

Green Innovation And Msme Performance: The Mediating Role Of Customer Satisfaction And The Moderating Role Of Digital Marketing In Sumbawa Regency

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Abstract

This study examines the effect of green innovation on the performance of micro, small, and medium enterprises (MSMEs), with customer satisfaction as a mediating variable and digital marketing as a moderating variable. The study focuses on MSMEs in Sumbawa Regency and applies a quantitative explanatory cross-sectional design. Instrument testing was conducted on 50 respondents, while the structural model was tested using data from 100 respondents. Data were analyzed using SPSS and Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS. The results show that all indicators meet validity and reliability requirements. Green innovation has a positive effect on customer satisfaction ($\beta = 0.528$; $p < 0.001$) and MSME performance ($\beta = 0.382$; $p < 0.001$). Customer satisfaction positively affects MSME performance ($\beta = 0.346$; $p < 0.001$) and partially mediates the effect of green innovation on MSME performance (indirect effect = 0.183; $p = 0.001$). Digital marketing positively affects MSME performance ($\beta = 0.442$; $p < 0.001$) and strengthens the relationship between green innovation and MSME performance ($\beta = 0.292$; $p < 0.001$). The model explains 61.8% of the variance in MSME performance. These findings indicate that environmentally oriented innovation creates stronger business results when it improves customer experience and is communicated through effective digital channels.

Keywords: green innovation, digital marketing, customer satisfaction, MSME performance, PLS-SEM.

INTRODUCTION

Micro, small, and medium enterprises (MSMEs) play a strategic role in employment, entrepreneurship, and inclusive economic growth. In Indonesia, MSMEs



account for the majority of business units, absorb more than 97% of the national workforce, and contribute more than 60% of gross domestic product. Their importance is also visible at the regional level, where MSMEs support household income, process local resources, and maintain the circulation of economic value within communities.

Despite their numerical growth, MSMEs continue to face limitations in managerial capability, product development, access to finance, market reach, and digital readiness. Changes in consumer preferences create an additional challenge. Consumers increasingly evaluate not only price and product function, but also quality, environmental impact, ethical value, and producer responsibility. Accordingly, sustainable business practices have become relevant not only to large corporations but also to small enterprises whose production and marketing activities directly interact with local communities.

Green innovation offers one pathway for MSMEs to respond to these demands. It includes environmentally oriented improvements to products, packaging, materials, production processes, and resource efficiency. Such innovation can reduce waste and environmental impact while creating differentiation and strengthening the value perceived by customers (Dangelico & Pujari, 2010);(Nuryakin, 2022). For food and beverage MSMEs, this may take the form of efficient use of raw materials, reduction of single-use packaging, cleaner production, local sourcing, and communication of environmentally responsible attributes.

The business value of green innovation, however, is not automatic. Customers must recognize and experience the benefits created by the innovation. Customer satisfaction therefore becomes an important mechanism connecting green innovation with performance. When products meet expectations in quality, usefulness, safety, and environmental responsibility, customers are more likely to repurchase and recommend them. Prior research also indicates that customer satisfaction can transmit the effects of responsible business practices to firm value and performance (Nurbismi & Gunawan, 2019); (Seok et al., 2024).

Digital marketing may further determine whether green innovation produces stronger performance. Social media, marketplaces, and other digital channels allow MSMEs to explain product value, reach wider markets, maintain customer relationships, and receive rapid feedback. Digital marketing can act as a direct driver of performance and as an amplifier that enables environmentally oriented innovation to be understood by the market (Mehralian & Khazaei, 2022); (Primadhita et al., 2023). This role is particularly important in non-metropolitan regions, where limited physical market access can be partly addressed through digital channels.

Studies of MSME performance often examine green innovation, customer satisfaction, or digital marketing separately. Fewer studies integrate customer



satisfaction as a mediating mechanism and digital marketing as a moderating condition in one model, particularly in the context of Sumbawa Regency. This study addresses that gap by testing the direct effect of green innovation on customer satisfaction and MSME performance, the mediating role of customer satisfaction, and the strengthening role of digital marketing.

The study aims to: (1) analyze the effect of green innovation on customer satisfaction; (2) analyze the direct effects of green innovation, customer satisfaction, and digital marketing on MSME performance; (3) test the mediating role of customer satisfaction; and (4) test whether digital marketing strengthens the effect of green innovation on MSME performance.

LITERATURE REVIEW AND HYPOTHESES

1) *Green Innovation and MSME Performance*

Green innovation refers to new or improved products and processes that reduce environmental harm, improve resource efficiency, and generate sustainable value. Product-oriented green innovation can include environmentally safer materials, recyclable packaging, and products with lower environmental impact. Process-oriented green innovation includes waste reduction, energy efficiency, cleaner production, and responsible resource utilization (Dangelico & Pujari, 2010).

For MSMEs, green innovation may improve performance through cost efficiency, product differentiation, reputation, market access, and adaptability. Empirical research has linked green product and process innovation to sustainable competitive advantage and improved business performance (Maziriri, 2022); (Nuryakin & Maryati, 2022). In the Indonesian food and beverage sector, environmentally responsible innovation has also been associated with improved MSME performance (Primadhita et al., 2023). Therefore:

H1: Green innovation has a positive effect on customer satisfaction.

H2: Green innovation has a positive effect on MSME performance.

2) *Customer Satisfaction as a Mediating Variable*

Customer satisfaction reflects the evaluation that product performance meets or exceeds customer expectations. Green innovation can improve satisfaction when environmental benefits are accompanied by functional quality, convenience, safety, and credible communication. Satisfied customers are more likely to repurchase, recommend products, and maintain relationships with the business, thereby supporting sales stability and market growth.

Customer satisfaction is therefore expected to act as a transmission mechanism. Green innovation improves the value experienced by customers, while satisfaction converts that value into favorable behavioral and performance outcomes. Evidence from



MSMEs indicates that satisfaction mediates the relationship between quality practices and business performance (Nurbismi & Gunawan, 2019). Accordingly:

H3: Customer satisfaction has a positive effect on MSME performance.

H5: Customer satisfaction mediates the effect of green innovation on MSME performance.

3) Digital Marketing as a Direct Driver and Moderator

Digital marketing is the use of internet-based channels to communicate, promote, transact, and manage customer relationships. For MSMEs, it expands reach at relatively low cost, supports more targeted communication, and enables rapid interaction with customers. Digital adoption has been linked to stronger sales and business performance because it reduces geographical constraints and improves market responsiveness (Mulyanto & Budi, 2025); (Naibaho et al., 2025).

Digital channels also make the attributes of green innovation more visible. Environmentally responsible improvements may remain unnoticed when they are not explained clearly. Through product stories, demonstrations, customer reviews, and interactive content, digital marketing can strengthen the market response to green innovation. Therefore:

H4: Digital marketing has a positive effect on MSME performance.

H6: Digital marketing strengthens the positive effect of green innovation on MSME performance.

RESEARCH METHOD

This research employed a quantitative explanatory cross-sectional design. The unit of analysis was the owner or principal manager of an MSME in Sumbawa Regency because this respondent group has knowledge of strategic decisions, resource management, innovation, marketing, and business outcomes. Data were collected through a structured questionnaire using reflective indicators.

The research model comprised green innovation as the main exogenous construct, customer satisfaction as a mediating construct, MSME performance as the final endogenous construct, and digital marketing as both a direct predictor and moderator. Green innovation was measured by four indicators, digital marketing by five indicators, customer satisfaction by four indicators, and MSME performance by four indicators.

Instrument quality was initially assessed using data from 50 respondents. Item validity was examined through item-total correlation, while internal consistency was evaluated using Cronbach's Alpha. Structural analysis used the full sample of 100 respondents. Diagnostic tests were conducted with SPSS, and hypothesis testing used

PLS-SEM with SmartPLS 3. The PLS algorithm applied path weighting, standardized data, a maximum of 300 iterations, and a stop criterion of 10^{-7} . Significance testing used bootstrapping with 500 subsamples, a two-tailed test, and a 5% significance level.

The measurement model was evaluated using outer loading, Average Variance Extracted (AVE), Cronbach's Alpha, composite reliability, Fornell–Larcker criteria, cross loadings, and the Heterotrait–Monotrait ratio (HTMT). The structural model was evaluated using collinearity statistics, path coefficients, R^2 , effect size (f^2), predictive relevance (Q^2), model fit, indirect effects, and interaction effects (Hair et al., 2022).

RESULTS AND DISCUSSION

4) *Instrument Validity and Reliability*

All 17 questionnaire items were valid. Item-total correlations ranged from 0.764 to 0.889, exceeded the critical value of 0.279, and were significant at $p < 0.001$. Cronbach's Alpha values ranged from 0.846 to 0.867, indicating adequate internal consistency in the pilot sample.

Table 1. Summary of item validity (N = 50)

Construct	Indicator	Item-total r	r-table	Sig. (2-tailed)	Decision
Green Innovation (X)	X1	0.858	0.279	0.000	Valid
	X2	0.845	0.279	0.000	Valid
	X3	0.821	0.279	0.000	Valid
	X4	0.808	0.279	0.000	Valid
Digital Marketing (M)	M1	0.764	0.279	0.000	Valid
	M2	0.822	0.279	0.000	Valid
	M3	0.779	0.279	0.000	Valid
	M4	0.784	0.279	0.000	Valid
	M5	0.790	0.279	0.000	Valid
Consumer Satisfaction (Z)	Z1	0.867	0.279	0.000	Valid
	Z2	0.827	0.279	0.000	Valid
	Z3	0.823	0.279	0.000	Valid



Construct	Indicator	Item-total r	r-table	Sig. (2-tailed)	Decision
	Z4	0.792	0.279	0.000	Valid
MSME Performance (Y)	Y1	0.830	0.279	0.000	Valid
	Y2	0.889	0.279	0.000	Valid
	Y3	0.834	0.279	0.000	Valid
	Y4	0.830	0.279	0.000	Valid

Source: SPSS output, processed (2026).

Instrument reliability (N = 50). Green Innovation: 4 items, Cronbach's Alpha 0.852; Digital Marketing: 5 items, 0.847; Customer Satisfaction: 4 items, 0.846; MSME Performance: 4 items, 0.867. All constructs were reliable.

Table 2. Summary of instrument reliability (N = 50)

Construct	Items	Cronbach's Alpha	Threshold	Decision
Green Innovation (X)	4	0.852	> 0.70	Reliable
Digital Marketing (M)	5	0.847	> 0.70	Reliable
Consumer Satisfaction (Z)	4	0.846	> 0.70	Reliable
MSME Performance (Y)	4	0.867	> 0.70	Reliable

Source: SPSS output, processed (2026).

Classical assumption tests used as supplementary diagnostics showed no material problems. The Kolmogorov–Smirnov significance value was 0.200, the significance values in the heteroskedasticity test ranged from 0.491 to 0.992, and predictor VIF values ranged from 1.011 to 1.372. Although PLS-SEM does not require multivariate normality, these results provide additional support for the quality of the data.

5) Measurement Model Evaluation

All outer loadings exceeded 0.70 and were significant at $p < 0.001$. AVE values ranged from 0.691 to 0.703, while composite reliability ranged from 0.899 to 0.921. The results indicate convergent validity and internal consistency without evidence of indicator redundancy.

Convergent validity and construct reliability. Green Innovation: Alpha 0.851, rho_A 0.863, CR 0.899, AVE 0.691; Digital Marketing: 0.893, 0.899, 0.921, 0.701; Customer Satisfaction: 0.856, 0.863, 0.903, 0.699; MSME Performance: 0.859, 0.864, 0.904, 0.703. All constructs met the criteria.

Source: SmartPLS 3 output, processed (2026). Discriminant validity was also established. The square root of AVE for each construct exceeded its correlations with the other constructs. In addition, all HTMT values were below 0.85, with the highest value of 0.631 for the customer satisfaction–MSME performance pair.

Table 3. Convergent validity and construct reliability

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
Green Innovation (X)	0.851	0.863	0.899	0.691
Digital Marketing (M)	0.893	0.899	0.921	0.701
Consumer Satisfaction (Z)	0.856	0.863	0.903	0.699
MSME Performance (Y)	0.859	0.864	0.904	0.703

Source: SmartPLS 3 (PLS Algorithm), processed (2026). The single-indicator interaction construct is excluded, as its Alpha, rho_A, CR, and AVE are automatically 1.000 and are not interpreted as reliability evidence.

HTMT discriminant validity. Green Innovation–Digital Marketing: 0.094; Green Innovation–Customer Satisfaction: 0.602; Green Innovation–MSME Performance: 0.622; Digital Marketing–Customer Satisfaction: 0.137; Digital Marketing–MSME Performance: 0.515; Customer Satisfaction–MSME Performance: 0.631. All values were below 0.85.

Source: SmartPLS 3 output, processed (2026).

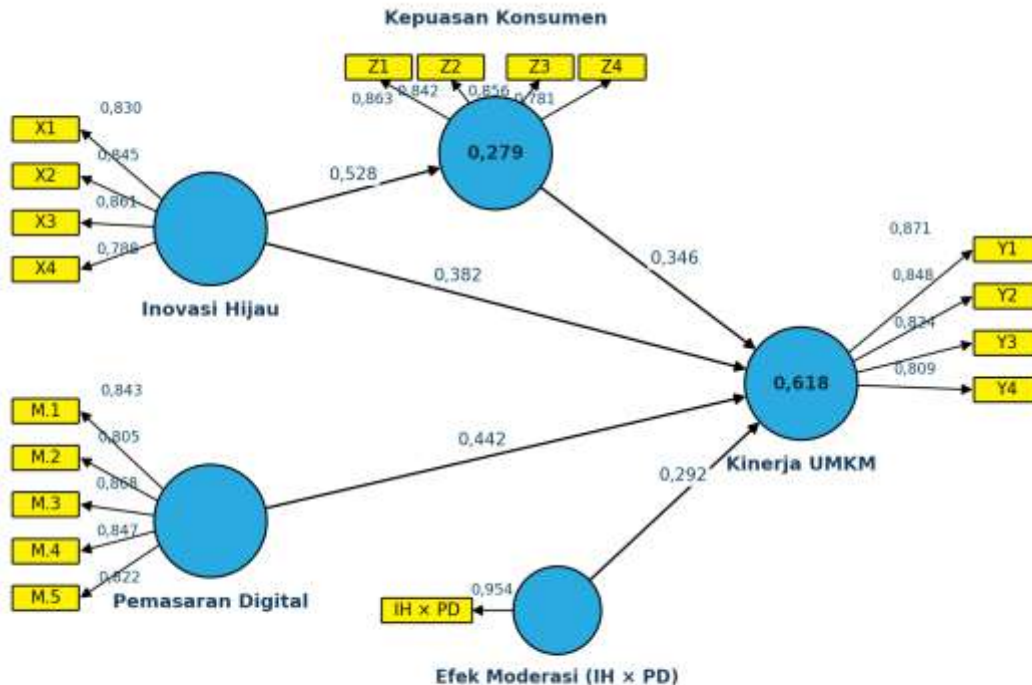


Figure 1. PLS algorithm results: outer loadings, path coefficients, and R²

6) Structural Model Evaluation

Inner VIF values ranged from 1.000 to 1.412 and were below the threshold of 5. The structural coefficients were therefore not materially affected by multicollinearity. The R² value for customer satisfaction was 0.279, indicating that green innovation explained 27.9% of its variance. The R² value for MSME performance was 0.618, meaning that green innovation, digital marketing, customer satisfaction, and the interaction effect jointly explained 61.8% of the variance in performance.

Coefficient of determination. Customer Satisfaction: R² = 0.279 and adjusted R² = 0.272 (weak toward moderate). MSME Performance: R² = 0.618 and adjusted R² = 0.602 (moderate).

The R² for consumer satisfaction was 0.279, indicating that green innovation explains 27.9 per cent of its variance, a weak-to-moderate result under Chin's (1998) criteria that suggests consumer satisfaction is also shaped by factors outside the model, such as service quality, price, or transaction experience. The R² for MSME performance was 0.618, indicating that green innovation, digital marketing, consumer satisfaction, and their interaction jointly explain 61.8 per cent of its variance, a moderate-to-substantial

result. Adjusted R^2 values of 0.272 and 0.602 respectively confirm that this explanatory strength does not stem from excessive predictor inclusion.

Table 4. Coefficient of determination (R^2)

Endogenous Construct	R^2	Adjusted R^2	Interpretation
Consumer Satisfaction (Z)	0.279	0.272	Weak-to-moderate
MSME Performance (Y)	0.618	0.602	Moderate

Source: SmartPLS 3 (PLS Algorithm), processed (2026).

The global predictive relevance value was $Q^2 = 0.725$, which was above zero and indicated good predictive relevance. The SRMR values were 0.068 for the saturated model and 0.071 for the estimated model, both below 0.08. These statistics support the adequacy of the measurement and structural models.

7) Hypothesis Testing

Bootstrapping results supported all six hypotheses. Green innovation had the strongest direct effect on customer satisfaction ($\beta = 0.528$), while digital marketing had the strongest direct effect on MSME performance ($\beta = 0.442$). All direct effects were positive and significant at $p < 0.001$.

Direct effect testing. Green Innovation $\rightarrow$ Customer Satisfaction: $\beta = 0.528$, $t = 7.777$, $p < 0.001$; Green Innovation $\rightarrow$ MSME Performance: $\beta = 0.382$, $t = 4.547$, $p < 0.001$; Digital Marketing $\rightarrow$ MSME Performance: $\beta = 0.442$, $t = 6.066$, $p < 0.001$; Customer Satisfaction $\rightarrow$ MSME Performance: $\beta = 0.346$, $t = 4.144$, $p < 0.001$; Green Innovation $\times$ Digital Marketing $\rightarrow$ MSME Performance: $\beta = 0.292$, $t = 4.437$, $p < 0.001$. All direct effects were significant

Table 5. Direct effects

Path	β	t-value	p-value	95% BCa CI	Decision
Green Innovation $\rightarrow$ Consumer Satisfaction (H1)	0.528	7.777	< 0.001	[0.363; 0.641]	Supported
Green Innovation $\rightarrow$ MSME Performance (H2)	0.382	4.547	< 0.001	[0.217; 0.534]	Supported
Customer Satisfaction $\rightarrow$ MSME Performance (H3)	0.346	4.144	< 0.001	[0.194; 0.520]	Supported

Path	β	t-value	p-value	95% BCa CI	Decision
Digital Marketing → MSME Performance (H4)	0.442	6.066	< 0.001	[0.274; 0.568]	Supported

Source: SmartPLS 3 (Bootstrapping, 500 subsamples), processed (2026).

The indirect effect of green innovation on MSME performance through customer satisfaction was 0.183 ($t = 3.294$; $p = 0.001$). Because the direct and indirect effects were both significant and had the same direction, customer satisfaction exhibited complementary partial mediation. The Variance Accounted For (VAF) was 32.4%, showing that approximately one-third of the total effect of green innovation on performance operated through customer satisfaction.

Mediation and moderation testing. The indirect effect of Green Innovation → Customer Satisfaction → MSME Performance was $\beta = 0.183$, $t = 3.294$, $p = 0.001$, with VAF = 32.4% (partial mediation). The Green Innovation × Digital Marketing interaction on MSME Performance was $\beta = 0.292$, $t = 4.437$, $p < 0.001$, with $f^2 = 0.191$ (strengthening moderation).

Table 6. Indirect effect and mediation test

Indirect Path	β	t-value	p-value	95% BCa CI	VAF	Mediation Type
Green Innovation → Consumer Satisfaction → MSME Performance (H5)	0.183	3.294	0.001	[0.087; 0.291]	32.4%	Complementary partial mediation

Source: Specific indirect effects, SmartPLS 3 Bootstrapping, processed (2026).

The indirect effect of green innovation on MSME performance via consumer satisfaction is 0.183 and significant at the 1 per cent level ($p = 0.001$), with a confidence interval that excludes zero. Because the direct effect is also significant and shares the same sign, this pattern indicates complementary partial mediation under the Zhao, Lynch, and Chen (2010) typology. A Variance Accounted For (VAF) of 32.4 per cent indicates that roughly one-third of the total effect of green innovation on performance flows through consumer satisfaction, with the remainder operating directly, confirming H5: consumer satisfaction is a genuine complementary channel rather than the sole mechanism linking green innovation to performance.

Table 7. Moderation test

Interaction	β	t-value	p-value	95% BCa CI	f ²	Decision
Green Innovation $\times$ Digital Marketing $\rightarrow$ MSME Performance (H6)	0.292	4.437	< 0.001	[0.169; 0.416]	0.191	Supported

Source: SmartPLS 3 (Bootstrapping, 500 subsamples), processed (2026).

The interaction coefficient of 0.292 is positive and significant ($t = 4.437$; $p < 0.001$), with a BCa confidence interval of [0.169; 0.416] entirely above zero, confirming H6. The positive sign indicates that digital marketing strengthens the relationship between green innovation and MSME performance: among MSMEs with higher digital marketing intensity, a given increase in green innovation produces a larger performance gain than among MSMEs with lower digital marketing intensity. This finding complements the significant direct effect of digital marketing ($\beta = 0.442$) reported above, so that digital marketing operates on two fronts at once, as a direct performance driver and as an amplifier of the returns to green innovation. With an f^2 of 0.191, the contribution of the interaction term is substantial for a moderation effect.

Table 8. Total effects

Path	Total β	t-value	p-value	95% BCa CI
Green Innovation $\rightarrow$ Consumer Satisfaction	0.528	7.777	< 0.001	[0.363; 0.641]
Green Innovation $\rightarrow$ MSME Performance	0.565	8.655	< 0.001	[0.429; 0.686]
Digital Marketing $\rightarrow$ MSME Performance	0.442	6.066	< 0.001	[0.274; 0.568]
Consumer Satisfaction $\rightarrow$ MSME Performance	0.346	4.144	< 0.001	[0.194; 0.520]
Interaction (GI $\times$ DM) $\rightarrow$ MSME Performance	0.292	4.437	< 0.001	[0.169; 0.416]

Source: SmartPLS 3 (Bootstrapping, 500 subsamples), processed (2026).

The total effect of green innovation on MSME performance, 0.565, is the largest in the model, combining its direct effect (0.382) with its indirect effect through consumer

satisfaction (0.183). This places green innovation as the single most decisive driver of performance in the model, operating both through direct process and product improvement and through the enhancement of consumer satisfaction.

Table 9. Summary of hypothesis testing

Hypothesis	Statement	β	p-value	Decision
H1	Green innovation has a positive effect on consumer satisfaction	0.528	< 0.001	Supported
H2	Green innovation has a positive effect on MSME performance	0.382	< 0.001	Supported
H3	Consumer satisfaction has a positive effect on MSME performance	0.346	< 0.001	Supported
H4	Digital marketing has a positive effect on MSME performance	0.442	< 0.001	Supported
H5	Consumer satisfaction mediates green innovation → MSME performance	0.183	0.001	Supported (partial mediation)
H6	Digital marketing moderates green innovation → MSME performance	0.292	< 0.001	Supported (strengthening)

Source: SmartPLS 3 (Bootstrapping, 500 subsamples), processed (2026).

DISCUSSION

The positive effect of green innovation on customer satisfaction shows that environmental improvements are recognized as customer value. For food and beverage MSMEs, efficient materials, safer products, reduced waste, and responsible packaging can improve both functional and symbolic value. This finding is consistent with the premise that green product and process innovation generates market benefits when it responds to consumer expectations (Dangelico & Pujari, 2010); (Adomako & Nguyen, 2023).

Green innovation also directly improves MSME performance. The result supports previous evidence that environmentally oriented innovation enhances efficiency, differentiation, sustainable competitive advantage, and business outcomes (Maziriri, 2022); (Nuryakin & Maryati, 2022); (Primadhita et al., 2023). In practical terms, green innovation should not be treated merely as compliance or social responsibility. It can form

part of the enterprise's competitive strategy by reducing input waste, improving product distinctiveness, and strengthening reputation.

Customer satisfaction has a positive effect on performance and partially mediates the effect of green innovation. This result clarifies the mechanism through which green innovation produces business value. Innovation contributes directly to performance, but part of its contribution arises because customers perceive better value and become more satisfied. The partial nature of the mediation indicates that green innovation also produces operational or reputational benefits independent of satisfaction. This pattern is aligned with findings that customer satisfaction connects quality and responsible practices to stronger business outcomes (Nurbismi & Gunawan, 2019); (Seok et al., 2024).

Digital marketing produces the largest direct contribution to MSME performance among the predictors of performance. This demonstrates the importance of digital channels for customer reach, interaction, sales conversion, and market learning. The finding is consistent with research showing that digital technology adoption and digital marketing strengthen MSME sales and performance (Mehralian & Khazaei, 2022); (Mulyanto & Budi, 2025); (Naibaho et al., 2025).

The significant positive interaction confirms that digital marketing strengthens the effect of green innovation on performance. Green attributes cannot create maximum market value when customers do not know, understand, or trust them. Digital content, product information, customer testimonials, and transparent explanations of materials or production processes enable MSMEs to communicate their environmental innovations more effectively. The moderation result implies that green innovation and digital marketing should be managed as complementary capabilities rather than isolated activities.

For MSME owners in Sumbawa Regency, the findings point to an integrated strategy. Enterprises should identify feasible green improvements, ensure that those improvements solve real customer concerns, and communicate the resulting value consistently through digital channels. Government and support institutions can reinforce this process through practical training, digital content assistance, access to suitable technology, green production guidance, and credible certification or labeling.

CONCLUSION

This study concludes that green innovation positively affects customer satisfaction and MSME performance in Sumbawa Regency. Customer satisfaction also improves MSME performance and partially mediates the effect of green innovation. Digital marketing has a positive direct effect on performance and strengthens the positive relationship between green innovation and MSME performance. Together, the predictors

explain 61.8% of the variation in MSME performance, and the model demonstrates good predictive relevance.

The main theoretical contribution is the integration of customer satisfaction as a mediating mechanism and digital marketing as a moderating capability in explaining how green innovation translates into MSME performance. Managerially, MSMEs should align environmental improvement, customer value, and digital communication. Green practices need to be relevant, verifiable, and easy for customers to understand, while digital marketing should be used not only for promotion but also for education, engagement, and relationship development.

The study is limited by its cross-sectional design, geographic concentration in Sumbawa Regency, self-reported responses, and sample size. Future research may use longitudinal designs, compare business sectors or regions, include objective financial indicators, and examine additional conditions such as government support, leadership, product quality, and local wisdom.

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