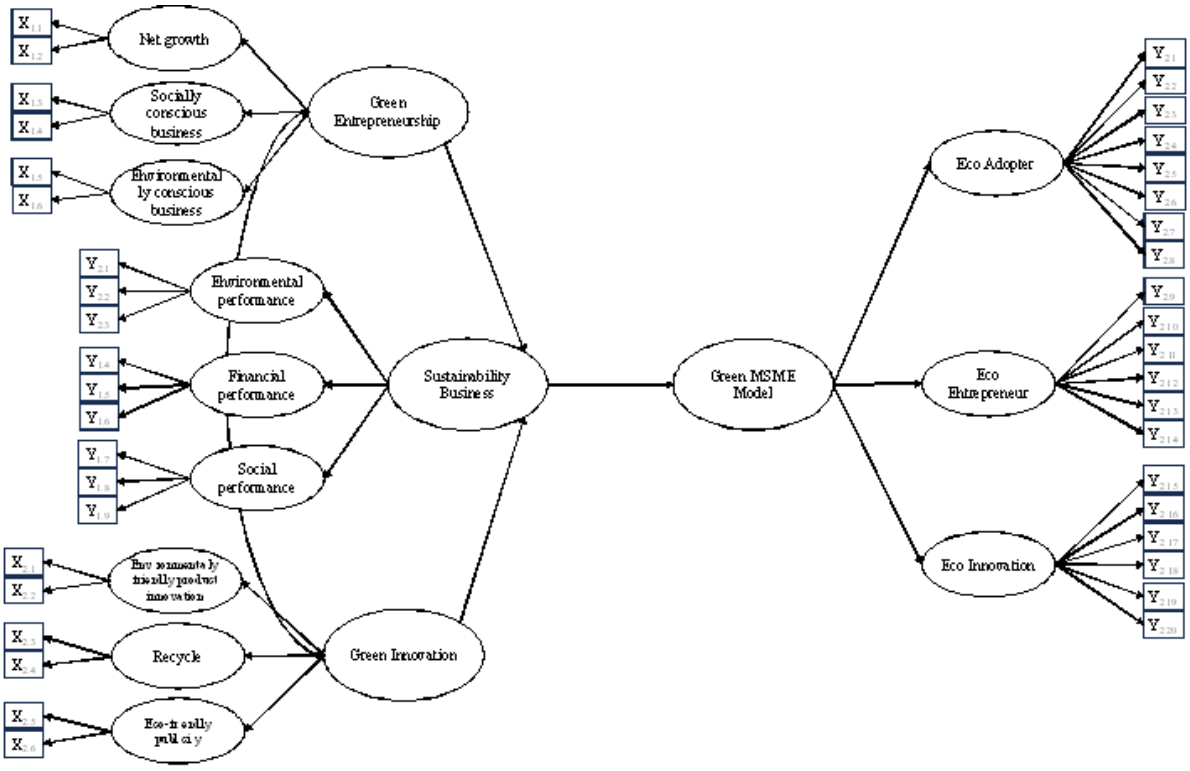

Figure 3. Submodel 2: The Influence of Green Entrepreneurship and Green Innovation on the Green MSME Model as a Mediating Variable

Figure 3 is an extension of Figure 2, which shows the relationship between Green Entrepreneurship (ξ1), Green Innovation (ξ2), and Green MSME Model (η2). However, this

relationship is extended by including Sustainability Business as an important mediating variable in the second submodel.
The following equation describes this model:

$$\eta_2 = \gamma_{2.1}\xi_1 + \gamma_{2.2}\xi_2 + \beta_{2.1}\xi_2 + \zeta_2. \quad (2)$$

The explanation of the components of this equation is as follows:

1) Variable η2: This dependent variable represents the Green MSME Model in the second submodel. It describes the result of how green entrepreneurship and green innovation are applied in green MSMEs.
2) Coefficients γ2.1 and γ2.2: These coefficients measure how much direct influence Green Entrepreneurship (γ2.1) and Green Innovation (γ2.2) have on the Green MSME Model. Suppose the value of this coefficient is positive and significant. In that case, it indicates that an increase in these two factors directly and positively impacts the green MSME model implementation.
3) Coefficient β2.1: This coefficient shows the indirect effect of Green Innovation through the mediating variable Sustainability Business. This indicates that green innovation, through implementing sustainable business practices, also impacts the Green MSME Model.
4) Residual (ζ2): Just like in the previous model, ζ2 is an error term that describes other factors that are not explained in the model but still affect the outcome (Green MSME Model). These factors could come from external dynamics such as regulatory changes, market fluctuations, or other internal factors not captured in this model.

This submodel illustrates that Green Entrepreneurship and Green Innovation directly affect the Green MSME Model. In addition, green innovation has an indirect effect through the mediating variable Sustainability Business (β2.1). This means that part of the impact of green innovation on the Green MSME Model occurs through how sustainability business practices are implemented in these MSMEs.

4. Results and Discussion

4.1. Descriptive Analysis

Table 1. Descriptive Analysis Results of Green Entrepreneurship, Green Business, Sustainability Business, and Green MSME Model

Variable	Dimension	Average Score	Category
Green Entrepreneurship	Net Growth	4.76	Very Good
	Social Awareness	4.44	Very Good
	Environmental Conscious Business	4.30	Very Good
Green Business	Environmentally Friendly Product Innovation	4.45	Very Good
	Recycling	3.32	Good
	Environmental Publicity	4.28	Very Good
Sustainability Business	Environmental Performance	4.26	Very Good
	Financial Performance	4.15	Good
	Social Work	4.30	Very Good
Green MSME Model	Eco Adopter	3.79	Good
	Eco Entrepreneur	4.17	Good

Variable	Dimension	Average Score	Category
	Eco-Innovation	4.10	Good

4.1.1. Green Entrepreneurship. The net growth dimension's descriptive analysis results show an average score of 4.76, which is in the "very good" range. This implies that MSMEs are rated as having very good net growth overall. Additionally, the descriptive analysis's findings for the social awareness dimension indicate an average score of 4.44, which is likewise classified as "very good." This suggests that MSMEs are generally rated as having extremely high levels of social awareness. Last, the Environmental Conscious Business dimension's descriptive analysis results show an average score of 4.30, likewise categorized as "very good." This shows that MSMEs are rated as having an extremely high degree of environmental consciousness overall.

4.1.2. Green Business. According to the descriptive analysis results, the Environmentally Friendly Product Innovation dimension has an average score of 4.45, falling into the "very good" category. This suggests that MSMEs are generally regarded as possessing a very high degree of environmentally friendly product innovation. Furthermore, the descriptive analysis results for the Recycling dimension indicate a "good" average score of 3.32. This implies that MSMEs are generally thought to have good recycling practices. Last, the Environmental Publicity dimension's descriptive analysis results show an average score of 4.28, classified as "very good." This implies that MSMEs are generally thought to have excellent environmental publicity practices.

4.1.3. Sustainability Business. According to the descriptive analysis results, the Environmental Performance dimension has an average score of 4.26, which is in the "very good" range. This suggests that MSMEs are generally rated as having very good environmental performance. Moreover, the financial performance dimension's descriptive analysis results indicate an average score of 4.15, classified as "good." This implies that MSMEs' financial performance is deemed to be good. Finally, the descriptive analysis results found an average score of 4.30, or "very good," for the Social Work dimension. This suggests that MSMEs are generally evaluated as having excellent social work practices.

4.1.4. Green MSME Model. As determined by the descriptive analysis, the Eco Adopter dimension's average value is 3.79, falling into the "good" range. This suggests that the MSMEs have good eco-adopter characteristics based on their rating. Additionally, the Eco Entrepreneur dimension's descriptive analysis results showed an average value of 4.17, likewise classified as "good." This shows that MSMEs are generally regarded as having positive eco-entrepreneur traits. Finally, the descriptive analysis discovered the Eco-Innovation dimension's average value of 4.10, likewise in the "good" range. This suggests that the MSMEs have good eco-innovation characteristics based on their rating.

4.2. The Influence of Green Entrepreneurship and Green Business on Sustainability Business and Its Impact on the Green MSME Model

To perform a confirmatory analysis, this study utilized a Structural Equation Modeling (SEM) approach based on structural variance, commonly referred to as Partial Least Squares Path Modeling (PLSPM). The results obtained through SmartPLS 4.0 calculations are as follows:

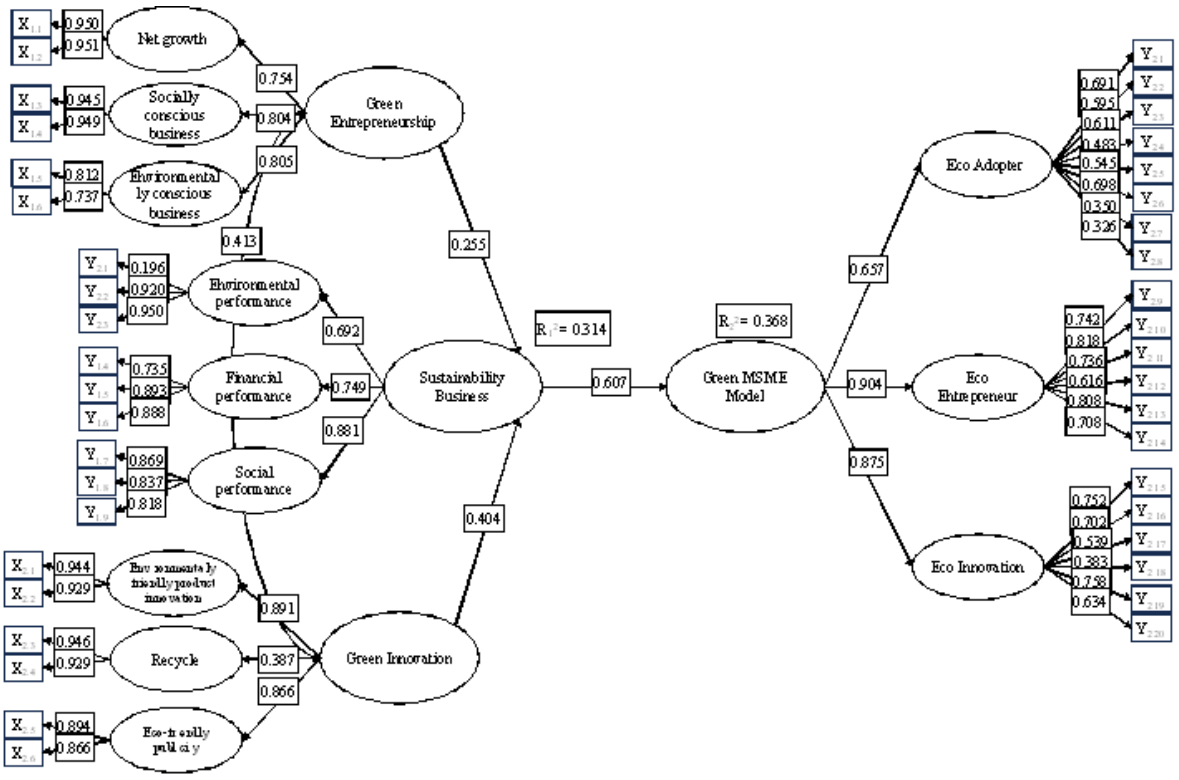

Figure 4. Green Entrepreneurship and Green Business on Sustainability Business and Its Impact on the Green MSME Model

Figure 4 illustrates how green entrepreneurship and innovation influence sustainability businesses and the green MSME model. This model explains that green entrepreneurship contributes directly to sustainable business practices, but green innovation has a stronger influence. In addition to the direct influence, this model shows that Sustainability Business is central to strengthening the relationship between entrepreneurship and green innovation with the green MSME model. Businesses that implement sustainable practices can strengthen the overall green MSME model, both through the direct impact and the mediating effect of sustainable business.

This model also identifies indirect effects, such as entrepreneurship and green innovation influencing the Green MSME Model through Sustainability Business. Green innovation has a direct impact and contributes significantly to strengthening the green MSME model through implementing sustainable business practices. This confirms the importance of business sustainability as a key factor in the success of the green MSME model.

In general, the above model demonstrates satisfactory results with factor loading coefficients, which are the coefficients between items, dimensions, and dimensions and variables, all exceeding 0.50, accompanied by influence coefficients between variables according to the hypothesis with positive values.

4.3. Analysis of the Measurement Model of Green Entrepreneurship and Green Business on Sustainability Business and Its Impact on the Green MSME Model

Measurement model analysis is used to evaluate the validity and reliability of the indicators for each dimension.

4.3.1. Green Entrepreneurship. The validity and reliability testing results indicate that all indicators for Net Growth, Socially Aware Business, and Environmentally Conscious Business are valid and reliable. All items exhibit validity coefficients greater than 0.50, composite reliability coefficients exceeding 0.700, and average variance extracted values greater than 0.500.

4.3.2. Green Innovation. The validity and reliability tests show that all indicators for environmentally friendly product innovation, recycling, and environmentally conscious businesses are valid and reliable. Each item has validity coefficients greater than 0.50, composite reliability coefficients exceeding 0.700, and average variance extracted values greater than 0.500.

4.3.3. Sustainability Business. The validity and reliability testing results indicate that all indicators for the Environmental Performance, Financial, and Social dimensions are generally valid and reliable. Despite one Environmental Performance item having a loading factor of less than 0.500, its composite reliability value of over 0.700 allows it to be retained. All items for the Financial and Social dimensions have validity coefficients greater than 0.50, composite reliability coefficients exceeding 0.700, and average variance extracted values greater than 0.500.

4.3.4. Green MSME Model. The validity and reliability tests show that all indicators for the Eco Adopter, Eco Entrepreneur, and Eco-Innovation dimensions are generally valid and reliable. Despite a few items with loading factors less than 0.500, such as those related to environmentally friendly promotional materials, financing from non-bank institutions, keeping financial records, and using environmentally friendly packaging, the composite reliability values exceeding 0.700 suggest these items can be retained. All items exhibit consistent and reliable measurements.

4.4. Analysis of the Model of the Influence of Green Entrepreneurship and Green Business on Sustainability Business and Its Impact on the Green MSME Model

A summary of the significant effects of each variable, both directly and indirectly, is depicted in the following Figure 5:

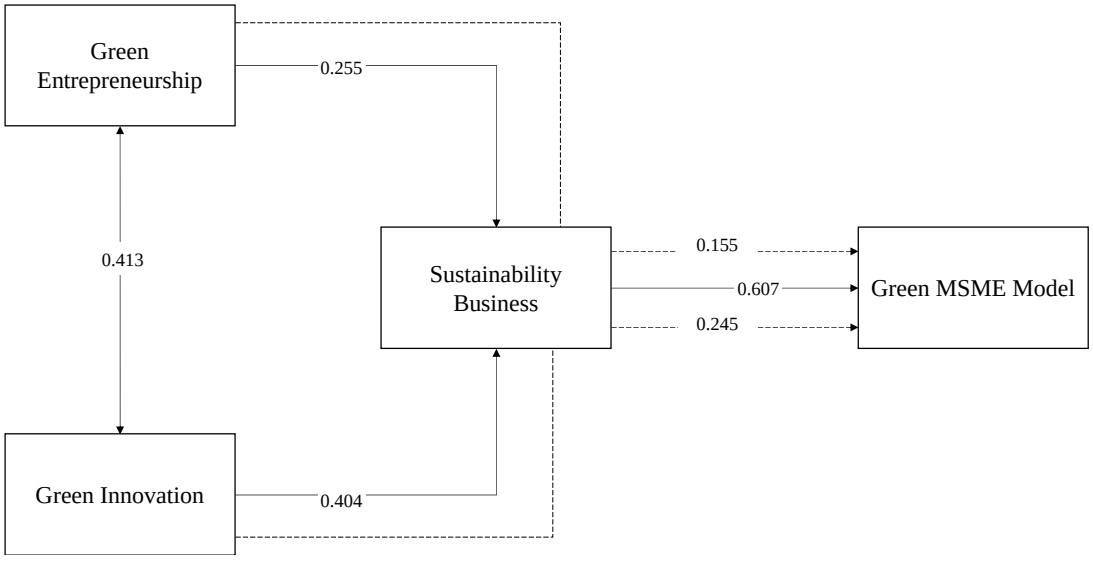

Figure 5. Model of the Influence of Green Entrepreneurship and Green Business on Sustainability Business and Its Impact on the Green MSME Model

Table 2. Model of the Influence of Green Entrepreneurship and Green Business on Sustainability Business and Its Impact on the Green MSME Model

Influence	Influence Magnitude	f^2	T-Statistics	p-Value	Description
Green Entrepreneurship → Sustainability Business	0.255	0.079	1.983	0.048	Reject H0
Green Innovation → Sustainability Business	0.404	0.197	2.549	0.011	Reject H0
Sustainability Business → Green MSME Model	0.607	0.583	5.935	0.000	Reject H0
Green Entrepreneurship → Sustainability Business → Green MSME Model	0.155	-	1.866	0.063	Reject H0
Green Innovation → Sustainability Business → Green MSME Model	0.245	-	2.155	0.032	Reject H0

4.5. Positive Hypothesis Testing

Hypothesis testing results show that all direct and indirect positive effects were significant with a p-value < 0.1 ($2 \times \alpha$), leading to the rejection of H0. Detailed findings are as follows:

1) Green Entrepreneurship
   Positively and significantly affects sustainability businesses with an effect size of 0.255 standard deviations and an f2 value of 0.079, indicating a strong effect. Increased green entrepreneurship promotes sustainability businesses.
2) Green Innovation
   Positively and significantly affects sustainability businesses with an effect size of 0.404 standard deviations and an f2 value of 0.197, indicating a strong effect. Increased green innovation promotes sustainability businesses.
3) Sustainability Business
   Positively and significantly affects the green MSME model with an effect size of 0.607 standard deviations and an f2 value of 0.583, indicating a very strong effect. Increased sustainability business promotes the green MSME model.
4) Indirect Effect of Green Entrepreneurship
   The green MSME model through sustainability business is 0.155 standard deviations, suggesting that increased green entrepreneurship enhances the green MSME model by promoting sustainable businesses.
5) Indirect Effect of Green Innovation
   The business has 0.245 standard deviations through sustainability on the green MSME model, suggesting that increased green innovation enhances the green MSME model by promoting sustainable businesses.
6) Comparative Impact
   Green innovation has a greater impact on sustainability business than green entrepreneurship, and its indirect effect on the green MSME model is also greater.

5. Conclusion

The analysis showed that the instruments used were generally valid and reliable. Both green entrepreneurship and green innovation positively and significantly impact sustainability businesses, with green innovation having a greater effect. Sustainability Business strongly

impacts the Green MSME model and is a suitable mediating variable for the effects of Green Entrepreneurship and Innovation. Improving green entrepreneurship and innovation is essential to enhancing the green MSME model. Additionally, increasing the understanding of the Green MSME model among MSME practitioners is crucial. The study has several limitations: a small sample size of 50 respondents, cross-sectional data collection, potential biases from self-reported data, and a focus on specific variables without accounting for others. Questionnaires alone may not capture all intricacies, and time constraints limited the investigation's depth. The Green MSME model concept is new, and understanding of it varies among respondents. These limitations should be considered when interpreting the findings and planning future research.

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