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Green Marketing and MSME Sustainability: Examining the Moderating Effect of Digital Marketing in Lhokseumawe City

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Abstract

Purpose: This study examines the effects of Green Product, Green Price, Green Place, and Green Promotion on MSME Sustainability and the moderating role of Digital Marketing in Lhokseumawe City.

Research Methodology: A quantitative survey was conducted among 96 MSME owners in Lhokseumawe City. Data were analyzed using Structural Equation Modeling (SEM) with the Partial Least Squares (PLS) approach through SmartPLS 4.0.

Results: Green Product, Green Place, and Green Promotion have positive and significant effects on MSME Sustainability, whereas Green Price does not show a significant effect. Digital Marketing significantly moderates the relationship between Green Place and MSME Sustainability but does not significantly moderate the relationships between Green Product, Green Price, or Green Promotion and MSME Sustainability. The model explains 68.3% of the variance in MSME Sustainability.

Conclusions: The findings demonstrate that the contribution of green marketing to MSME Sustainability differs across marketing dimensions. Importantly, the moderating role of Digital Marketing is selective and context-specific, with a significant effect only on the Green Place–MSME Sustainability relationship.

Limitations: his study was limited to 96 MSMEs in Lhokseumawe City and examined four green marketing dimensions with Digital Marketing as a moderating variable.

Contributions: This study contributes to the development of contemporary green marketing and sustainability theory by introducing a context-dependent perspective on the moderating role of digital marketing. The findings enrich existing theoretical frameworks by demonstrating that the effectiveness of digital marketing in supporting MSME Sustainability depends on specific green marketing dimensions, particularly Green Place.

Keywords: *Business Sustainability, Digitalization, Environmental Practices, Green Marketing, SMEs*

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1. Introduction

Environmental degradation, climate change, and increasing public awareness of sustainability have encouraged businesses to adopt more environmentally responsible practices. Green marketing has consequently developed beyond a promotional approach into a strategic business practice that incorporates environmental considerations into products, pricing, distribution, and promotion (Papadas, Avlonitis, Carrigan, & Piha, 2019). For Micro, Small, and Medium Enterprises (MSMEs), such practices are increasingly relevant because environmental responsibility can contribute to competitiveness, customer acceptance, and long-term business sustainability.

MSMEs play a strategic role in the Indonesian economy. According to OECD (2026), Indonesia had 56.14 million MSMEs in 2024, representing 99.90% of the total business population and contributing 59.64% of national GDP. Despite their substantial economic contribution, MSMEs commonly face limitations in resources, technology, and capabilities that may constrain their ability to adopt sustainable business practices. Therefore, improving MSME sustainability requires not only economic performance but also the integration of environmental responsibility and technological capabilities.

This issue is particularly relevant in Lhokseumawe City, Aceh. Biby, Asbar, and Jufridar (2023) reported that Lhokseumawe had 2,058 MSMEs operating across culinary, craft, and other production sectors under the guidance of the local government agency responsible for industry, trade, cooperatives, and SMEs. Their study also identified MSME sustainability as an important issue in Lhokseumawe and examined the role of green business practices in supporting MSME sustainability. These findings indicate that sustainability is not merely a general issue for MSMEs but has already become a relevant concern within the local business context.

The environmental dimension is particularly important because MSME activities may involve the use of raw materials, energy, packaging, transportation, and waste-generating processes. Green marketing provides a practical approach for integrating environmental considerations into these activities through Green Product, Green Price, Green Place, and Green Promotion (Papadas et al., 2019). In the Lhokseumawe context, Biby et al. (2023) found that green business practices, particularly green process and green product, were related to MSME sustainability. This provides an important empirical basis for further examining individual dimensions of green marketing and their contribution to MSME sustainability.

At the same time, the rapid development of digital technology has changed the way MSMEs communicate with customers, promote products, and access markets. Digital marketing enables businesses to reach wider markets and interact with customers through social media, e-commerce, and other digital platforms. Evidence from Lhokseumawe shows that digital marketing is increasingly relevant but its adoption remains challenging. For example, Effendi, Abubakar, and Bachri (2022) found that digital marketing had a positive and significant effect on the marketing performance of 160 fashion MSMEs in Lhokseumawe, with product innovation serving as a mediating mechanism. Riski, Hafni, Maisyura, Meliza, Mujiburrahman, Fazil, Lubis, and Fatmasari (2024) reported that MSMEs in Gampong Blang Pulo, Lhokseumawe, still faced limited knowledge of digital marketing and e-commerce as well as limited technological skills, leading to the implementation of digital marketing training and mentoring.

These conditions suggest that digital marketing may have a role beyond improving marketing performance. Digital platforms can provide MSMEs with additional opportunities to communicate environmental values, promote green products, reach environmentally conscious consumers, and improve the visibility of environmentally responsible business practices. Consequently, digital marketing may strengthen the effectiveness of green marketing practices in supporting business sustainability. However, the extent to which digital marketing changes the effectiveness of specific green marketing dimensions remains insufficiently understood.

Previous studies have generally examined green marketing, green business practices, or digital marketing as separate determinants of business performance and sustainability. Biby et al. (2023), for

instance, examined green economy practices and MSME sustainability in Lhokseumawe, while Effendi et al. (2022) examined the effect of digital marketing on MSME marketing performance in the same city. Although these studies provide important evidence, they do not specifically examine whether digital marketing changes the strength of the relationship between individual green marketing dimensions and MSME sustainability. This represents an important research gap, particularly because the effectiveness of digital marketing may depend on how it is integrated with specific environmental marketing practices.

Therefore, this study examines the effects of Green Product, Green Price, Green Place, and Green Promotion on MSME Sustainability in Lhokseumawe City. In addition, this study investigates the moderating role of Digital Marketing in the relationships between each dimension of Green Marketing and MSME Sustainability. By integrating green marketing and digital marketing within a single sustainability framework, this study contributes empirical evidence regarding how environmental marketing practices and digital capabilities interact to support MSME sustainability in a local developing-market context.

2. Literature Review and Hypotheses Development

2.1 Business Sustainability

Business sustainability refers to an organization's ability to maintain long-term operations and growth while balancing economic, social, and environmental responsibilities. Nadkarni and Prügl (2021) describe sustainability as an effort to minimize negative environmental and social impacts while ensuring the availability of resources for future generations. This concept is consistent with the Triple Bottom Line, which emphasizes the balance among economic, social, and environmental dimensions (Elkington, 1998).

For Micro, Small, and Medium Enterprises (MSMEs), sustainability reflects the ability to maintain business performance, adapt to changing market conditions, strengthen competitiveness, and ensure business continuity. MSMEs play a strategic role in Indonesia economy by contributing substantially to national output and employment (OECD, 2026). Recent evidence indicates that digital upgrading can improve MSME sustainability (Habibie, Santoso, Islamudin, & Vizandra, 2024; Ta, Al-Qudah, Asad, Magableh, & Riyadh, 2024), while creative digital marketing contributes to business sustainability through improved marketing performance and market expansion (Vania & Fikriah, 2023). These findings highlight the importance of integrating environmental and digital strategies into MSME business practices.

2.2 Green Marketing

Green marketing refers to marketing activities that integrate environmental considerations into product development, pricing, distribution, and promotion (Papadas et al., 2019). It aims to satisfy customer needs while reducing environmental impacts and creating value through environmentally responsible business practices. Green marketing has increasingly become an important strategic approach as environmental concerns influence consumer preferences and firms' competitive strategies. Empirical evidence indicates that green marketing orientation can strengthen competitive advantage and contribute to business performance (Papadas et al., 2019).

In the MSME context, green marketing can support sustainability by encouraging environmentally responsible products, pricing, distribution, and promotional practices while creating value for customers and other stakeholders. Accordingly, this study conceptualizes green marketing through four dimensions: Green Product, Green Price, Green Place, and Green Promotion.

2.2.1 Green Product

Green product refers to products designed and produced using environmentally friendly materials and processes to reduce environmental impacts throughout their life cycle. Key characteristics include the use of sustainable materials, energy efficiency, waste reduction, environmental certification, and safe chemical use (Sumarlin & Nuvriasari, 2024). For MSMEs, green products can create customer value while improving competitiveness and supporting environmentally responsible business practices. Ta,

Al-Qudah, Asad, Magableh, and Riyadh (2024) found that green product innovation contributes positively to SME performance, while Sumarlin and Nuvriasari (2024) reported that green innovation supports MSME competitiveness and marketing performance. These findings suggest that green product practices can contribute to long-term business sustainability.

2.2.2 Green Price

Green price refers to pricing strategies that consider the environmental value and additional costs associated with environmentally responsible products and processes. Green products may require higher costs due to sustainable materials, production methods, and packaging (Jaiswal & Kant, 2018). Consumers with stronger environmental awareness may be more willing to accept premium prices when they perceive meaningful environmental value (Jaiswal & Kant, 2018). Thus, appropriate green pricing can help MSMEs balance economic returns with environmental responsibility and potentially support business sustainability.

2.2.3 Green Place

Green place refers to environmentally responsible distribution and logistics practices that reduce environmental impacts through efficient transportation, recyclable packaging, energy-efficient facilities, and environmentally responsible distribution channels (Qorri et al., 2018). Such practices can improve resource efficiency and reduce environmental impacts while supporting sustainable business operations. Recent evidence also indicates that sustainable distribution practices can contribute to organizational performance and environmental sustainability (Ghobbe & Nohekhan, 2023). Therefore, green place may strengthen the ability of MSMEs to achieve long-term sustainability through more environmentally responsible distribution practices.

2.2.4 Green Promotion

Green promotion refers to marketing communication that emphasizes the environmental benefits and sustainability values of products through advertising, social media, public relations, and other promotional activities (Papadas et al., 2019). Effective green promotion can increase consumer awareness, strengthen green trust, and improve market positioning. Lestari et al. (2020) found that green promotional activities strengthen green trust and purchase intention. For MSMEs, communicating environmental value effectively may therefore support customer engagement and contribute to long-term business sustainability.

2.3 Digital Marketing

Digital marketing refers to marketing activities that use internet-based technologies and digital platforms to communicate with customers, expand market reach, and improve marketing efficiency (Chaffey & Ellis-Chadwick, 2022). Digital marketing enables MSMEs to strengthen customer relationships and access broader markets through social media, websites, e-commerce platforms, and other digital channels.

Recent empirical evidence highlights its relevance to MSME sustainability. Vania and Fikriah (2023) found that digital marketing contributes to business sustainability through improved marketing performance and market expansion, while Habibie et al. (2024) reported that digital upgrading supports MSME sustainability. Rachmawati et al. (2023) further found that digital marketing and green marketing contribute positively to MSME business sustainability. These findings indicate that digital marketing can support sustainability directly and may also enhance the effectiveness of green marketing practices. Therefore, this study proposes Digital Marketing as a moderating variable in the relationship between Green Marketing and MSME Sustainability.

2.4 Conceptual Framework

This study is primarily grounded in Stakeholder Theory, which emphasizes the creation of value for customers, communities, employees, and the environment. From this perspective, Green Product, Green Price, Green Place, and Green Promotion represent environmental marketing practices through which MSMEs respond to stakeholder expectations and support business sustainability.

The study is also supported by the Triple Bottom Line, which emphasizes the balance of economic, social, and environmental aspects of sustainability. Digital Marketing is positioned as a moderating variable because digital platforms can improve the communication, visibility, and market reach of green marketing practices. Thus, higher Digital Marketing capability is expected to strengthen the relationships between the four Green Marketing dimensions and MSME Sustainability. The conceptual framework is presented in Figure 1.

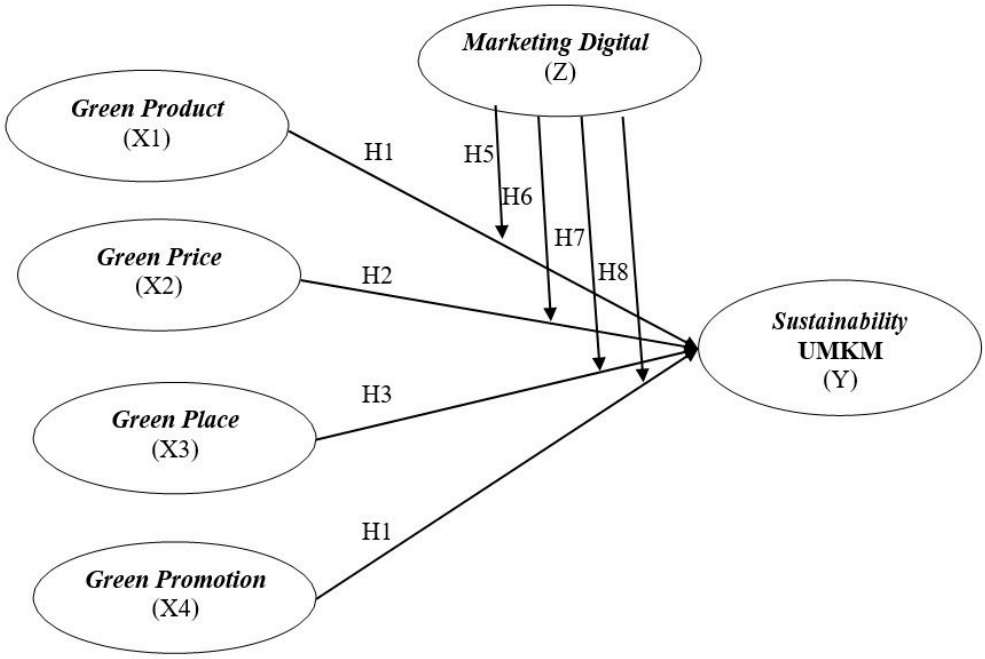


Figure 1. Research framework

2.5 Hypotheses Development

2.5.1 The Effect of Green Product on MSME Sustainability

Green product refers to products designed and produced using environmentally friendly materials and processes that minimize environmental impacts throughout their life cycle (Sumarlin & Nuvriasari, 2024). For MSMEs, green products can improve resource efficiency, reduce waste, strengthen customer trust, and create competitive value that supports long-term business sustainability.

Previous studies support this relationship. Papadas et al. (2019) found that green product innovation contributes to competitive advantage and business performance. Fitriyah et al. (2020) also reported that green product innovation improves business performance through consumer trust, while Sumarlin and Nuvriasari (2024) found that green innovation contributes to MSME competitiveness and sustainability. Therefore, the following hypothesis is proposed:

H_1: Green Product has a positive effect on MSME sustainability

2.5.2 The Effect of Green Price on MSME Sustainability

Green price refers to pricing strategies that incorporate the environmental costs and value associated with environmentally friendly products (Jaiswal & Kant, 2018). Although green products may involve higher production costs, appropriate pricing can communicate their environmental value and support profitability while maintaining environmental responsibility.

Jaiswal and Kant (2018) found that consumers with stronger environmental awareness are more willing to accept premium prices for green products. Rahayu, Setiyawami, Marjuki, Fitriani, Rahmawati, and Anjani (2025) also reported a positive relationship between green pricing and consumer purchasing decisions. Furthermore, Rachmawati, Wijaya, and Pambreni (2023) indicated

that green pricing can support MSME sustainability by balancing economic and environmental considerations. Therefore, the following hypothesis is proposed:

H_2: Green Price has a positive effect on MSME sustainability

2.5.3 The Effect of Green Place on MSME Sustainability
Green place refers to environmentally responsible distribution activities, including sustainable logistics, eco-friendly packaging, efficient transportation, and green supply chain practices (Qorri et al., 2018). Such practices can improve resource efficiency, reduce environmental impacts, and strengthen operational effectiveness.

Empirical studies indicate that green distribution and supply chain practices contribute to sustainability performance. Ahmad et al. (2022) found that green supply chain management improves sustainability performance, while Azam et al. (2022) reported that green supply chain initiatives strengthen sustainable performance. Raza et al. (2021) and Lazar et al. (2021) similarly emphasized the contribution of sustainable supply and logistics practices to operational efficiency and sustainability.

Based on these findings, the following hypothesis is proposed:

H_3: Green Place has a positive effect on MSME sustainability

2.5.4 The Effect of Green Promotion on MSME Sustainability
Green promotion refers to marketing communication that emphasizes environmental responsibility through advertising, public relations, sales promotion, and social media (Papadas et al., 2019). Effective green promotion can increase environmental awareness, strengthen corporate image, and improve customer engagement.

Lestari et al. (2020) found that green promotional activities strengthen green trust and purchase intention. Papadas et al. (2019) also demonstrated that green marketing orientation contributes to firm performance and competitive advantage. In the MSME context, Habibie et al. (2024) showed that environmental communication can support sustainability through improved customer engagement and market positioning. Therefore, the following hypothesis is proposed:

H_4: Green Promotion has a positive effect on MSME sustainability

2.5.5 The Moderating Effect of Digital Marketing on the Relationship between Green Product and MSME Sustainability
Digital marketing can strengthen the value created by green products by enabling MSMEs to communicate environmental attributes, product benefits, and sustainability practices to wider markets. The interaction mechanism suggests that when digital marketing capability is higher, the positive effect of green product practices on sustainability can be more effectively communicated and converted into market value.

Ainin et al. (2015) found that social media adoption improves SME performance, while Chatterjee and Kar (2020) showed that digital technologies strengthen business strategies and organizational outcomes. Nurhadi et al. (2024) further highlighted the role of digitalization in strengthening green marketing practices. Therefore, higher digital marketing capability is expected to strengthen the contribution of green products to MSME sustainability:

H_5: Digital Marketing positively moderates the relationship between Green Product and MSME sustainability

2.5.6 The Moderating Effect of Digital Marketing on the Relationship between Green Price and MSME Sustainability
Digital marketing may influence how effectively MSMEs communicate the environmental value underlying green pricing. Through digital content, social media interaction, and online product

information, businesses can provide customers with greater information about the sustainability benefits associated with their products. Thus, digital marketing may strengthen the extent to which green pricing contributes to business sustainability.

Chatterjee and Kar (2020) found that digital technologies improve firms' ability to communicate and implement business strategies, while Nurhadi et al. (2024) emphasized the role of digitalization in communicating sustainable value. Rachmawati et al. (2023) also indicated that digital marketing can support the implementation of green marketing strategies. Based on this interaction mechanism:

> *H_6:* Digital Marketing positively moderates the relationship between Green Price and MSME sustainability

2.5.7 The Moderating Effect of Digital Marketing on the Relationship between Green Place and MSME Sustainability

Digital marketing can enhance the effectiveness of green place practices by improving communication, accessibility, and information exchange between MSMEs and customers. In particular, digital channels can make information about product availability, environmentally responsible distribution, and sustainable delivery practices more accessible. Consequently, higher digital marketing capability may strengthen the contribution of green place to MSME sustainability.

Chatterjee and Kar (2020) demonstrated that digital transformation improves organizational efficiency and market responsiveness. Nurhadi et al. (2024) also emphasized the role of digitalization in supporting sustainable business practices, while Habibie et al. (2024) highlighted the contribution of digital capabilities to environmentally responsible business activities. Therefore:

> *H_7:* Digital Marketing positively moderates the relationship between Green Place and MSME sustainibility

2.5.8 The Moderating Effect of Digital Marketing on the Relationship between Green Promotion and MSME Sustainability

Digital marketing provides MSMEs with interactive channels to communicate environmental messages, engage customers, and expand the reach of green promotional activities. The interaction mechanism implies that stronger digital marketing capability may increase the effectiveness of green promotion in creating customer engagement and market value, which can contribute to sustainability.

Nurhadi et al. (2024) found that digitalization supports the implementation of green marketing, while Chatterjee and Kar (2020) showed that digital technologies improve communication and customer interaction. Rachmawati et al. (2023) further indicated that digital marketing can strengthen the implementation of green marketing strategies.

Thus, the final hypothesis of this study is formulated as follows:

> *H_8:* Digital Marketing positively moderates the relationship between Green Promotion and MSME sustainability

3. Research Methodology

3.1 Research Design and Object of Study

This study employed a quantitative approach with an explanatory research design. The explanatory design was used to examine the relationships between Green Marketing dimensions and MSME Sustainability and to investigate the moderating role of Digital Marketing. A quantitative approach was considered appropriate because it enables the relationships among the research variables to be empirically examined through statistical analysis.

The object of this study was Micro, Small, and Medium Enterprises (MSMEs) operating in Lhokseumawe City, Aceh Province, Indonesia. The study focused on four dimensions of Green Marketing, namely Green Product, Green Price, Green Place, and Green Promotion, and examined

their relationships with MSME Sustainability. In addition, Digital Marketing was examined as a moderating variable to determine whether the use of digital marketing strengthens the relationships between Green Marketing practices and MSME Sustainability.

3.2 Population and Sample

The population of this study consisted of 2,058 MSMEs in Lhokseumawe City under the supervision of the Department of Industry, Trade, Cooperatives, and Small and Medium Enterprises of Lhokseumawe City. The MSMEs operate across various business sectors, including culinary, production, handicrafts, and other sectors.

Considering the limitations of time, cost, and accessibility, it was not feasible to collect data from the entire population. Therefore, this study employed a non-probability purposive sampling technique. Respondents were selected based on the following criteria: they were MSME owners or managers operating in Lhokseumawe City, and they utilized digital media in conducting their business activities.

The sample size was determined using Slovin's formula with a 10% margin of error, resulting in 96 respondents. The preliminary instrument test was conducted separately using 30 MSME owners or managers and was not included in the 96 respondents used for the main analysis. The characteristics of the 96 respondents included gender, marital status, education level, business type, and business age, as presented in Table 1.

Table 1. Respondent characteristics

Category	Item	Frequency	Percentage (%)
Gender	Male	18	18.4
	Female	78	81.6
Marital Status	Married	58	60.5
	Single	35	36.8
	Widow/Widower	3	2.6
Education	Junior High School	5	5.3
	Senior High School	43	44.7
	Diploma	5	5.3
	Undergraduate	43	44.7
Business Type	Culinary	71	73.7
	Agriculture	5	5.3
	Clothing	8	7.9
	Souvenir	8	7.9
	Cosmetics	2	2.6
	Service	2	2.6
Business Age	< 1 year	10	10.5
	1–3 years	45	47.4
	4–6 years	20	21.1
	7–9 years	3	2.6
	10–12 years	10	10.5
	>12 years	8	7.9

3.3 Operational Definition of Variables

The operationalization of variables was conducted to translate the conceptual constructs into measurable indicators. The variables examined in this study were adapted from previous studies related to Green Marketing, Digital Marketing, and MSME Sustainability. Each construct was measured using indicators relevant to its respective conceptual definition. The operational definitions, indicators, and measurement scales are presented in Table 2.

Table 2. Operational Definition of Variables

Variables	Definition	Indicators	Scale
Green Product (X_1)	Environmentally friendly products designed to minimize environmental impacts throughout their lifecycle (Mishra & Sharma, 2014).	Environmental certification; Sustainable raw materials; Energy efficiency; Waste reduction; Safe chemical usage	Likert
Green Price (X_2)	Pricing strategy that reflects environmental value and sustainability considerations (Jaiswal & Kant, 2018).	Price of green products; Perceived value; Perceived environmental costs	Likert
Green Place (X_3)	Environmentally responsible distribution and logistics practices (Qorri et al., 2018).	Distribution channels; Recyclable packaging; Product availability; Energy-saving distribution; Eco-friendly retail outlets	Likert
Green Promotion (X_4)	Marketing communication emphasizing environmental responsibility and sustainability (Hashem & Al-Rifai, 2011).	Customer communication; Green campaigns; Environmental incentives	Likert
Digital Marketing (Z)	Marketing activities utilizing internet-based technologies and digital platforms (Young Kim & Kim, 2004).	Coordination; Commerce; Community; Content; Communication	Likert
MSME Sustainability (Y)	The ability of MSMEs to maintain and develop business performance over time (Indriati et al., 2025).	Business planning; Business plan updates; Competitor analysis; New business opportunities; Calculated risk-taking	Likert

3.4 Data Collection Method

This study used primary data collected through structured questionnaires distributed to MSME owners or managers in Lhokseumawe City. Before the main questionnaire was administered, a preliminary instrument test involving 30 MSME owners or managers was conducted separately from the main sample. The preliminary test was intended to assess the validity and reliability of the questionnaire items before the main data collection. In addition to the questionnaire, interviews were conducted prior to questionnaire distribution to help ensure that the respondents understood the purpose and content of the research instrument. Secondary information was obtained from government publications, academic journals, books, and other relevant sources related to Green Marketing, Digital Marketing, and MSME Sustainability. The main survey resulted in 96 usable responses, which were subsequently analyzed using PLS-SEM.

3.5 Measurement Scale

All research indicators were measured using a five-point Likert scale ranging from 1 to 5, where 1 represented Strongly Disagree and 5 represented Strongly Agree. The five-point Likert scale was used to capture respondents' perceptions regarding the implementation of Green Marketing practices, Digital Marketing activities, and MSME Sustainability.

3.6 Data Analysis Technique

The data were analyzed using Structural Equation Modeling based on the Partial Least Squares approach (PLS-SEM). The analysis was performed using SmartPLS version 4.0. PLS-SEM was

selected because the research model involves several latent constructs and includes a moderating relationship. The method also enables the simultaneous assessment of the measurement model and structural model (Hair et al., 2021). The data analysis consisted of three main stages: measurement model evaluation, structural model evaluation, and hypothesis testing.

3.6.1 Measurement Model Evaluation (Outer Model)
The measurement model was assessed for convergent validity, discriminant validity, and reliability. Convergent validity was evaluated using outer loadings and Average Variance Extracted (AVE), with acceptable values of ≥0.70 and >0.50, respectively. Discriminant validity was assessed using the Fornell-Larcker criterion and cross-loadings, while reliability was evaluated using Cronbach Alpha and Composite Reliability (CR), with values >0.70 considered acceptable. A preliminary Pearson Product-Moment validity test was also conducted using 30 respondents separately from the main sample of 96 respondents.

3.6.2 Structural Model Evaluation (Inner Model)
The structural model was evaluated using the coefficient of determination (R^2) to assess the explanatory power of the model. The model was then used to examine the direct and moderating relationships among the research variables.

3.6.3 Hypotheses Testing
Hypotheses testing was performed using bootstrapping in SmartPLS 4.0. The relationships were evaluated based on path coefficients, t-statistics, and p-values, with t >1.96 and p <0.05 indicating statistical significance. The moderating effect of Digital Marketing was tested through interaction terms between Digital Marketing and Green Product, Green Price, Green Place, and Green Promotion. A significant interaction indicates that Digital Marketing changes the strength or direction of the relationship between the respective Green Marketing dimension and MSME Sustainability.

4. Results and Discussions
This section presents the results of data analysis and discussion regarding the effect of Green Product, Green Price, Green Place, and Green Promotion on MSME Sustainability, with Digital Marketing as a moderating variable. The analysis was conducted using Structural Equation Modeling (SEM) based on Partial Least Squares (PLS) using SmartPLS 4.0. The analysis consisted of preliminary instrument screening, descriptive analysis, measurement model evaluation, and structural model assessment.

4.1 Instrument Validity and Reliability Test
Before the main data analysis, the research instrument was subjected to preliminary validity and reliability testing using data collected from 30 MSME managers. This preliminary screening was conducted to ensure that the questionnaire items were appropriate for measuring the intended constructs before the questionnaire was administered to the main respondents.

4.1.1 Instrument Validity Test
The preliminary validity test was conducted using Pearson Product Moment correlation analysis. An item is considered valid when the calculated correlation coefficient (r-count) exceeds the critical value (r-table). With 30 preliminary respondents, the r-table value at the 5% significance level was 0.361. As shown in Table 3, all questionnaire items obtained r-count values greater than 0.361. Therefore, all items were considered valid and suitable for use in the main data collection.

Table 3. Instrument validity test results

Variables	Item	r-count	r-table	Remark
MSME Sustainability	Y1	0.774	0.361	Valid
	Y2	0.945	0.361	Valid
	Y3	0.926	0.361	Valid
	Y4	0.926	0.361	Valid
	Y5	0.876	0.361	Valid

Variables	Item	r-count	r-table	Remark
Green Product	X11	0.846	0.361	Valid
	X12	0.871	0.361	Valid
	X13	0.924	0.361	Valid
	X14	0.637	0.361	Valid
	X15	0.773	0.361	Valid
Green Price	X21	0.976	0.361	Valid
	X22	0.934	0.361	Valid
	X23	0.842	0.361	Valid
Green Place	X31	0.864	0.361	Valid
	X32	0.884	0.361	Valid
	X33	0.896	0.361	Valid
	X34	0.745	0.361	Valid
	X35	0.662	0.361	Valid
Green Promotion	X41	0.733	0.361	Valid
	X42	0.628	0.361	Valid
	X43	0.753	0.361	Valid
Digital Marketing	Z1	0.734	0.361	Valid
	Z2	0.739	0.361	Valid
	Z3	0.932	0.361	Valid
	Z4	0.925	0.361	Valid
	Z5	0.841	0.361	Valid

Table 3 shows that all questionnaire items have r-count values greater than the r-table value of 0.361. Therefore, all indicators were declared valid and retained for the main survey.

4.1.2 Instrument Reliability Test

Reliability testing was conducted using Cronbach Alpha. The reliability results for each construct are presented in Table 4. A Cronbach Alpha value above 0.70 indicates satisfactory internal consistency of the measurement items.

Table 4. Cronbach's alpha values

Variables	Cronbach Alpha	Threshold	Remark
MSME Sustainability	0.935	0.70	Reliable
Green Product	0.743	0.70	Reliable
Green Price	0.885	0.70	Reliable
Green Place	0.863	0.70	Reliable
Green Promotion	0.726	0.70	Reliable
Digital Marketing	0.844	0.70	Reliable

Based on Table 4 , all constructs obtained Cronbach Alpha values above 0.70. These results indicate satisfactory internal consistency and support the use of the questionnaire in the main research.

4.2 Descriptive Analysis of Respondents' Responses

A total of 96 responses were obtained for the main study, and all 96 responses were complete and usable for further analysis. Therefore, no responses were excluded from the main dataset. The descriptive statistics of the research variables are presented in Table 5.

Table 5. Descriptive statistics of research variables

Variable	Indicator	Mean	Category
MSME Sustainability	Compilation of business plan	3.948	High
	Regular updating of business plan	4.104	High
	Regular analysis of competitor	4.156	High
	Ease of venturing into a new business	3.990	High
	Not a problem to take calculated risk	4.167	High
Green Product	Environmental certification	3.859	High
	Sustainable raw materials	3.980	High
	Energy efficiency	3.929	High
	Waste reduction	3.970	High
	Use of safe chemicals	3.970	High
Green Price	The price of a green product	3.812	High
	Perceived value of a green product	3.802	High
	Perceptions of environmental costs	3.708	High
Green Place	Distribution channel	4.094	High
	Recycled packaging	4.115	High
	Widely available	4.125	High
	Energy saving	4.062	High
	Eco-friendly supermarkets	4.146	High
Green Promotion	Good communication with customers	3.698	High
	Green product campaign	3.708	High
	Incentives to greenery	3.729	High
Digital Marketing	Coordination	3.802	High
	Commerce	3.854	High
	Community	3.833	High
	Content	3.875	High
	Communications	3.896	High

Based on Table 5, all indicators are categorized as high. Green Place records the highest average scores, while Green Promotion shows the lowest average scores among the variables. These descriptive findings indicate relatively high respondent perceptions across the measured dimensions of green marketing, Digital Marketing, and MSME Sustainability.

4.3 Measurement Model Analysis (Outer Model)

4.3.1 Convergent Validity Test

The measurement model was evaluated to assess convergent validity by examining the outer loadings of each indicator. In PLS-SEM, indicator loadings of approximately 0.70 or higher are generally considered adequate, while AVE values above 0.50 indicate that a construct explains more than half of the variance of its indicators (Hair et al., 2021). The complete measurement model generated using SmartPLS is presented in Figure 2.

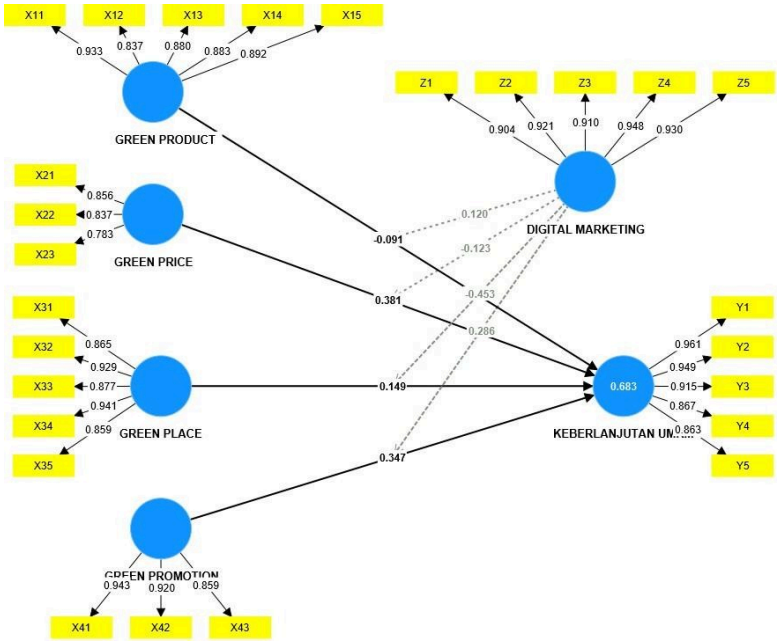


Figure 2. Measurement model with loading factors

The loading factor values obtained from the convergent validity assessment are presented in Table 6.

Table 6. Loading factor values

Indicator	Loading Factor	Remark
X11	0.933	Valid
X12	0.837	Valid
X13	0.880	Valid
X14	0.883	Valid
X15	0.892	Valid
X21	0.856	Valid
X22	0.837	Valid
X23	0.783	Valid
X31	0.865	Valid
X32	0.929	Valid
X33	0.877	Valid
X34	0.941	Valid
X35	0.859	Valid
X41	0.943	Valid
X42	0.920	Valid
X43	0.859	Valid
Y1	0.961	Valid
Y2	0.949	Valid
Y3	0.915	Valid
Y4	0.867	Valid
Y5	0.863	Valid
Z1	0.904	Valid
Z2	0.921	Valid
Z3	0.910	Valid
Z4	0.948	Valid

Indicator	Loading Factor	Remark
Z5	0.930	Valid

All loading factor values exceed 0.70, ranging from 0.783 to 0.961. This indicates adequate indicator reliability and convergent validity. No indicator required removal based on the reported loading values.

The results of construct reliability and convergent validity are summarized in Table 7.

Table 7. AVE, composite reliability, and cronbach's alpha

Variables	Cronbach Alpha	Composite Reliability	AVE
Digital Marketing	0.957	0.966	0.852
Green Place	0.938	0.952	0.801
Green Price	0.774	0.866	0.682
Green Product	0.931	0.948	0.784
Green Promotion	0.895	0.934	0.825
MSME Sustainability	0.949	0.961	0.831

All constructs have Cronbach Alpha and Composite Reliability values above 0.70, while all AVE values exceed 0.50. Thus, the constructs demonstrate satisfactory internal consistency and convergent validity (Hair et al., 2021).

4.3.2 Discriminant Validity Test

The discriminant validity assessment was primarily evaluated using the Heterotrait-Monotrait Ratio (HTMT). As presented in Table 8, all HTMT values are below the 0.90 threshold, indicating adequate discriminant validity among the constructs.

Table 8. HTMT values

Variables	DM	GPla	GPri	GPro	GProm	MSME
Green Place	0.411					
Green Price	0.272	0.228				
Green Product	0.316	0.318	0.765			
Green Promotion	0.392	0.867	0.406	0.367		
MSME Sustainability	0.587	0.594	0.614	0.558	0.677	

The HTMT values range from 0.228 to 0.867. All values remain below the 0.90 criterion, indicating acceptable discriminant validity. The highest HTMT value is observed between Green Place and Green Promotion (0.867), which remains below the more liberal threshold of 0.90. Therefore, the HTMT results provide sufficient evidence that the constructs are empirically distinguishable. The discriminant validity assessment based on the Fornell-Larcker criterion is presented in Table 9.

Table 9. Fornell-Larcker Criterion

Variable	DM	GPla	GPri	GPro	GProm	MSME
Digital Marketing	0.923					
Green Place	0.404	0.895				
Green Price	0.246	0.207	0.826			
Green Product	0.299	0.301	0.918	0.885		
Green Promotion	0.376	0.891	0.351	0.342	0.908	
MSME Sustainability	0.576	0.581	0.555	0.538	0.649	0.912

The Fornell-Larcker criterion is presented as a supplementary assessment. The diagonal values represent the square root of AVE for each construct. Most inter-construct correlations are lower than the corresponding diagonal values. However, the correlation between Green Price and Green Product

(0.918) exceeds the diagonal values of Green Price (0.826) and Green Product (0.885). Therefore, the Fornell-Larcker criterion is not fully satisfied based on the values reported in Table 9.

Accordingly, discriminant validity is assessed primarily using the HTMT results in Table 8, which provide stronger evidence for discriminant validity in PLS-SEM. This approach is consistent with methodological recommendations that identify HTMT as a more sensitive measure than the Fornell-Larcker criterion (Hair et al., 2021).

4.4 Structural Model Analysis (Inner Model)

4.4.1 Coefficient of Determination (R-Square)

The coefficient of determination (R^2) values for the endogenous construct are presented in Table 10.

Table 10. R-Square Values

Variable	R-Square	R-Square Adjusted
MSME Sustainability	0.683	0.650

The R-square value of 0.683 indicates that 68.3% of the variance in MSME Sustainability is explained by the predictors included in the structural model, while the remaining 31.7% is explained by factors outside the model.

4.4.2 Direct and Moderating Effect Analysis

The structural model was evaluated using the bootstrapping procedure to examine the significance of the hypothesized relationships and moderating effects. The analysis used 5,000 bootstrap subsamples. The bootstrapping results are illustrated in Figure 3.

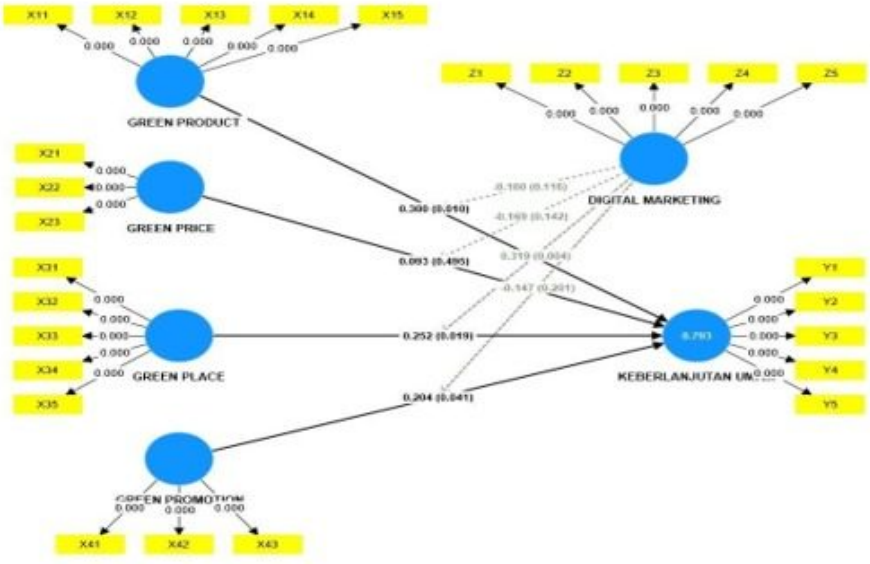


Figure 3. Bootstrapping result

The results of the structural model analysis are presented in Table 11.

Table 11. Path Coefficients Results

Path	β	T-Statistic	P-Value	Result
Green Place → MSME Sustainability	0.252	2.340	0.019	Supported
Green Price → MSME Sustainability	0.093	0.683	0.495	Not Supported
Green Product → MSME Sustainability	0.300	2.579	0.010	Supported
Green Promotion → MSME Sustainability	0.204	2.047	0.041	Supported

Path	β	T-Statistic	P-Value	Result
DM × Green Place → MSME Sustainability	0.319	2.862	0.004	Supported
DM × Green Price → MSME Sustainability	-0.169	1.467	0.142	Not Supported
DM × Green Promotion → MSME Sustainability	-0.147	1.279	0.201	Not Supported
DM × Green Product → MSME Sustainability	-0.160	1.573	0.116	Not Supported

Based on Table 11, Green Product, Green Place, and Green Promotion have positive and statistically significant effects on MSME Sustainability, with Green Product showing the largest coefficient (β = 0.300; p = 0.010). Green Price does not show a statistically significant effect (β = 0.093; p = 0.495).

For the moderating effects, Digital Marketing significantly moderates the relationship between Green Place and MSME Sustainability (β = 0.319; p = 0.004). The interaction effects of Digital Marketing with Green Price, Green Promotion, and Green Product are not statistically significant (p > 0.05). Thus, the moderating effect of Digital Marketing is observed selectively in the Green Place–MSME Sustainability relationship.

4.5 Hypotheses Testing Results

The summary of the hypothesis testing results is presented in Table 12.

Table 12. Hypotheses testing results

Hypotheses	β	P-Value	Decision
Green Place → MSME Sustainability	0.252	0.019	Accepted
Green Price → MSME Sustainability	0.093	0.495	Rejected
Green Product → MSME Sustainability	0.300	0.010	Accepted
Green Promotion → MSME Sustainability	0.204	0.041	Accepted
Digital Marketing moderates Green Place → MSME Sustainability	0.319	0.004	Accepted
Digital Marketing moderates Green Price → MSME Sustainability	-0.169	0.142	Rejected
Digital Marketing moderates Green Promotion → MSME Sustainability	-0.147	0.201	Rejected
Digital Marketing moderates Green Product → MSME Sustainability	-0.160	0.116	Rejected

The hypotheses testing results show that three direct effects, namely Green Product, Green Place, and Green Promotion, are statistically significant, whereas Green Price is not statistically supported. Among the moderating relationships, only the interaction between Digital Marketing and Green Place is statistically significant. This selective moderation represents the main moderating finding of the study and indicates that the role of Digital Marketing differs across the dimensions of green marketing.

4.6 Discussion

The findings show that Green Product, Green Place, and Green Promotion significantly contribute to MSME Sustainability, whereas Green Price does not show a significant relationship. The positive effects of Green Product and Green Promotion are consistent with (Papadas et al., 2019), Fitriyah et al. (2020), and Sumarlin and Nuvriasari (2024), who emphasized the contribution of green product innovation and green marketing orientation to business performance and sustainability. The significant effect of Green Place is also in line with Ahmad et al. (2022) and Azam et al. (2022), who found that environmentally responsible supply chain and distribution practices support sustainability performance. These findings indicate that

product, distribution, and communication dimensions of green marketing are relevant to MSME Sustainability.

In contrast, Green Price does not show a significant effect on MSME Sustainability. This result differs from Jaiswal and Kant (2018), Rahayu et al. (2025), and Rachmawati et al. (2023), who reported positive relationships between green pricing and consumer or sustainability-related outcomes. The difference may be associated with the outcome examined, as those studies primarily considered consumer responses or purchasing decisions, whereas the present study focuses on MSME Sustainability. Thus, the current finding does not suggest that green pricing is unimportant, but indicates that its direct contribution to MSME Sustainability is not statistically supported in the studied context.

The most notable finding concerns the moderating role of Digital Marketing. Digital Marketing significantly strengthens the relationship between Green Place and MSME Sustainability, while its interactions with Green Product, Green Price, and Green Promotion are not significant. This finding extends the studies of Ainin et al. (2015), Chatterjee and Kar (2020), and Nurhadi et al. (2024), which generally highlight the contribution of digitalization to SME performance and green marketing. The present result provides a more specific perspective by showing that the contribution of Digital Marketing is selective rather than universal. Its significant moderating role emerges specifically in the Green Place relationship, where digital channels can support accessibility and communication related to distribution practices.

This selective moderation represents the key insight of the study. Rather than assuming that Digital Marketing strengthens all green marketing dimensions, the findings indicate that its contribution depends on the specific dimension with which it interacts. The significant Green Place × Digital Marketing relationship suggests that integrating digital capabilities with environmentally responsible distribution practices may provide greater relevance for MSME Sustainability. Meanwhile, the nonsignificant moderation effects for Green Product, Green Price, and Green Promotion indicate that there is insufficient statistical evidence that Digital Marketing changes these relationships. This finding provides a more nuanced understanding of the relationship between green marketing, digitalization, and MSME Sustainability.

5. Conclusions

5.1 Conclusion

This study confirms that Green Product, Green Place, and Green Promotion contribute positively to MSME Sustainability, while Green Price does not show a statistically significant relationship. The main contribution of this study is the selective moderating role of Digital Marketing. Digital Marketing significantly strengthens the relationship between Green Place and MSME Sustainability, but does not significantly moderate the relationships involving Green Product, Green Price, or Green Promotion. This finding indicates that the contribution of Digital Marketing is context-specific rather than universal across green marketing dimensions.

5.2 Research Limitations

This study has several limitations. First, the study involved only 96 MSMEs in Lhokseumawe, which may limit the generalizability of the findings to MSMEs in other regions. Second, the cross-sectional design captures green marketing and digital marketing practices at a single point in time, limiting the examination of changes in MSME sustainability over time. Third, the model focuses on Green Product, Green Price, Green Place, Green Promotion, and Digital Marketing, while other factors may also contribute to MSME sustainability. Finally, the use of self-reported questionnaire data may involve differences in respondents' perceptions.

5.3 Suggestions and Directions for Future Research

Future research could employ larger and geographically diverse samples, adopt longitudinal research designs to examine changes in MSME sustainability over time, and incorporate additional variables such as green innovation, environmental awareness, government support, and entrepreneurial

orientation to provide a more comprehensive understanding of the factors influencing MSME sustainability.

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Author Contributions
SB contributed to the conceptualization, research design, data collection, data analysis, interpretation, and manuscript preparation. YA contributed to the methodology, validation, and manuscript review. YY contributed to data collection, data curation, and literature review. GS contributed to supervision, critical revision, and validation of the findings. All authors approved the final version of the manuscript.

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