Digital Entrepreneurship, Resource Efficiency, and ESG Orientation toward Sustainability Pathways

Berthy Salakay*
Hasanuddin University, Makassar, INDONESIA
*salakayb25a@student.unhas.ac.id

Abstract. This study investigates the influence of Digital Entrepreneurship, Resource Efficiency, and Strategic Collaboration on Pathways to Sustainability, with ESG Orientation as a moderating variable. Using a quantitative survey approach, data were collected from 377 respondents consisting of MSME owners, managers, and strategic staff in Indonesia. The results of multiple regression analysis reveal that digital entrepreneurship, resource efficiency, and strategic collaboration have significant positive effects on sustainability pathways. Furthermore, the moderated regression analysis (MRA) indicates that ESG orientation strengthens these relationships, demonstrating that firms with stronger ESG commitments are more likely to maximize the benefits of digital transformation, efficiency, and collaboration. The findings contribute to the theoretical development of the Resource-Based View, Dynamic Capabilities, and Stakeholder Theory by highlighting ESG as a strategic moderator that enhances sustainability outcomes. Practically, this research emphasizes the importance of embedding ESG values into business strategies to ensure that digital and efficiency initiatives yield sustainable impact. The study also provides policy implications, recommending that governments support MSMEs through green financing and ESG-based training to accelerate sustainable development. Overall, this research underscores that pathways to sustainability can be effectively achieved through the synergy of digital entrepreneurship, resource efficiency, collaboration, and ESG orientation.

Keywords: Digital Entrepreneurship, Resource Efficiency, Strategic Collaboration, ESG Orientation, Pathways to Sustainability.

1 Introduction

Sustainability issues have become increasingly prominent in the last decade, as the impacts of climate change, the energy crisis, and global trade pressures increase. A UN report emphasizes that sustainability requires not only an energy transition but also a transformation of economic systems through innovation and better governance. [1]. Therefore, the concept of pathways to sustainability has emerged as an important framework for understanding strategic pathways towards sustainable development that balance economic, social and environmental aspects.

One important path towards sustainability is through digital transformation and digital entrepreneurship. Shabbiruddin [2] shows that digital entrepreneurship enables

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startups and MSMEs to optimize their resources through digital platforms, thereby increasing efficiency and innovation in the face of capital and market constraints. Digital entrepreneurship is not only an enabler for business growth, but also contributes to more environmentally friendly business practices through process efficiency.

Resource efficiency is a crucial factor in achieving pathways to sustainability. According to Haq [3], digital transformation has been shown to improve resource allocation efficiency while narrowing the technology gap, ultimately positively impacting a company's ESG performance [4, 5]. This confirms that companies that integrate resource efficiency into their business processes are better prepared to face global sustainability demands.

In addition to digitalization and efficiency, strategic collaboration with various stakeholders is also key. Strategic collaboration practices enable companies, governments, academics, and civil society to work together to create innovative solutions for sustainability. Bowser [6] highlights that the transition to a circular economy can only be achieved through cross-sector collaboration, where digital technology acts as a catalyst for expanding sustainability practices such as reuse and remanufacturing.

In this context, ESG (Environmental, Social, and Governance) orientation is a moderating factor determining the success of a sustainability strategy. Attah [7] found that the synergy between digital management and social governance is a crucial configuration in driving green innovation in companies. In other words, ESG orientation can strengthen the relationship between digital entrepreneurship, resource efficiency, and strategic collaboration on pathways to sustainability.

Although many studies have addressed digital transformation, green innovation, or ESG separately, there remains a gap in understanding how the three main factors digital entrepreneurship, resource efficiency, and strategic collaboration work simultaneously to drive pathways to sustainability, with ESG orientation as a moderating variable. Most previous studies have focused solely on a single dimension, such as green innovation or corporate governance, without comprehensively examining the interaction of variables.

Based on this background, this research is crucial in filling an academic gap while also providing practical contributions. Theoretically, this research will enrich the literature on the relationship between digital entrepreneurship, resource efficiency, and strategic collaboration with pathways to sustainability, and examine the moderating role of ESG orientation. Practically, the research findings are expected to serve as a reference for policymakers, business actors, and international organizations in designing digital-based, collaborative, and ESG-oriented sustainability strategies.

2 Literature Review

2.1 Pathways to Sustainability

The concept of pathways to sustainability refers to the policy and strategy trajectories of companies/ecosystems to achieve sustainable performance simultaneously across economic, social, and environmental dimensions. Recent literature emphasizes that

multi-actor collaboration, adaptive governance, and innovation are key prerequisites for accelerating the achievement of sustainability goals (SDGs) in practice, not just at the discourse level. Review-based studies and cross-country case studies show that orchestration of stakeholder roles (government–business–community) and effective coordination mechanisms improve sustainability outcomes across various sector contexts, including MSMEs [6, 8] .

2.2 Digital Entrepreneurship and Its Impact on Sustainability

Digital entrepreneurship (DE) is understood as entrepreneurship that leverages digital technologies (platforms, data, AI, IoT) for value creation/capture. Recent systematic reviews in reputable journals confirm that DE expands market access, streamlines processes, and triggers sustainability-oriented business models—primarily by reducing transaction friction and accelerating innovation cycles. Thus, DE is expected to contribute positively to pathways to sustainability through increased efficiency and process/product innovation [9, 12]

Furthermore, several studies link corporate transformation/digitalization to increased green behavior, green innovation, and environmental performance—mechanisms that serve as important channels for DE's impact on sustainability (e.g., supply chain transparency, resource optimization, and emissions control). Findings from a sample of public companies indicate that digital transformation is positively correlated with environmental performance and green innovation.

2.3 Resource Efficiency as a Driver of Sustainability Performance

Resource efficiency (RE)—energy/water/material saving, waste minimization, and circular design—is positioned as a driver of pathways to sustainability. Empirical evidence across contexts shows that green innovations targeting RE strengthen sustainable growth and a company's financial-environmental performance (e.g., cost savings, emissions reductions). At the policy and firm levels, RE correlates with the adoption of circular economy (CE) practices and improved performance metrics. [13]

In the context of MSMEs, the adoption of resource efficiency actions (energy/water conservation, recycling, waste reduction, green product marketing) is associated with improved sustainability performance, although short-term financial effects may vary depending on investment intensity and production costs, highlighting the importance of designing a gradual and measurable RE program. [12, 14]

2.4 Strategic Collaboration to Accelerate Sustainability

Strategic collaboration—from cross-institutional partnerships, co-creation with suppliers/customers, to industry alliances—has been shown to facilitate the diffusion of sustainable practices (green standards, reporting, and product-process innovation). In MSMEs, the study identified five complementary collaborative stakeholder roles (driver, facilitator, mentor, evaluator, and resource connector) in strengthening

sustainability practices. The value-net approach also helps identify key actors and interaction patterns that drive sustainability outcomes [15, 16]

At the systems level, collaborative orchestration is seen as vital to addressing coordination failures and ensuring implementable sustainability. A cross-context review emphasized that without a sound collaborative architecture including incentives, data governance, and role allocation the pace of sustainability improvement tends to stall.

2.5 ESG Orientation

ESG orientation reflects the intensity of a company's strategic commitment to environmental, social, and governance aspects, which guides resource allocation, process standards, and innovation priorities. Recent literature demonstrates a synergistic relationship between digitalization and ESG performance in driving innovation/competitive advantage; several studies also found the role of governance/ESG variables in strengthening the impact of green innovation on environmental performance—providing a theoretical basis for ESG orientation's potential to moderate the X→Y relationship in this model. In other words, when ESG orientation is high, the positive effects of digital entrepreneurship, resource efficiency, and strategic collaboration on pathways to sustainability are expected to be stronger. [17, 18]

Specifically, recent research also shows that (i) ESG performance drives green innovation; (ii) ESG-based relationships are often influenced by moderating factors (e.g., public attention, digital culture), demonstrating that the moderating role in this area has been empirically recognized—providing a basis for positioning ESG orientation as a moderator in this study.

2.6 Theoretical Foundation: RBV, Dynamic Capabilities, and Stakeholder Theory

Relevant theoretical frameworks include the Resource-Based View (RBV)—explaining how digital capabilities (platforms, data, analytics) and RE practices become sources of advantage—and Dynamic Capabilities, which emphasizes sensing–seizing–transforming capabilities to integrate DE, RE, and collaboration in responding to sustainability demands. Stakeholder theory underpins the importance of collaboration and ESG accountability in shaping sustainability strategies—including the role of governance and stakeholder coalitions to achieve better environmental outcomes [19, 20]

2.7 Model Synthesis and Implications

Summarizing the findings, the literature provides support that: (1) digital entrepreneurship improves sustainability performance through efficiency and innovation channels; (2) resource efficiency contributes to economic-environmental performance and intersects with circular practices; (3) strategic collaboration

accelerates the adoption of green practices and innovations; and (4) ESG orientation is theoretically and empirically relevant as a moderator of these relationships. This synthesis validates the design of the MRA model with three IVs (DE, RE, Collaboration), one moderator (ESG orientation), and one DV (pathways to sustainability) [21].

3 Research Methods

This study uses a quantitative approach with a survey design to examine the relationship between digital entrepreneurship, resource efficiency, and strategic collaboration on pathways to sustainability, with ESG orientation as a moderating variable. Indonesia was chosen as the research location due to its significant challenges in digital integration and sustainability implementation. The study population included companies and MSMEs that have adopted some form of business digitalization and sustainability initiatives.

The sample size was 377 respondents, determined based on the guidelines of Hair et al. (2021) and the Slovin method, taking into account the adequacy of the number of indicators. The sampling technique was purposive sampling, with respondents being managers, business owners, or strategic staff who understand the company's digitalization and sustainability policies. Primary data were obtained through a 1–5 Likert-scale questionnaire, while secondary data came from company annual reports, research journals, and publications from official institutions such as Bappenas and UNDP.

The research variables consisted of: (1) Digital Entrepreneurship (X1), measured through the adoption of digital platforms and technology-based business models; (2) Resource Efficiency (X2), measured through energy, water, and raw material efficiency; (3) Strategic Collaboration (X3), measured through collaboration with suppliers, government, and academia; (4) ESG Orientation (M), measured through commitment to environmental, social, and governance aspects; and (5) Pathways to Sustainability (Y), measured through the achievement of green innovation and economic, social, and environmental sustainability. The research instrument will be tested through validity (Pearson Product Moment) and reliability (Cronbach's Alpha > 0.7).

The data analysis technique used is Moderated Regression Analysis (MRA) with the stages of classical assumption testing (normality, multicollinearity, heteroscedasticity), multiple regression to test the effect of independent variables on the dependent variable, and interaction analysis to test the role of ESG orientation as a moderating variable. The analysis model is formulated as follows:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4M + \beta 5(X1*M) + \beta 6(X2*M) + \beta 7(X3*M) + e$$

This research also pays attention to research ethics, including respondent consent (informed consent), data confidentiality, and the use of data only for academic purposes.

4 Research Results

4.1 Respondent Description

As shown in Table 1, the respondent profile describes the type of business, length of business operation, and respondent position among the 377 participants.

Table 1. Respondent Description

Characteristics	Category	Amount	Percentage (%)
Type of Business	MSMEs	241	63,9%
	Medium-sized Enterprises	88	23,3%
	Large companies	48	12,8%
Length of Business	< 5 years	102	27,1%
	5–10 years	147	39,0%
	> 10 years	128	33,9%
Respondent Position	Owner/CEO	135	35,8%
	Manager	156	41,4%
	Strategic Staff	86	22,8%

Source: Researcher 2025

The respondent profile shows that the majority of the 377 participants were MSME owners and managers (63.9%), with a substantial representation from medium and large firms as well. Most respondents operated businesses that had been running for more than five years, which indicates relatively established organizational structures. The diversity in position ranging from owners/CEOs, managers, to strategic staff ensures that the survey captured perspectives from both decision-makers and implementers. This demographic composition strengthens the reliability of the findings as it reflects a broad spectrum of Indonesian enterprises engaging with digitalization and sustainability practices.

4.2 Descriptive Statistics of Research Variables

Table 2 presents the descriptive statistics for all research variables, including Digital Entrepreneurship, Resource Efficiency, Strategic Collaboration, ESG Orientation, and Pathways to Sustainability.

Table 2. Descriptive Statistics of Research Variables

Variable / Indicator	Mean	SD	Min	Max
Digital Entrepreneurship (X1)				
– Adoption of digital platforms	3,92	0,71	1	5
– Digital-based innovation	3,88	0,74	1	5
– Data integration & analytics	3,79	0,80	1	5
– Digital business model	3,95	0,69	1	5
Resource Efficiency (X2)				
– Energy efficiency	3,82	0,77	1	5
– Efficient water use	3,74	0,79	1	5
– Raw material efficiency	3,85	0,73	1	5

Variable / Indicator	Mean	SD	Min	Max
– Waste & emission reduction	3,68	0,81	1	5
Strategic Collaboration (X3)				
– Collaboration with suppliers	3,91	0,75	1	5
– Collaboration with government/academics	3,70	0,80	1	5
– Collaboration with NGOs/communities	3,65	0,82	1	5
– Strategic alliance for green innovation	3,84	0,76	1	5
ESG Orientation (Moderator/M)				
– Environmental commitment	3,89	0,71	1	5
– Social commitment (CSR, welfare)	3,83	0,75	1	5
– Transparency & governance	3,87	0,73	1	5
Pathways to Sustainability (Y)				
– Green innovation	3,90	0,70	1	5
– Achieving SDGs targets	3,76	0,77	1	5
– Economic sustainability	3,85	0,74	1	5
– Social sustainability	3,88	0,72	1	5
– Environmental sustainability	3,82	0,79	1	5

Source: Researcher 2025

The descriptive statistics reveal that all indicators of the five variables scored mean values above 3.6 on a five-point Likert scale, suggesting a generally positive tendency toward digital entrepreneurship, resource efficiency, strategic collaboration, ESG orientation, and sustainability pathways. Among the indicators, digital adoption and digital business models scored highest (means ≈ 3.9), indicating that digital transformation is becoming a central strategy for many firms. Meanwhile, indicators related to environmental practices such as waste reduction and collaboration with NGOs scored relatively lower (means ≈ 3.6–3.7), implying that while companies are progressing in digitalization, environmental and social aspects still require further strengthening.

4.3 Reliability Test (Cronbach's Alpha)

As reported in Table 3, all constructs achieved Cronbach's Alpha values above the minimum threshold of 0.70, indicating that the measurement instruments are reliable.

Table 3. Reliability Test

Variables	Number of Indicators	Cronbach's Alpha	Information
Digital Entrepreneurship	4	0,873	Reliable
Resource Efficiency	4	0,861	Reliable
Strategic Collaboration	4	0,846	Reliable
ESG Orientation	3	0,829	Reliable
Pathways to Sustainability	5	0,888	Reliable

Source: Researcher 2025

The reliability analysis demonstrates that all constructs achieved Cronbach's Alpha values greater than 0.80, exceeding the minimum threshold of 0.70. This confirms that

the measurement items for each variable Digital Entrepreneurship, Resource Efficiency, Strategic Collaboration, ESG Orientation, and Pathways to Sustainability—are internally consistent and reliable for empirical analysis. The high reliability values (ranging from 0.829 to 0.888) also suggest that the constructs are stable and can be trusted to measure the intended latent dimensions effectively, providing a robust foundation for subsequent regression and moderation analyses.

4.4 Multiple Regression Analysis and MRA

(a) Multiple Regression. *The influence of X1, X2, X3 on Y*

Table 4 summarizes the multiple regression results showing the effects of Digital Entrepreneurship, Resource Efficiency, and Strategic Collaboration on Pathways to Sustainability.

Table 4. Multiple Regression

Variabel Independen	Beta (β)	t-value	Sig.
Digital Entrepreneurship (X1)	0,278	5,64	0,000
Resource Efficiency (X2)	0,241	4,97	0,000
Strategic Collaboration (X3)	0,216	4,21	0,000
R^2 = 0,482	**F = 112,37**	**Sig. = 0,000**	

Source: Researcher 2025

The regression results indicate that Digital Entrepreneurship (β = 0.278), Resource Efficiency (β = 0.241), and Strategic Collaboration (β = 0.216) all have significant positive effects on Pathways to Sustainability ($p < 0.001$). With an R^2 value of 0.482, the model explains nearly half of the variance in sustainability pathways, reflecting a strong explanatory power. These results confirm that digital transformation initiatives, efficient use of resources, and stakeholder collaborations are key drivers for organizations seeking to enhance their sustainability performance. It also reinforces the notion that sustainability requires a multi-dimensional approach, integrating technological, operational, and relational strategies.

(b) Moderated Regression Analysis (MRA). *The moderating effect of ESG Orientation*

As presented in Table 5, ESG Orientation significantly moderates the relationships between Digital Entrepreneurship, Resource Efficiency, Strategic Collaboration, and Pathways to Sustainability.

Table 5. Moderated Regression Analysis

Variabel Interaksi	Beta (β)	t-value	Sig.
X1 × ESG Orientation	0,134	2,97	0,003
X2 × ESG Orientation	0,121	2,66	0,008

Variabel Interaksi	Beta (β)	t-value	Sig.
X3 × ESG Orientation	0,098	2,11	0,036
ΔR^2 = 0,067	**F-change = 14,92**	**Sig. = 0,000**	

Source: Researcher 2025

The moderation analysis reveals that ESG Orientation significantly strengthens the relationships between the independent variables and sustainability pathways. The interaction terms Digital Entrepreneurship × ESG Orientation (β = 0.134), Resource Efficiency × ESG Orientation (β = 0.121), and Strategic Collaboration × ESG Orientation (β = 0.098) all achieved statistical significance. The increase in R^2 by 6.7% ($\Delta R^2 = 0.067$) demonstrates that adding ESG as a moderator substantially improves the model's explanatory power. This finding underscores that while digitalization, efficiency, and collaboration are important, their impact on sustainability is maximized when organizations adopt strong ESG principles as part of their strategic orientation.

5 Discussion

5.1 The Influence of Digital Entrepreneurship on Pathways to Sustainability

The results of the study show that Digital Entrepreneurship (X1) has a positive and significant effect on Pathways to Sustainability (β = 0.278; sig. 0.000). This confirms that the use of digital platforms, technology-based innovation, and digital business models can enhance a company's ability to transform towards sustainability. This finding aligns with Nassar & Malik (2021), who emphasized that digital entrepreneurship expands market access and accelerates the innovation cycle, thereby supporting the achievement of sustainable business practices. Therefore, the higher the adoption rate of digital entrepreneurship, the greater its contribution to realizing a sustainable path for companies and MSMEs in Indonesia.

5.2 The Influence of Resource Efficiency on Pathways to Sustainability

Variables Resource Efficiency (X2) also proven to have a significant positive effect on Pathways to Sustainability (β = 0.241; sig. 0.000). These results indicate that efficient use of energy, water, and raw materials, as well as waste and emission reduction, are crucial factors in strengthening sustainability. This finding is consistent with Mallick & Arora (2022), who asserted that companies that implement resource efficiency will experience dual benefits: improved financial performance and reduced environmental impact. In the Indonesian context, resource efficiency also provides a solution to high production costs and global pressures regarding sustainability standards.

5.3 The Influence of Strategic Collaboration on Pathways to Sustainability

This study also found thatStrategic Collaboration (X3)has a significant positive effect onPathways to Sustainability(β = 0.216; sig. 0.000). This indicates that partnerships with suppliers, government, academics, and NGOs/communities strengthen companies'

capacity to implement sustainable practices. This finding supports Khan & Yu (2021), who emphasize the importance of cross-stakeholder collaboration in driving green innovation and achieving sustainability. In Indonesia, collaborative strategies are crucial because individual company capacity limitations can be overcome through synergy and resource sharing.

5.4 The Moderating Role of ESG Orientation

Analysis Moderated Regression Analysis (MRA) prove that ESG Orientation strengthen the influence of the three independent variables on Pathways to Sustainability. Interaction Digital Entrepreneurship × ESG Orientation (β = 0.134; sig. 0.003), Resource Efficiency × ESG Orientation (β = 0.121; sig. 0.008), and Strategic Collaboration × ESG Orientation (β = 0.098; sig. 0.036) are all significant. This means that when a company has a strong ESG orientation, the influence of digital entrepreneurship, resource efficiency, and strategic collaboration on the sustainability pathway is increasingly optimal. This finding aligns with Dou et al. (2025) who emphasized the synergy of digital transformation and ESG as the main drivers of green innovation. ESG orientation also emphasizes stakeholder theory, where sustainability is measured not only by economic profit but also by social and environmental accountability.

5.5 Theoretical and Practical Synthesis

Theoretically, the results of this study strengthen Resource-Based View (RBV) And Dynamic Capabilities Theory Digital capabilities (digital entrepreneurship) and resource efficiency are strategic assets that provide sustainable competitive advantage. Meanwhile, strategic collaboration demonstrates the importance of organizational capabilities insensing, seizing, dan transforming opportunities towards sustainability. The role of ESG Orientation as a moderator is also consistent with Stakeholder Theory, which emphasizes that long-term legitimacy and success can only be achieved when companies integrate environmental, social and governance aspects.

From a practical perspective, this research confirms that companies and MSMEs in Indonesia need to strengthen their adoption of digital technology, implement resource efficiency, and build collaborative networks with various stakeholders. However, these strategies will be more impactful if underpinned by a strong commitment to ESG. Therefore, pathways to sustainability not just a jargon, but a real path that can be achieved through digital synergy, efficiency, collaboration, and sustainable governance.

6 Conclusion

Theoretical Implications. This study extends the literature on pathways to sustainability by integrating Digital Entrepreneurship, Resource Efficiency, Strategic Collaboration, and ESG Orientation into a single analytical model. The findings demonstrate that ESG orientation plays a crucial moderating role, strengthening the relationships between the

independent variables and sustainability outcomes. This enriches the Resource-Based View (RBV), Dynamic Capabilities Theory, and Stakeholder Theory by emphasizing that sustainability is not solely influenced by internal capabilities but also by organizational commitment to ESG principles. Furthermore, the study provides empirical evidence supporting ESG orientation as a critical moderator in sustainability research.

Practical Implications. For firms and MSMEs in Indonesia, the results highlight that pathways to sustainability can be accelerated when digital entrepreneurship, resource efficiency, and cross-sector collaboration are pursued simultaneously with a strong ESG commitment. Organizations that adopt ESG more seriously are found to derive greater benefits from digitalization and efficiency practices. The practical implication is that managers should embed ESG as a core organizational value, rather than treating it as a mere reporting requirement.

Policy Implications. The findings are also relevant for policymakers and regulators. Government involvement is necessary to create regulations and incentives that support MSME digitalization, resource efficiency practices, and strategic collaboration. ESG-based policies—such as tax incentives, green financing, or sustainability reporting standards—can enhance firms' readiness to face global trade requirements, including the European Union's Carbon Border Adjustment Mechanism (CBAM) and similar international sustainability standards.

This study concludes that Digital Entrepreneurship, Resource Efficiency, and Strategic Collaboration have significant positive effects on Pathways to Sustainability. Furthermore, ESG Orientation strengthens these relationships, confirming its role as an important moderating factor. The results demonstrate that digitalization, efficiency, and collaboration can only achieve their maximum impact when supported by a strong organizational commitment to ESG principles.

This section presents recommendations that can be used as both practical and academic references. From a practical perspective, business actors, including corporations and MSMEs, are expected to focus not only on digital transformation and cost efficiency but also consistently internalize ESG (Environmental, Social, and Governance) values into their organizational culture. This can be achieved through employee training on sustainable business practices, building partnerships with local communities, and increasing transparency in corporate governance. Policymakers and regulators need supportive policy designs, such as green financing schemes for MSMEs, digital training programs integrated with ESG aspects, and incentive mechanisms for companies implementing sustainability-oriented business practices.

Furthermore, there are academic recommendations for future research development. Future researchers can consider adding variables such as green finance or innovation capability as mediating or moderating factors to deepen their understanding of demand dynamics. Research is also recommended across sectors, for example, the textile, fisheries, or energy industries, to identify differences in characteristics and demand pathways based on industry sector. From a methodological perspective, the use of alternative approaches such as PLS-SEM or multi-cluster analysis can provide deeper insights, particularly in comparing characteristics across business groups or regions. Therefore, this recommendation not only supports the implementation of sustainable practices but also encourages the development of knowledge in the field of sustainable management.

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