

## Green Innovation for Sustainable MSMEs Performance

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**Abstract** This study examines the determinants of green innovation and its impact on sustainable business performance among micro, small, and medium enterprises (MSMEs) in the Bandung Raya region of Indonesia. Specifically, the study analyzes the influence of environmental knowledge and market pressure on green innovation, as well as the effect of green innovation on sustainable performance. A quantitative approach was employed using data from 150 MSMEs, and structural relationships were tested through multiple regression analysis. All measurement instruments demonstrated high reliability (Cronbach's Alpha 0.89–0.95) and validity (corrected item–total correlation > 0.80). The results reveal that environmental knowledge has the strongest positive and significant effect on green innovation ( $\beta = 0.728$ ;  $p < 0.001$ ), indicating that MSMEs with greater environmental awareness are more likely to adopt eco-friendly innovations. Market pressure also significantly influences green innovation ( $\beta = 0.257$ ;  $p < 0.001$ ), demonstrating the role of consumer expectations, competition, and green product trends in shaping sustainable business practices. Furthermore, green innovation has a very strong and significant impact on sustainable business performance ( $\beta = 0.847$ ;  $p < 0.001$ ), suggesting that eco-friendly practices enhance cost efficiency, customer satisfaction, firm reputation, and environmental outcomes. Overall, the study highlights the importance of combining internal awareness with external pressures to foster green innovation and strengthen sustainability among MSMEs. The findings provide theoretical contributions to green innovation and sustainability frameworks, while offering practical implications for MSMEs, policymakers, and business support institutions.

**Keywords:** Environmental Knowledge; Green Innovation; Market Pressure; MSMEs; Sustainable Business Performance.

### 1. Introduction

MSMEs are an important part of the Indonesian economy because they employ around 97% of the workforce and contribute more than 61% to the Gross Domestic Product (Ministry of Cooperatives and SMEs, 2023). Their significant role makes MSMEs a very important sector in maintaining the country's economic balance. This contrasts with the fact that amid increasingly fierce market competition and higher consumer demand for healthy, safe and environmentally friendly products, many MSMEs still face difficulties in managing raw materials, production processes and waste reduction activities. This shows that the ability of MSMEs to survive and grow is highly dependent on their ability to adapt to environmental issues, which are becoming an increasing concern in modern business (Feng et al., 2022; Horbach & Rammer, 2020; X. Li et al., 2023).

In recent years, the concept of green innovation has been considered an effective way to increase competitiveness while reducing environmental impact. Green innovation encompasses various efforts, such as using raw materials more efficiently, reducing waste, maximizing energy use, implementing environmentally friendly packaging, or utilizing simple technologies to reduce pollution (Dangelico et al., 2017; Xie et al., 2019). Not all of these practices have to be expensive or complicated; many small and medium-sized enterprises have started with small steps such as replacing single-use plastics, sorting waste, and using energy-efficient appliances (Chen et al., 2015; Khan et al., 2021; Oduro et al., 2022). According to the 2022 ASEAN SME Monitor report, the level of green innovation adoption among Indonesian MSMEs is still relatively low compared to other Southeast Asian countries such as Vietnam and Thailand.

Received: June 14, 2025

Revised: August 26, 2025

Accepted: October 20, 2025

Published: December 31, 2025

Curr. Ver.: December 31, 2025



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Previous studies have shown that green innovation can help save costs, strengthen a company's reputation, and increase customer loyalty (Sharma, 2022; Susanto & Wirawan, 2022). However, most existing studies still focus on large companies or the industrial manufacturing sector. Meanwhile, research on micro, small, and medium enterprises, especially MSMEs in Indonesia, is still very limited. In fact, the MSME sector produces a significant amount of waste, especially from the food and beverage, textile, and handicraft sectors. This indicates a gap in research that needs to be addressed, namely the lack of empirical studies on the extent to which MSMEs implement green innovation and its impact on sustainable business performance.

In addition, there are still many things that have not been studied regarding the factors that influence MSMEs in implementing green innovation. For example, the role of environmental science, market pressure for environmentally friendly products, and assistance from government policies such as the 'MSME Go Green' program. Research in Indonesia (Chen et al., 2021) usually focuses on only one or two factors, so it is not yet able to fully describe the internal and external factors that drive green innovation. This gap needs to be further explored because MSMEs have limitations in capital, technology, and access to information.

Therefore, in implementing green innovation, MSMEs need a simpler approach that is tailored to their capabilities. Given these conditions, this study has several notable new aspects. First, this study specifically focuses on Indonesian MSMEs, which have rarely been discussed in studies on green innovation. Second, this study explains the relationship between green innovation and business sustainability, a relationship that has not been widely discussed in the context of local MSMEs. Third, this study analyses several contributing factors, such as environmental knowledge, market incentives, and government support, simultaneously rather than separately as in previous studies. Fourth, this study provides practical solutions in the form of simple green innovations that can be implemented by MSMEs without requiring large capital, making the results more relevant to actual needs.

With this background, this research is important so that we can understand how MSMEs can implement green innovation as a way to improve business continuity amid increasingly fierce competition. The results of this research are expected to serve as a guide for MSME entrepreneurs in implementing environmentally friendly methods, as well as providing policy recommendations for the government so that sustainability-based MSME assistance and support program can be strengthened.

Based on this explanation, this study formulates several questions to be discussed, namely: (1) what factors influence MSMEs in implementing green innovation? (2) how does green innovation affect the sustainability of MSME businesses? and (3) what are the most appropriate strategies to encourage MSMEs to implement green innovation effectively?

In line with these research questions, the objectives of this study are: (1) to identify the factors that drive and hinder the adoption of green innovation in MSMEs; (2) to analyze the impact of green innovation on the sustainability of MSME businesses; and (3) to provide strategic recommendations for MSME actors and policy makers in promoting environmentally friendly business practices in the future.

## **2. Literature Review**

### **Green Innovation**

Green innovation is a company's effort to reduce its negative impact on the environment by producing goods more efficiently, managing raw materials in a more environmentally friendly manner, and using technologies or methods that can reduce waste and energy consumption (Sharma, 2022). In micro, small, and medium enterprises (MSMEs), green innovation does not always involve the use of complex technology, but can take the form of simple actions such as reducing the use of single-use plastics, using energy optimally, utilising waste to create new products, and using environmentally friendly packaging.

According to (H. Li et al., 2023), the application of green innovation in small businesses can increase cost efficiency and improve business image, thereby providing additional benefits for consumers who are increasingly concerned about environmental issues. Several factors that encourage MSMEs to implement green innovation are increasing market demand for environmentally friendly products, government policies, and the need to improve

competitiveness. In Indonesia, the 'MSMEs Go Green' program has begun to encourage businesses to adopt environmentally friendly production methods. However, the level of green innovation adoption among MSMEs remains low due to a lack of knowledge, high costs, and limited technical assistance (OECD, 2021).

### **Sustainable Business Performance**

Sustainable business performance means the ability of a business to achieve balanced economic, social and environmental outcomes. In micro, small and medium enterprises (MSMEs), sustainability is not only related to profit, but also to the efficient use of resources, the ability to survive in the long term, and a positive impact on the surrounding environment (Susanto & Wirawan, 2022). According to the (OECD, 2021), MSMEs that implement environmentally friendly practices usually have better results in managing costs and business reputation.

Green innovation is considered an important factor in improving sustainable performance, as green innovation practices can reduce production costs, minimise waste, and increase product value. Research by Rodríguez-Rebés et al., (2024) shows that MSMEs that implement simple measures such as reducing the use of raw materials and using environmentally friendly packaging have been proven to increase customer satisfaction and business efficiency.

### **Factors Affecting the Adoption of Green Innovation in MSMEs**

#### 1. Environmental Knowledge

Business owners' knowledge of environmental impacts and the benefits of green innovation is an important factor in implementing green innovation. (H. Li et al., 2023) explain that MSME owners who have a better understanding of these issues tend to implement environmentally friendly practices on a regular basis.

#### 2. Market and Consumer Pressure

Increasing consumer demand for environmentally friendly products is the main reason for MSMEs to continue innovating (Sharma, 2022). MSMEs that do not follow market trends may fall behind in the competition.

#### 3. Government Support and Policies

Policies such as energy-efficient production equipment assistance, guidance for MSMEs, or environmental incentives can encourage the use of green innovations. National programmes such as 'MSMEs Go Green' demonstrate structural support for small entrepreneurs (Ministry of Cooperatives and SMEs, 2023).

#### 4. Internal Capacity and Resource Availability

The availability of capital, technological capabilities, and management capabilities influence how ready SMEs are to implement green innovations. SMEs with limited capacity generally find it difficult to implement new technologies despite clear benefits, as mentioned in the OECD in 2021.

### **The Relationship between Green Innovation and Sustainable Business Performance**

Based on various studies, green innovation has a positive impact on business success. Sharma (2022) states that green innovation can improve operational efficiency and help small businesses become more competitive. Susanto & Wirawan (2022) also found that small and medium-sized enterprises that implement environmentally friendly practices tend to have better customer satisfaction and brand image.

In Indonesia, Rahman & Prasetyo (2021) say that small and medium-sized enterprises that implement green innovation in simple ways, such as using environmentally friendly materials and reducing waste, usually experience improvements in economic performance and long-term business resilience. Therefore, based on these references, green innovation is an effective way to improve the sustainable performance of small and medium-sized enterprises.

### **Hipotesis**

H1: The environmental knowledge of MSME actors has a positive effect on the adoption of green innovation.

This hypothesis is based on the belief that entrepreneurs who better understand the environmental impact and benefits of environmentally friendly innovations are usually more prepared to implement green innovation practices.

H2: Market pressures and consumer demand have a positive effect on the adoption of green innovation in MSMEs.

This hypothesis states that increased consumer preference for environmentally friendly products encourages micro, small and medium enterprises to continue innovating in order to remain competitive.

H3: Green innovation has a positive effect on the sustainable business performance of MSMEs.

This hypothesis states that the implementation of green innovation through energy efficiency, waste reduction, process improvement, and the use of environmentally friendly materials can increase cost efficiency, business reputation, income stability, and long-term sustainability.

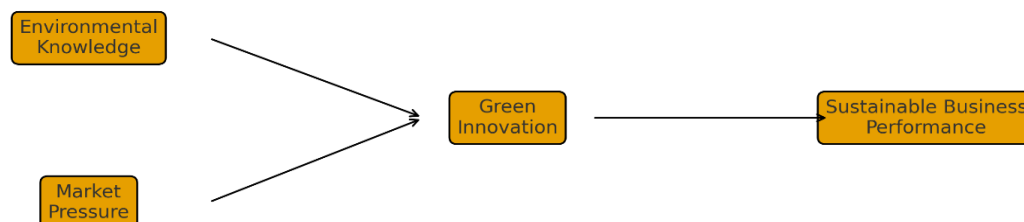


Figure 1. Mind Maps.

### 3. Method

#### Research Design

This study employed a quantitative research design using a cross-sectional survey method to examine the determinants of green innovation and its impact on sustainable business performance among micro, small, and medium enterprises (MSMEs) in Indonesia. This design was chosen because it allows for objective testing of hypothesized relationships between variables using numerical data.

#### Population and Sampling

The research population consisted of MSMEs operating in the food and beverage, fashion, handicraft, and household industries within the Greater Bandung region. These sectors were selected because of their relatively high levels of production activity and waste generation, which make them particularly relevant to the study of green innovation.

A purposive sampling technique was applied to select respondents who met the following criteria:

1. The MSME has been in operation for at least two years.
2. The enterprise engages in a production process that generates waste.
3. The business owner or manager is directly involved in production and decision-making.

A total of 150 valid responses were collected, which met the minimum sample size requirement for multiple regression analysis (Hair, 2019).

#### Data Collection

Data were collected through both online and offline questionnaires distributed to MSME owners and managers. The questionnaire consisted of two sections:

1. Section A: demographic and business profile information.
2. Section B: statements related to the research constructs, measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

All measurement items were adapted from previous studies and adjusted to the MSME context to ensure clarity and relevance.

#### Measurement of Variables

1. Environmental Knowledge (EK) was measured using items related to awareness of waste reduction, energy efficiency, and environmental impact (Li et al., 2023).
2. Market Pressure (MP) was measured through indicators reflecting customer demand, competitive intensity, and trends toward eco-friendly products (Sharma, 2022).
3. Green Innovation (GI) was measured by items assessing waste reduction, eco-friendly materials, process improvement, and energy efficiency (Baqis et al., 2024).
4. Sustainable Business Performance (SP) was measured using indicators of cost efficiency, customer satisfaction, reputation, income stability, and environmental impact (Susanto & Wirawan, 2022).

## Data Analysis Procedure

Data were analysed using multiple linear regression in two stages:

1. Model 1: Environmental Knowledge and Market Pressure → Green Innovation.
2. Model 2: Green Innovation → Sustainable Business Performance.

Before conducting the regression analysis, validity and reliability tests were performed. Item validity was assessed using corrected item–total correlation (threshold > 0.50), and internal consistency reliability was verified using Cronbach’s Alpha (threshold > 0.70).

Classical assumption tests were conducted to ensure model validity:

1. Normality using the Kolmogorov–Smirnov test,
2. Multicollinearity using Variance Inflation Factor (VIF < 10),
3. Homoscedasticity using the Glejser test.

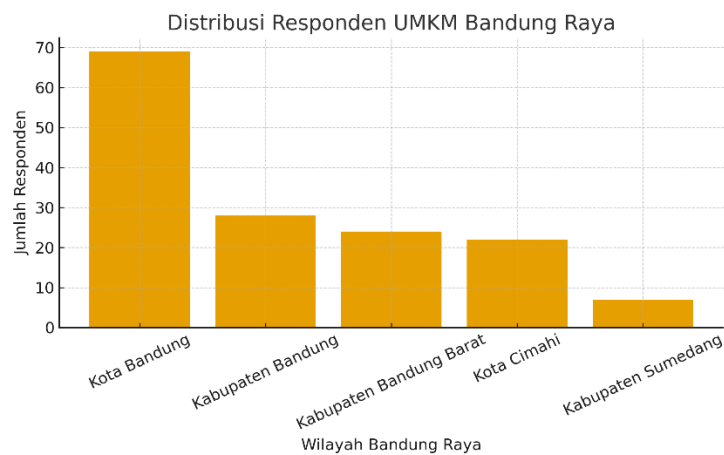
The model fit was evaluated using  $R^2$ , Adjusted  $R^2$ , F-statistics, and significance levels (p-values). Statistical analysis was conducted using SPSS 26.0.

## 4. RESULT AND DISCUSSION

### Result

#### *Statistik Deskriptif*

The distribution of MSME respondents based on the Greater Bandung area is shown in Figure 2. The graph shows that most respondents came from Bandung City (around 46%), followed by Bandung Regency, Cimahi City, West Bandung Regency, and a smaller number from Sumedang Regency. This distribution pattern shows that MSMEs are more concentrated in urban areas such as Bandung City, but the surrounding areas still play an important role in building the MSME ecosystem in Greater Bandung.



**Figure 2.** Responden UMKM.

#### *Reliability and Validity Test Results*

Table 1 shows the Cronbach Alpha scores for each variable in the study. All variables have scores above 0.80, and most are between 0.89 and 0.95. This indicates that all indicators have excellent internal consistency. Thus, the research instrument can be trusted to measure the constructs of Environmental Knowledge, Market Pressure, Green Innovation, and Sustainable Performance.

**Table 1.** Hasil Uji Realibilitias.

Variable	Cronbach Alpha	Description
Environmental Knowledge (PL)	<b>0.938</b>	Highly reliable
Market Pressure (TP)	<b>0.896</b>	Reliable
Green Innovation (GI)	<b>0.953</b>	Highly reliable
Sustainable Performance (SP)	<b>0.947</b>	Highly reliable

Based on the reliability test results, all variables showed Cronbach Alpha values above 0.70, meaning that the research instrument was considered highly reliable. The highest value was found in the Green Innovation variable (0.953), indicating that indicators such as energy efficiency, waste reduction, environmentally friendly materials, and packaging innovation

received consistent and credible responses. The Market Pressure variable also showed a strong level of reliability with a value of 0.896, which means that consumer demands, competition, and green product trends were assessed consistently by respondents.

Overall, this research instrument is quite good and can be used in the next stage of analysis. The validity test results show that all indicators are valid, as indicated by a corrected item–total correlation value above 0.80 for all items. This means that each indicator is able to explain the variable consistently and has a strong relationship with the total score of the variable. The highest validity was seen in indicators GI3 and SP3 (each > 0.90), indicating that environmentally friendly materials and business reputation are the strongest dimensions in explaining the Green Innovation and Sustainable Performance variables. Overall, the validity and reliability results confirm that the research instrument is very suitable for regression analysis and further discussion.

### ***Hypothesis Testing Results***

Hypothesis testing was conducted using two regression models. The first model was used to examine the impact of Environmental Knowledge (H1) and Market Pressure (H2) on Green Innovation. The second model was used to examine the effect of Green Innovation on Sustainable Performance (H3). The results showed that all hypotheses were accepted.

#### **H1: Environmental knowledge has a positive effect on green innovation**

The regression results indicate that Environmental Knowledge has a positive and significant effect on Green Innovation with a coefficient value of  $\beta = 0.728$ ,  $t = 21.49$ , and  $p < 0.001$ . This indicates that the higher the level of understanding of MSME actors regarding environmental issues, energy efficiency, waste reduction, and the use of environmentally friendly materials, the greater their tendency to apply green innovation in their business activities. This finding reinforces the view that knowledge is a key internal factor that drives change in practices towards sustainability.

#### **H2: Market pressure has a positive effect on green innovation**

Market Pressure has a positive and significant effect on Green Innovation with a coefficient value of  $\beta = 0.257$ ,  $t = 7.57$ , and  $p < 0.001$ . These results indicate that consumer demands, competitive pressures, and market trends that are increasingly shifting towards environmentally friendly products encourage MSMEs to implement green innovations. Thus, although its influence is smaller than that of Environmental Knowledge, Market Pressure remains an important factor influencing the implementation of sustainable innovation.

#### **H3: Green Innovation berpengaruh positif terhadap Sustainable Performance**

The regression results in Model 2 show that Green Innovation has a very strong influence on Sustainable Performance with a coefficient value of  $\beta = 0.847$ ,  $t = 25.79$ , and  $p < 0.001$ . This indicates that increased green innovation in MSMEs significantly improves cost efficiency, customer satisfaction, business reputation, and reduces negative environmental impacts. These findings confirm that green innovation not only provides ecological benefits, but also improves overall business performance.

**Table 2** Hipotesis Result.

	<b>Hipotesis</b>	<b>Result</b>
<b>H1</b>	Pengetahuan Lingkungan → Green Innovation	Accepted
<b>H2</b>	Tekanan Pasar → Green Innovation	Accepted
<b>H3</b>	Green Innovation → Sustainable Performance	Accepted

In general, the results of the study indicate that internal factors such as knowledge about the environment and external factors such as market pressure play an important role in encouraging MSMEs to implement green innovations. These innovations are implemented through energy conservation, waste reduction, the use of environmentally friendly materials, and innovative packaging design. The success of these innovations has a significant positive impact on the sustainability performance of businesses. This proves that green innovation is not only a strategy for protecting the environment, but also a business strategy that provides economic benefits and enhances the reputation of MSMEs.

## Discussion

This study provides a clear picture of the factors that influence the implementation of green innovations and their impact on the sustainability performance of small and medium-sized enterprises in the Greater Bandung area. In general, all hypotheses in the study were accepted, and the model used showed excellent predictive ability, with R-squared values in both regression models exceeding 0.80. This indicates that the variables studied were able to explain green innovation behaviour and business sustainability significantly.

### The Influence of Environmental Knowledge on Green Innovation

Research shows that knowledge about the environment has the greatest influence on the implementation of green innovation ( $\beta = 0.728$ ;  $p < 0.001$ ). These results indicate that the greater the understanding of SME actors regarding the impact of waste, the use of environmentally friendly materials, energy efficiency, and the importance of reducing waste, the more likely they are to implement sustainable innovations.

These results reinforce the theory that environmental knowledge is the main driver of environmentally friendly actions. When SME actors have a high awareness of environmental issues, they are more prepared to change their production methods, choose safer materials, and implement more efficient production strategies (Qi et al., 2020; Susanto & Wirawan, 2022). These findings are in line with previous studies that mention environmental knowledge as an important factor in the adoption of environmentally friendly innovations by small businesses (Li et al., 2023; Sharma, 2022). In Greater Bandung, an urban area with a high level of economic activity, environmental knowledge is an important asset for MSMEs in maintaining competitiveness while reducing their impact on the environment.

### The Influence of Market Pressure on Green Innovation

This study also shows that market pressure has a positive and significant effect on green innovation ( $\beta = 0.257$ ;  $p < 0.001$ ). Although its impact is not as high as environmental knowledge, market pressure remains a factor that encourages MSMEs to develop. These results indicate that consumer demand for safe and environmentally friendly products, as well as competition with other companies that have already implemented green innovation, encourage SMEs to adopt more sustainable practices.

Market pressure can also stem from changes in consumer preferences, particularly among younger generations in urban areas such as Bandung, who are increasingly concerned about sustainability issues. In addition, trends towards environmentally friendly packaging, plastic reduction, and increased demand for organic products further strengthen the drive for MSMEs to continue innovating (Wang et al., 2021). These findings are consistent with previous studies that emphasise that external factors, particularly consumer preferences, are the main drivers of sustainable innovation (Wang et al., 2021)).

### The Impact of Green Innovation on Sustainable Performance

Research findings indicate that green innovation has a significant impact on sustainable performance ( $\beta = 0.847$ ;  $p < 0.001$ ). Several sustainability performance indicators, such as cost efficiency, customer satisfaction, business reputation, and reduced environmental impact, continue to improve as the application of green innovation increases. Green innovation helps MSMEs improve operational efficiency by reducing waste, saving energy, and using environmentally friendly materials.

In addition, green innovation also increases product value, strengthens brand image, and increases customer loyalty. These results are in line with previous studies that state that environmentally friendly innovations can improve the competitiveness and sustainability performance of small and medium-sized enterprises (Chen et al., 2021; Zameer et al., 2020). In Greater Bandung, which has high competition, the implementation of green innovation is not only part of a sustainability strategy but also an important part of a business strategy to maintain profits amid changing market demand.

## 5. Conclusion

This study aims to analyse the influence of environmental knowledge and market pressure on green innovation, as well as to examine the impact of green innovation on sustainable business performance in micro, small, and medium enterprises in Greater Bandung. Based on the results of regression analysis, validity, and reliability, all research hypotheses were accepted. This indicates that the model created is able to explain the

dynamics of green innovation and sustainable business performance in a strong and significant manner.

First, knowledge about the environment greatly influences the ability of MSMEs to implement green innovation. Small and medium-sized business actors who better understand the impact of waste, the use of environmentally friendly materials, energy conservation, and ways to reduce waste are usually more prepared and motivated to develop innovations in their businesses. Second, market pressures also have a major influence on green innovation, although not as great as the influence of environmental knowledge. Consumer demand, market competition, and environmentally friendly product trends encourage MSMEs to adjust their production processes to be more environmentally friendly.

Third, this study found that green innovation has a significant impact on sustainable business performance. Various forms of innovation that have been implemented, such as energy conservation, waste reduction, use of environmentally friendly raw materials, and innovations in packaging, have been proven to increase cost efficiency, customer satisfaction, business reputation, and reduce negative impacts on the environment. This shows that green innovation not only benefits the environment, but also directly helps improve the competitiveness and sustainability of SME businesses.

Overall, this study confirms that a combination of internal awareness and external pressure are the main factors driving the implementation of green innovation. Green innovation plays an important role in strengthening the performance and sustainability of MSME businesses. The results of this study also contribute to the development of green innovation models among small businesses, as well as providing practical guidance for MSME actors and policy makers in designing more effective sustainability strategies.

## **Implications**

### ***Theoretical Implications***

This study makes an important contribution to the development of theory in the field of green innovation and business sustainability. First, the results reinforce the conceptual framework that states that internal factors (environmental knowledge) and external factors (market pressures) are the main determinants in driving the adoption of green innovation in SMEs.

This finding reinforces organizational behavior theory and the environmental knowledge framework, which places environmental awareness as the main foundation for business behavior change. Secondly, this study confirms that green innovation plays a central role in improving sustainable performance. This supports the resource-based view (RBV) theory, which states that intangible resources—such as innovation and environmental competence—can be a source of sustainable competitive advantage for SMEs. Third, this study provides empirical evidence from the Greater Bandung context, enriching the literature on green innovation in the SME sector in urban and semi-urban areas in developing countries. Thus, this research model can serve as a basis for further research that seeks to examine the dynamics of green innovation in different geographical contexts.

### ***Practical Implications***

In practical terms, the research results provide important insights for MSME players, local governments, and relevant stakeholders. For MSME players, increasing environmental knowledge is key to driving green innovation. Therefore, MSME players need to participate in training related to waste management, energy efficiency, and the selection of environmentally friendly materials.

The implementation of simple measures such as reducing plastic waste, using environmentally friendly packaging, and waste management can increase business competitiveness and reputation. For local governments, these findings can be used as a basis for designing more targeted policies, such as environment-based SME capacity building programs, providing incentives for businesses that implement green innovation, and developing a 'SME Go Green' training curriculum. Local governments can also encourage collaboration between MSMEs, universities, and industry in creating more applicable green innovations. For MSME support institutions (cooperatives, associations, financial institutions), these results provide a basis for creating assistance programmes that focus on sustainability. For example, providing business loans with conditions for implementing

environmentally friendly practices or giving awards to MSMEs that excel in environmental management.

### **Recommendations for Further Research**

This study has several limitations that may present opportunities for future research. The scope of the study is limited to Greater Bandung. Future research could add mediating or moderating variables, such as digital capabilities, entrepreneurial orientation, access to green financing, or government regulatory support. The measurement of green innovation still uses perceptual variables (self-report). Further research could use observational data, environmental audits, or technical indicators to improve objectivity.

The method used is still simple linear regression. Future research could apply more complex methods, such as SEM-PLS or covariance-based SEM, to validate the model structurally and test the relationships between variables in greater depth. The types of businesses represented by the respondents were diverse but were not analysed by sector. Future research could conduct separate analyses of food, fashion, handicrafts, and other SMEs to examine variations in the application of green innovation by industry sector.

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