GIJEA
Greenation International Journal of Economics and Accounting
+62 81210467572 https://research.e-greenation.org/GIJEA greenation.info@gmail.com
GREENATION RESEARCH

DOI: https://doi.org/10.38035/gijea.v4i4.1290
https://creativecommons.org/licenses/by/4.0/
Received: 05 August 2026 | **Revised:** 06 August 2026 | **Accepted:** 22 October 2026

Green Technological Transformation, Investment Risk Management, and Investment Sustainability: The Mediating Role of Increased Investment in North Sumatra's Green Business Sector

Petrus Loo[1], Sri Rezeki[2], Afrizal Afrizal[3], Irvan Rolyesh Situmorang[4], Leylawati Joremi[5]
[1]Sekolah Tinggi Ilmu Ekonomi Eka Prasetya, Medan, Indonesia, loo.petrus@eka-prasetya.ac.id
[2]Universitas Negeri Medan, Medan, Indonesia, srirezekieko@unimed.ac.id
[3]Sekolah Tinggi Ilmu Ekonomi Eka Prasetya, Medan, Indonesia, rizal.loebis74@gmail.com
[4]Sekolah Tinggi Ilmu Ekonomi Eka Prasetya, Medan, Indonesia, irvanrolyesh15@gmail.com
[5]Universiti Teknologi MARA Shah Alam, Shah Alam, Malaysia, leylawati@uitm.edu.my

Corresponding Author: loo.petrus@eka-prasetya.ac.id[1]

Abstract: This study examines how green technological transformation (GTT) and investment risk management (IRM) relate to investment sustainability (IS), with increased investment (II) as mediator. A purposive survey of 200 decision makers in North Sumatra's green-business sector was analyzed using PLS-SEM and 5,000 bootstrap subsamples. GTT was associated with II ($\beta = 0.204$, $p = 0.001$) and IS ($\beta = 0.170$, $p = 0.007$). IRM was associated with II ($\beta = 0.274$, $p < 0.001$), but not directly with IS ($\beta = 0.003$, $p = 0.964$). II was associated with IS ($\beta = 0.426$, $p < 0.001$). Both indirect effects were significant (GTT: $\beta = 0.087$; IRM: $\beta = 0.117$), indicating complementary and indirect-only mediation, respectively. The findings identify increased financial commitment as a pathway linking organizational capabilities with perceived continuity of green investment.

Keyword: Green Technological Transformation, Investment Risk Management, Increased Investment, Investment Sustainability, Resource Orchestration.

INTRODUCTION

Green investment is often discussed as a one-off decision, yet its environmental and economic returns depend on whether organizations keep committing capital after the first project is installed. Cleaner technologies can involve long payback periods, uncertain performance in the early years, and partly irreversible costs. Braga et al., (2021) demonstrate, in a green-bond-market setting, how public and multilateral support can de-risk green investment and lower financing costs; they do not directly measure organizational continuity of green-investment commitments. An organization that buys an energy-efficient machine or a waste-treatment unit but then stops upgrading, maintaining, or expanding these assets may

capture only part of their potential value. This study therefore examines continuity of green-investment commitment as a distinct outcome. Fu et al., (2023) review green finance in the broader context of sustainable development, but do not directly establish the continuity of organizational green-investment commitments.

Indonesia has moved this issue onto the policy agenda. In February 2024 the Financial Services Authority (OJK) issued the Taksonomi untuk Keuangan Berkelanjutan Indonesia (TKBI), which classifies economic activities as green or transitional in order to steer capital toward the national net-zero target (OJK, 2024). Policy signals of this kind, however, do not automatically translate into sustained investment at the organizational level. Costa et al., (2024) find, in cross-country evidence on large listed companies, that financing constraints and weaker green managerial capacity reduce the likelihood of investment in green technologies. Their separate analysis of Portuguese firms indicates that green investment is more sensitive to financing conditions than other types of investment. Smaller organizations face an additional barrier because they find it difficult to tap the growing pool of sustainable finance (OECD, 2022). For the North Sumatra setting examined here, the relevant research question is whether organizational commitments to green investment can be maintained, rather than merely initiated.

Two organizational capabilities appear especially relevant. The first is Green Technological Transformation (GTT), the capability to adopt and upgrade technologies and processes that reduce waste, emissions, and resource use. Survey evidence from 283 Indian manufacturers links green technology innovation to environmental performance and highlights resource commitment as a condition for green initiatives (Sahoo et al., 2023), while panel evidence from Chinese listed firms shows that green transformation improves green investment efficiency mainly by reducing underinvestment (Yang et al., 2026). The second is Investment Risk Management (IRM), the capability to identify, assess, treat, and monitor investment risks (ISO, 2018). Effective risk management committees have been found to curb both over- and underinvestment (Jiang et al., 2024), and executives with stronger climate-risk awareness achieve higher green investment efficiency (Zhao et al., 2026).

The literature on uncertainty, however, does not point in a single direction. Subsidy-policy uncertainty reduces green R&D and patenting (Wang et al., 2023), and US monetary-policy uncertainty discourages green-investor entry into Chinese listed firms (Ren et al., 2024). Yet listed small and medium-sized enterprises in China increase environmental investment when their exposure to economic policy uncertainty rises, particularly when they face fewer financial constraints (Yue et al., 2025). These findings concern different forms of policy uncertainty and different investment outcomes, so they should not be treated as directly contradictory estimates of one relationship. They suggest that organizational responses and available resources may condition green-investment decisions. This is precisely where an organizational capability such as IRM should become visible, yet most of the cited studies measure uncertainty exposure rather than the capability to manage it.

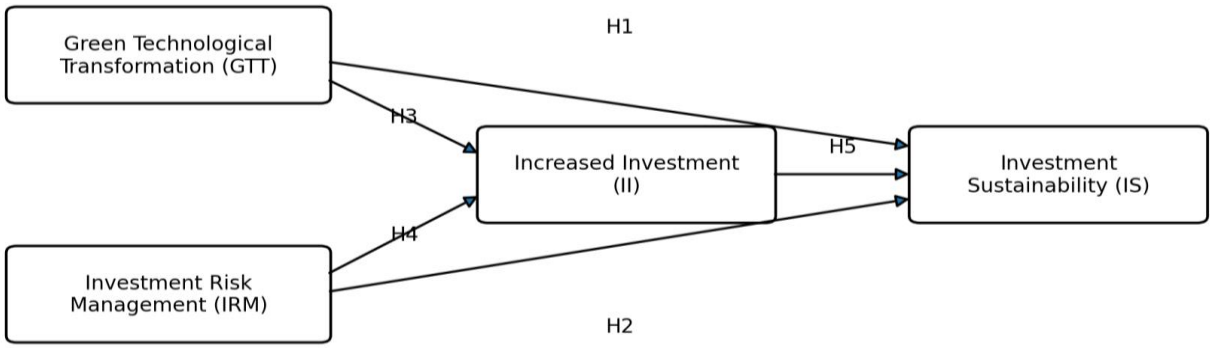
Reviewing these studies reveals four gaps that motivate the present research. The first is an outcome gap. Prior work evaluates green investment through efficiency indices (Yang et al., 2026; Zhao et al., 2026), green R&D and innovation activity (Wang et al., 2023), environmental investment responses (Yue et al., 2025), or broad corporate business sustainability (Abdurrohman et al., 2026). The continuity of an organization's commitment to green investment, which this study calls Investment Sustainability (IS), has received little direct measurement. The second is a mechanism gap. The mediators examined so far include uncertainty perception and labor employment (Yang et al., 2026), green technology

innovation (Zhao et al., 2026), and governance and corporate social responsibility (Abdurrohman et al., 2026)

Among the studies reviewed, none tests whether a perceived increase in green capital allocation is associated with the relationship between technological and risk-management capabilities and perceived investment continuity. This statement is limited to the literature reviewed here and should not be read as a claim that the mechanism has never been examined. The third is a theoretical gap. The resource-based view and its natural-resource extension explain why capabilities matter (Barney, 1991; Hart, 1995), but they say less about the process by which capabilities are converted into sustained outcomes. Resource orchestration theory addresses this process by distinguishing the structuring, bundling, and leveraging of resources (Sirmon et al., 2007), but it has rarely been used to explain green investment continuity. The fourth is a contextual and population gap. Most quantitative evidence on green transformation and green investment comes from archival data on large listed firms in China or the United States (Liu, 2024; Ren et al., 2024; Yang et al., 2026). Survey evidence from regional Indonesian organizations exists but focuses on other outcomes, such as MSME competitiveness in Medan (Agusman et al., 2026) or supply-chain sustainability performance in manufacturing SMEs (Kosasih et al., 2023).

Accordingly, this study examines the associations of GTT and IRM with II and IS and assesses whether II statistically mediates their relationships with IS among green-business organizations in North Sumatra. Three contributions are proposed. First, the study distinguishes perceived continuity of green-investment commitment (IS) from reported growth in green-investment allocation (II), rather than treating investment volume, efficiency, and continuity as interchangeable outcomes. Second, it brings technological and risk-management capabilities into a common explanatory model and tests their direct and indirect associations with continuity. Third, it uses resource orchestration to specify an observable allocation channel through which organizational capabilities may be associated with longer-term investment commitment. Because the evidence is cross-sectional and self-reported, these pathways are interpreted as theoretically directed statistical relationships rather than established causal sequences.

The framework specifies five direct relationships and two specific indirect relationships, as presented in Figure 1.



Source: Developed by the authors (2026).

Figure 1. Conceptual Framework

METHOD

Research Design

The study uses quantitative, explanatory, cross-sectional survey design. Partial Least Squares Structural Equation Modeling (PLS-SEM) was chosen because the research aims to

explain and predict endogenous constructs, the model contains a mediation structure, and the sample is moderate in size (Hair et al., 2019).

Population, Unit of Analysis, and Sampling

The target population consists of organizations engaged in green-business activities in North Sumatra. A green-business activity is defined as the implementation of at least one environmentally oriented practice, such as renewable-energy use, energy efficiency, environmentally friendly equipment, waste or emission reduction, resource efficiency, or dedicated spending on sustainability. The unit of analysis is the organization, and key informants are owners, directors, managers, or supervisors directly involved in decisions on technology, investment, financing, risk, or business development. Because no complete sampling frame of green-business organizations in the province is available, non-probability purposive sampling was applied. Four screening questions ensured that each respondent represented an organization operating in North Sumatra, was involved in decision making, knew the focal decisions, and confirmed at least one green-business practice. Respondents who failed to follow any criteria were not allowed to continue the questionnaire.

Sample Profile and Eligibility

The final analytical sample consists of 200 eligible key informants representing organizations engaged in green-business activities in North Sumatra. Eligibility required operation in the province, involvement in organizational decision-making, knowledge of the focal investment decisions, and at least one qualifying green-business practice. Purposive recruitment and the use of a single organizational informant limit statistical generalization. A demographic distribution is not reported because the available manuscript does not contain a verified breakdown by respondent role, industry, or organizational size; no subgroup frequencies are inferred.

Sample Size

Sample-size adequacy was evaluated using the inverse square root approach of Kock & Hadaya (2018). The illustrative calculation assumes a 5% significance level, 80% statistical power, and a minimum anticipated path coefficient of $|\beta| = 0.20$, yielding a conditional minimum of 155 observations. The final analytical dataset contains 200 valid responses. The numerical sample-size calculation and its assumptions should be retained with the study records so that this estimate can be independently reproduced; a significant observed coefficient below the assumed minimum should be interpreted cautiously.

Data Collection and Measurement

Data were collected using a structured Indonesian-language questionnaire during July–October 2026. All items used a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The instrument contains 17 reflective items: five for GTT, five for IRM, three for II, and four for IS (Table 1). The items are author-adapted or author-developed operationalizations informed by the cited conceptual literature; the citations should not be interpreted as claims that the source publications validated these exact 17 items. The manuscript reports expert review and pretesting, but does not document the number of experts, the pretest sample, or item-level changes. Accordingly, the evidence reported here supports assessment of the measurement model in the present sample, rather than prior validation of an identical questionnaire.

Table 1. Variables and Measurement Indicators

Construct	Code	Measurement Item	Source / Status
Green Technological Transformation	GTT1	Our organization uses technologies or processes that help reduce waste, emissions, or environmental impacts from operations.	Sahoo et al. (2023) adapted
	GTT2	Our organization uses technology to improve energy-use efficiency.	OECD (2025); Sahoo et al. (2023); adapted
	GTT3	Our organization uses technology to improve the efficiency of materials and resource use.	OECD (2025); adapted
	GTT4	Our organization upgrades processes or technologies to better comply with environmental requirements and standards.	Sahoo et al. (2023); adapted
	GTT5	Our organization continuously replaces or upgrades conventional technologies with more environmentally friendly alternatives.	Sahoo et al. (2023); OECD (2025); adapted
Investment Risk Management	IRM1	Before making investment decisions, our organization systematically identifies potential risks.	Yoshiura et al. (2023); adapted
	IRM2	Our organization assesses the likelihood and impact of risks that may affect investment success.	Yoshiura et al. (2023); adapted
	IRM3	Risk information is used as an important consideration before investment decisions are finalized.	Yoshiura et al. (2023); adapted
	IRM4	Our organization establishes actions to reduce or control identified investment risks.	Yoshiura et al. (2023); ISO (2018); adapted
	IRM5	Our organization monitors investment risks and updates risk-management actions when conditions change.	Yoshiura et al. (2023); ISO (2018); adapted
Increased Investment	II1	During the past two years, the funds allocated to green-business activities or investments in our organization have increased.	Sahoo et al. (2023), resource commitment; researcher-developed/adapted
	II2	During the past two years, expenditure on environmentally friendly technology, energy efficiency, or sustainability activities in our organization has increased.	Sahoo et al. (2023), resource commitment; researcher-developed/adapted
	II3	During the past two years, the financial resources allocated to developing green-business activities in our organization have increased.	Sahoo et al. (2023), resource commitment; researcher-developed/adapted
Investment Sustainability	IS1	Our organization is committed to maintaining green-business investment over the long term.	World Bank Group (2020); Flammer & Bansal (2017); researcher-developed
	IS2	Green-business investment has become part of our organization's long-term development plan.	World Bank Group (2020); Flammer & Bansal (2017); researcher-developed
	IS3	Our organization seeks to maintain the continuity of green-business investment even when business conditions change.	World Bank Group (2020); Flammer & Bansal (2017) researcher-developed
	IS4	Green-business investment decisions in our organization consider the sustainability of both economic and environmental benefits.	World Bank Group (2020); Flammer & Bansal (2017); researcher-developed

Source: Items adapted or developed by the authors with conceptual guidance from the cited literature.

GTT operationalize green technology and resource efficiency; IRM items operationalize risk identification, assessment, decision use, mitigation, and monitoring; II items are author-developed perceived changes in green investment over the past two years; IS items are author-developed measures of perceived long-term commitment and continuity. None of these sources is presented as having validated the exact wording of the 17 items.

Data Analysis Technique

The model was estimated in SmartPLS 4 (Ringle et al., 2024) using the path weighting scheme. Following Hair et al. (2019), the reflective measurement model was assessed before evaluating the structural model. It was assessed through outer loadings, Cronbach's alpha, composite reliability (rho_A and rho_C), and average variance extracted (AVE). Discriminant validity was evaluated mainly with the heterotrait-monotrait ratio (HTMT) below 0.85 (Henseler et al., 2015), with the Fornell-Larcker criterion as supplementary evidence (Fornell & Larcker, 1981). The structural model was evaluated through collinearity (VIF), path coefficients, R^2, f^2 (Cohen, 1988), and out-of-sample predictive power with PLSpredict using 10 folds and 10 repetitions (Shmueli et al., 2019). Significance was tested with percentile bootstrapping on 5,000 subsamples, two-tailed at $\alpha = 0.05$. Mediation was assessed through the specific indirect effects and classified following Zhao et al. (2010) and Nitzl et al. (2016). Common method bias was assessed with the full collinearity test, with a threshold of 3.3 (Kock, 2015), and Harman's single-factor test (Podsakoff et al., 2003).

Ethical Considerations

Participation was voluntary and preceded by informed consent. Respondents were told that their answers would be kept confidential, analyzed in aggregate, and used only for academic purposes.

RESULT AND DISCUSSION

Common Method Bias

The reported full collinearity VIF values ranged from 1.112 to 1.396, below the adopted 3.3 screening threshold (Kock, 2015). The first unrotated factor accounted for 26.57% of total variance, a descriptive single-factor diagnostic, not a definitive test of common-method bias (Podsakoff et al., 2003). These diagnostics do not pronounce common-method problems under the specified tests, but neither procedure rules out common-method bias in a single-informant, cross-sectional survey.

Measurement Model Evaluation

Table 3 reports on the measurement model. Outer loading ranged from 0.695 to 0.853, and all were significant ($p < 0.001$). Indicator GTT1 (0.695) fell slightly below 0.70 but was retained because it captures the waste and emission-reduction aspect of GTT, and the AVE and composite reliability of the construct remained above their thresholds (Hair et al., 2019). Cronbach's alpha ranged from 0.779 to 0.826, rho_A from 0.783 to 0.859, and rho_C from 0.850 to 0.875, which indicates satisfactory internal consistency. All AVE values exceeded 0.50 (lowest = 0.531 for GTT), supporting convergent validity. Outer VIF values ranged from 1.436 to 1.759.

Table 3. Outer Loadings, Reliability, and Convergent Validity

Construct	Item	Loading	VIF	Cronbach's α	rho_A	rho_C	AVE
Green Technological Transformation	GTT1	0.695	1.469	0.779	0.783	0.850	0.531
	GTT2	0.744	1.543				
	GTT3	0.728	1.441				
	GTT4	0.703	1.436				
	GTT5	0.773	1.606				
Investment Risk Management	IRM1	0.726	1.657	0.826	0.859	0.875	0.584
	IRM2	0.757	1.678				
	IRM3	0.759	1.610				
	IRM4	0.812	1.576				
	IRM5	0.765	1.709				
Increased Investment	II1	0.811	1.537	0.786	0.789	0.875	0.700
	II2	0.845	1.759				
	II3	0.853	1.679				
Investment Sustainability	IS1	0.785	1.631	0.797	0.818	0.866	0.619
	IS2	0.821	1.545				
	IS3	0.733	1.519				
	IS4	0.804	1.698				

Source: SmartPLS output, processed by the authors (2026).

Discriminant validity is summarized in Tables 4a and 4b. The previously combined matrix has been separated using the conventional arrangement in which the upper-triangular entries represent HTMT, and the lower-triangular entries represent interconstruct correlations; the Fornell–Larcker diagonal contains the square roots of AVE. All reported HTMT values are below 0.85 (maximum = 0.576 for II–IS), and each square root of AVE exceeds the corresponding interconstruct correlations. These results support discriminant validity under the reported criteria.

Table 4a. Heterotrait–Monotrait Ratio (HTMT)

Construct	GTT	IRM	II	IS
GTT	—	—	—	—
IRM	0.201	—	—	—
II	0.311	0.359	—	—
IS	0.342	0.207	0.576	—

Table 4b. Fornell–Larcker Criterion

Construct	GTT	IRM	II	IS
GTT	0.729	—	—	—
IRM	0.157	0.764	—	—
II	0.247	0.306	0.836	—
IS	0.276	0.160	0.469	0.787

Source: Authors reported SmartPLS results (2026). Matrix entries were reorganized from the combined table without changing numerical values.

Structural Model Evaluation

Inner VIF values ranged from 1.025 to 1.154, so collinearity among predictors is not a problem. The model explains 13.4% of the variance in II (adjusted $R^2 = 0.125$) and 24.7% of the variance in IS (adjusted $R^2 = 0.236$). Both values are modest, which is common in survey models that explain organizational outcomes with a small number of capabilities, and they indicate that other factors, such as access to finance, regulation, and market demand, also shape green investment. The SRMR value of 0.067 is below 0.08, which suggests an acceptable approximate fit.

Predictive power was evaluated with PLSpredict (Table 5). All Q^2predict values were positive (ranging from 0.015 to 0.103), meaning that the model predicts better than the naive

mean benchmark. In addition, the PLS-SEM model produced lower RMSE and MAE than the linear model benchmark for all seven endogenous indicators. Following Shmueli et al. (2019), this pattern indicates high predictive power relative to the benchmark, although the small Q^2predict values mean that the absolute out-of-sample accuracy remains limited.

Table 5. PLSpredict Results

Indicator	Q^2 predict	PLS-SEM RMSE	LM RMSE	PLS-SEM MAE	LM MAE
II1	0.041	1.346	1.383	1.161	1.199
II2	0.070	1.293	1.352	1.102	1.152
II3	0.103	1.316	1.353	1.104	1.122
IS1	0.035	1.361	1.411	1.155	1.189
IS2	0.051	1.380	1.411	1.175	1.185
IS3	0.047	1.286	1.328	1.085	1.124
IS4	0.015	1.371	1.430	1.184	1.237

Source: SmartPLS output, processed by the authors (2026).

Hypothesis Testing

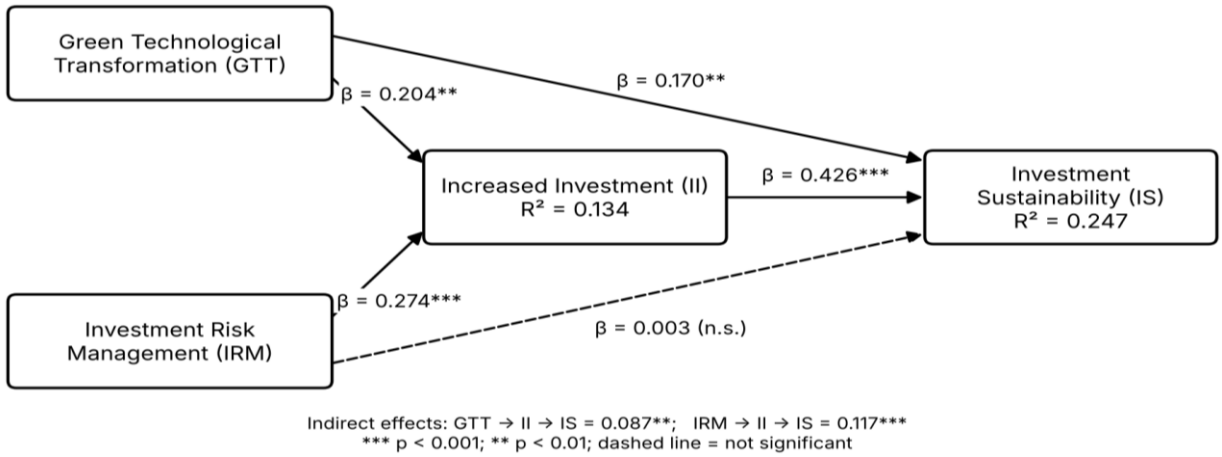
Table 6 and Figure 2 present the results of the bootstrapping procedure.

Table 6. Hypothesis Testing Results (Direct Effects)

Hyp.	Path	β	SD	t-value	p-value	95% CI	f^2	Decision
H1	GTT → IS	0.170	0.063	2.698	0.007	[0.056; 0.301]	0.036	Supported
H2	IRM → IS	0.003	0.076	0.045	0.964	[-0.148; 0.154]	0.000	Not supported
H3	GTT → II	0.204	0.064	3.188	0.001	[0.088; 0.335]	0.047	Supported
H4	IRM → II	0.274	0.058	4.701	< 0.001	[0.168; 0.395]	0.084	Supported
H5	II → IS	0.426	0.059	7.187	< 0.001	[0.304; 0.541]	0.209	Supported

Source: SmartPLS output, processed by the authors (2026).

GTT had a positive and significant relationship with IS (β = 0.170, t = 2.698, p = 0.007), so H1 is supported, although the effect size is small (f^2 = 0.036). The relationship between IRM and IS was close to zero and not significant (β = 0.003, t = 0.045, p = 0.964; 95% CI [-0.148; 0.154]), so H2 is not supported. GTT (β = 0.204, p = 0.001) and IRM (β = 0.274, p < 0.001) were both positively related to II, supporting H3 and H4; the effect of IRM was somewhat larger (f^2 = 0.084 versus 0.047). II showed the strongest relationship in the model (β = 0.426, t = 7.187, p < 0.001) with a medium effect size (f^2 = 0.209), supporting H5.



Source: SmartPLS output, processed by the authors (2026)

Figure 2. Structural Model Results

Mediation Analysis

Table 7. Specific Indirect Effects and Mediation Type

Hyp.	Indirect path	β	t-value	p-value	95% CI	Direct effect	Total effect	Mediation type	Decision
H6	GTT → II → IS	0.087	2.803	0.005	[0.035; 0.154]	0.170 (p = 0.007)	0.257 (p < 0.001)	Complementary (partial)	Supported
H7	IRM → II → IS	0.117	3.743	< 0.001	[0.065; 0.185]	0.003 (p = 0.964)	0.120 (p = 0.108)	Indirect-only (full)	Supported

Source: SmartPLS output, processed by the authors (2026).

The indirect effect of GTT on IS through II was positive and significant (β = 0.087, p = 0.005, 95% CI [0.035; 0.154]), so H6 is supported. Because the direct effect of GTT on IS was also significant and had the same sign, the mediation is complementary (Zhao et al., 2010), and the indirect path accounts for about 33.8% of the total effect. The indirect effect of IRM on IS through II was also significant (β = 0.117, p < 0.001, 95% CI [0.065; 0.185]), so H7 is supported. Since the direct effect of IRM was not significant, this is an indirect-only mediation. The total effect of IRM on IS was not significant (β = 0.120, p = 0.108). Under the approach of Zhao et al. (2010), a significant total effect is not a precondition for mediation, but the observed total association is not statistically significant; the significant association is confined to the indirect pathway through II. These cross-sectional estimates do not establish causal transmission.

Robustness Check

To ensure that the correction of the single out-of-range value did not drive the conclusions, the model was re-estimated after excluding respondent 179 (n = 199). The results were substantively identical: GTT → IS (β = 0.170, p = 0.008), IRM → IS (β = -0.009, p = 0.908), GTT → II (β = 0.203, p = 0.001), IRM → II (β = 0.269, p < 0.001), and II → IS (β = 0.426, p < 0.001). Both indirect effects remained significant (GTT → II → IS: β = 0.087, 95% CI [0.034; 0.157]; IRM → II → IS: β = 0.115, 95% CI [0.062; 0.187]).

Discussion

Green technological transformation and investment sustainability (H1). Organizations that have embedded cleaner technologies in their operations report a stronger commitment to maintaining green investment. This result agrees with the natural-resource-based view, in which environmental capabilities become part of how an organization creates value (Hart, 1995; Khanra et al., 2022). It also complements Yang et al. (2026), who found that green transformation improves green investment efficiency. Their evidence concerns the quality of allocation in listed Chinese firms, while the present result concerns the continuity of commitment in regional organizations, so the two findings are compatible but not interchangeable. One interpretation is that technological change creates sunk assets and know-how that make it costly to retreat from green activities. The effect is small, however, which suggests that technology alone is a limited guarantee of continuity.

Investment risk management and investment sustainability (H2). Contrary to expectations, IRM showed no direct relationship with IS (β = 0.003). This result differs from studies that link risk management to firm value and lower risk (Hoyt & Liebenberg, 2011; Jurdi & AlGhnaimat, 2021) and from evidence that executives' climate-risk awareness improves green investment efficiency (Zhao et al., 2026). Several explanations are plausible. Risk management is a decision-support capability: it improves the information on which decisions are made but does not, by itself, commit an organization to anything. Rigorous risk assessment can also reveal reasons to slow down rather than to continue, so its net direct

effect on continuity may be neutral. Differences in study settings, samples, and outcome definitions may also contribute to divergent findings; the present data do not establish that respondents' organizations are systematically smaller or less formalized. The result should therefore be read as a non-significant conditional direct association between IRM and perceived investment sustainability, rather than proof that risk management has no independent role.

Green technological transformation and increased investment (H3). GTT was positively associated with growth in green funding. This is conceptually compatible with Sahoo et al. (2023), who model resource commitment as a moderator of green knowledge acquisition relationships rather than measuring growth in green-investment allocations. It is also consistent in a broader sense with Yang et al. (2026), who study green investment efficiency and underinvestment rather than the present II construct. Zhang et al. (2024) examine the investment-to-green-innovation direction in Chinese listed firms, whereas the present model examines GTT-to-II. These findings suggest a possible reverse pathway but do not establish reciprocity; the cross-sectional design cannot identify temporal direction.

Investment risk management and increased investment (H4). IRM was positively related to II, and its effect was larger than that of GTT. This finding provides an organizational-capability perspective alongside mixed evidence on uncertainty exposure and green investment, although it does not directly reconcile differences between study designs or samples. Studies that find negative effects measure uncertainty exposure (Ren et al., 2024; Wang et al., 2023), while Yue et al. (2025) show that SMEs can respond to uncertainty with more environmental investment when financial constraints are weaker. The present result suggests that risk-management capability is associated with greater reported green-capital commitment. This interpretation is compatible with real options reasoning (Dixit & Pindyck, 1994), while Jiang et al. (2024) provide related—but not construct-identical—evidence on risk management committees and investment efficiency.

Increased investment and investment sustainability (H5). II was the strongest predictor of IS. Organizations reporting greater growth in green funding over the past two years also report a stronger long-term green-investment commitment. This is conceptually consistent with Abdurrohman et al. (2026), who examine green investment and broader corporate business sustainability in Indonesia, and with Flammer & Bansal (2017), who investigate executive long-term incentives, long-horizon strategies, and firm performance rather than green-investment continuity. In resource orchestration terms, structuring the resource portfolio through additional capital appears to be the step that makes sustained leveraging possible (Sirmon et al., 2007).

The mediating role of increased investment (H6 and H7). The two capabilities exhibit distinct statistical mediation patterns. For GTT, the significant direct and indirect associations with IS are both positive; the indirect path represents approximately 34% of the reported total association, consistent with complementary mediation. For IRM, the specific indirect association through II is significant while the direct path is not consistent with indirect-only mediation; the reported total effect is not statistically significant. Thus, the evidence is compatible with a financial-allocation channel for both capabilities, but it does not establish that increases in investment temporally or causally transmit their effects. Longitudinal evidence would be required to test that sequence directly.

Theoretical contribution and novelty. Relative to the studies reviewed, the contribution lies in the combination of a distinct outcome definition, a proposed financial-allocation mechanism, and contrasting mediation patterns for technological and risk-management capabilities. First, IS represents perceived continuity of green-investment commitment, whereas the closest studies emphasize investment efficiency (Yang et al., 2026; Zhao et al., 2026) or broader business sustainability (Abdurrohman et al., 2026). Second, II is modeled as

a common mediator linking both capabilities with IS, allowing their indirect and direct pathways to be compared within one specification. Third, the organization-level evidence extends the geographical and organizational settings considered in the cited literature. These findings are consistent with resource orchestration logic but do not constitute a direct test of its temporal stages. The novelty therefore concerns conceptual differentiation and the pattern of associations rather than an assertion that mediation or green-investment continuity has never been studied.

CONCLUSIONS AND RECOMMENDATIONS

This study examined whether green technological transformation and investment risk management support the sustainability of green investment among green-business organizations in North Sumatra, and whether increased investment carries these effects. GTT was positively related to both increased investment and investment sustainability. IRM was positively related to increased investment but had no direct relationship with investment sustainability. Increased investment was the strongest predictor of investment sustainability and mediated the effects of both capabilities, in a complementary way for GTT and in an indirect-only way for IRM. Six of the seven hypotheses were supported. Theoretically, the findings refine the natural-resource-based view by showing that environmental and managerial capabilities do not influence green investment continuity in the same way. Drawing on resource orchestration, the study identifies capital mobilization as the step through which risk-management capability becomes relevant to sustained green investment and as an additional channel for technological capability.

The results suggest that risk assessment should be linked explicitly to funding decisions, for instance by using risk analysis to design staged green investment plans and to support applications for green financing, rather than treating it as a stand-alone compliance exercise. Organizations that have already upgraded their technology should plan the complementary budget needed to maintain and expand these assets. For policymakers and financial institutions, the central role of increased investment indicates that instruments aligned with the TKBI, such as green credit schemes accessible to smaller organizations, may be decisive for turning initial green adoption into lasting commitment (OECD, 2022; OJK, 2024).

The study has several limitations. Its cross-sectional design cannot establish causal direction or temporal mediation, and reverse relationships, including investment growth facilitating subsequent technological transformation, remain possible. Purposive sampling and reliance on one knowledgeable informant per organization constrain generalizability and may introduce perceptual and common-method bias; the reported screening tests cannot eliminate these concerns. The IS indicators capture reported commitment and long-term orientation rather than verified investment persistence over time, and II reflects perceived changes in allocation rather than audited expenditure. The explained variance of the endogenous constructs is modest, and the observed GTT → IS coefficient is below the effect size assumed in the sample-size planning. Future research could combine longitudinal investment records with survey data, add financial access, regulatory pressure and firm characteristics, and compare sectors or provinces using appropriately powered designs.

REFERENCES

Abdurrohman, Sunardi, & Subiyantoro, E. (2026). Exploring corporate business sustainability through green investment in Indonesia using a moderated mediation approach. *Discover Sustainability*, *7*(1), 221. https://doi.org/10.1007/s43621-025-02564-0

Agusman, A., Victor, V., & Sofyan, S. (2026). Digital Technology-Based Green Innovation Adoption Model in MSME Development to Promote Performance and Sustainable Business Competitiveness. *International Journal of Management Science and Information Technology*, *6* (2), 1775–1786. https://doi.org/10.35870/ijmsit.v6i2.7705

Barney, Jay. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Braga, J. P., *Management* Semmler, W., & Grass, D. (2021). De-risking of green investments through a green bond market – Empirics and a dynamic model. *Journal of Economic Dynamics and Control*, *131*, 104201. https://doi.org/10.1016/J.JEDC.2021.104201

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Costa, H., Demmou, L., Franco, G., & Lamp, S. (2024). Making the grass greener: The role of firm's financial and managerial capacity in paving the way for the green transition. *OECD Economics Department Working Papers*, *1791*. https://doi.org/10.1787/cdffe7eb-en

Dewi, A. A., Saraswati, E., Rahman, A. F., & Atmini, S. (2024). Moderating role of enterprise risk management in the relationship between sustainability performance and a firm's competitive advantage. *Problems and Perspectives in Management*, *22*(2), 226–239. https://doi.org/10.21511/ppm.22(2).2024.18

Dixit, A. K., & Pindyck, R. S. (1994). *Investment under Uncertainty*. Princeton University Press. https://doi.org/10.2307/j.ctt7sncv

Flammer, C., & Bansal, P. (2017). Does a long-term orientation create value? Evidence from a regression discontinuity. *Strategic Management Journal*, *38*(9), 1827–1847. https://doi.org/10.1002/smj.2629

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39–50. https://doi.org/10.1177/002224378101800104

Fu, C., Lu, L., & Pirabi, M. (2023). Advancing green finance: a review of sustainable development. *Digital Economy and Sustainable Development 2023*, *1*(1), 20-. https://doi.org/10.1007/s44265-023-00020-3

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hart, S. L. (1995). A Natural-Resource-Based View of the Firm. *The Academy of Management Review*, *20*(4), 986–1014. https://doi.org/10.2307/258963

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Hoyt, R. E., & Liebenberg, A. P. (2011). The Value of Enterprise Risk Management. *Journal of Risk and Insurance*, *78*(4), 795–822. https://doi.org/https://doi.org/10.1111/j.1539-6975.2011.01413.x

International Organization for Standardization. (2018). *ISO 31000: 2018, Risk Management - Guidelines*. International Organization for Standardization.

Jiang, Haiyan, Jia, Jing, & (Ellie) Chapple, Larelle. (2024). Enterprise risk management and investment efficiency: Australian evidence from risk management committees. *Australian Journal of Management*, *49*(3), 366–402. https://doi.org/10.1177/03128962221144513

Jurdi, D. J., & AlGhnaimat, S. M. (2021). The Effects of ERM Adoption on European Insurance Firms Performance and Risks. *Journal of Risk and Financial Management*, *14*(11), 554. https://doi.org/10.3390/jrfm14110554

Khanra, S., Kaur, P., Joseph, R. P., Malik, A., & Dhir, A. (2022). A resource-based view of green innovation as a strategic firm resource: Present status and future directions. *Business Strategy and the Environment*, *31*(4), 1395–1413. https://doi.org/https://doi.org/10.1002/bse.2961

Kock, N. (2015). Common Method Bias in PLS-SEM: A Full Collinearity Assessment Approach. *Int. J. e-Collab.*, *11*(4), 1–10. https://doi.org/10.4018/ijec.2015100101

Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, *28*(1), 227–261. https://doi.org/https://doi.org/10.1111/isj.12131

Kosasih, W., Pujawan, I. N., Karningsih, P. D., & Shee, H. (2023). Integrated lean-green practices and supply chain sustainability framework. *Cleaner and Responsible Consumption*, *11*, 100143. https://doi.org/https://doi.org/10.1016/j.clrc.2023.100143

Liu, L. (2024). Green innovation, firm performance, and risk mitigation: evidence from the USA. *Environment, Development and Sustainability*, *26*(9), 24009–24030. https://doi.org/10.1007/s10668-023-03632-z

Mansour, N. (2023). Green Technology Innovation and Financial Services System: Evidence from China. In *Businesses* (Vol. 3, Issue 1, pp. 98–113). https://doi.org/10.3390/businesses3010008

Nitzl, C., Roldan, J. L., & Cepeda, G. (2016). Mediation analysis in partial least squares path modeling: Helping researchers discuss more sophisticated models. *Industrial Management & Data Systems*, *116*(9), 1849–1864. https://doi.org/10.1108/IMDS-07-2015-0302

OECD. (2022). Financing SMEs for sustainability: Drivers, Constraints and Policies. *OECD SME and Entrepreneurship Papers*, *35*. https://doi.org/10.1787/a5e94d92-en

OECD. (2025). Measuring Science and Innovation for Sustainable Growth. In *Measuring Science and Innovation for Sustainable Growth*. OECD Publishing. https://doi.org/10.1787/3b96cf8c-en

Otoritas Jasa Keuangan. (2024). Taksonomi Untuk Keuangan Berkelanjutan Indonesia. In *OJK*.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Ren, Y.-S., Klein, T., & Jiang, Y. (2024). Monetary policy uncertainty and green investment decisions: A cross-national spillover perspective. *International Review of Financial Analysis*, *96*, 103642. https://doi.org/https://doi.org/10.1016/j.irfa.2024.103642

Ringle, C. M., Wende, S., & Becker, J.-M. (2024). *SmartPLS 4. Bönningstedt: SmartPLS*.

Sahoo, S., Kumar, A., & Upadhyay, A. (2023). How do green knowledge management and green technology innovation impact corporate environmental performance? Understanding the role of green knowledge acquisition. *Business Strategy and the Environment*, *32*(1), 551–569. https://doi.org/https://doi.org/10.1002/bse.3160

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. *European Journal of Marketing*, *53*(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189

Sirmon, D. G., Hitt, M. A., & Ireland, R. D. (2007). Managing Firm Resources in Dynamic Environments to Create Value: Looking Inside the Black Box. *Academy of Management Review*, *32*(1), 273–292. https://doi.org/10.5465/amr.2007.23466005

Wang, M., Wurgler, J., & Zhang, H. (2023). Policy uncertainty reduces green investment. *NBER Working Paper No. W31401*, 53. https://doi.org/10.3386/w31401

World Bank Group. (2020). *Catalyzing Investment for Green Growth: The Role of Business Environment and Investment Climate Policy in Environmentally Sustainable Private Sector Development*. http://documents.worldbank.org/curated/en/464811610960949219

Yang, J., Zhou, C., Chen, H., & Yang, A. (2026). The Impact of Green Transformation on Corporate Green Investment Efficiency: Evidence from China. In *Sustainability* (Vol. 18, Issue 5, p. 2288). https://doi.org/10.3390/su18052288

Yoshiura, L. J. M., Martins, C. L., Costa, A. P. C. S., & Dos Santos-Neto, J. B. S. (2023). a Multicriteria Decision Model for Risk Management Maturity Evaluation. *Pesquisa Operacional*, *43*, 1–21. https://doi.org/10.1590/0101-7438.2023.043.00270186

Yue, S., Anderson, H. D., & Liao, J. (2025). Who does not advance loses ground: Green investment as a strategic response by small and medium-sized enterprises to economic policy uncertainty. *Energy Economics*, *148*, 108712. https://doi.org/https://doi.org/10.1016/j.eneco.2025.108712

Zhang, Y., Shou, S., & Li, Y. (2024). Do green investments impact corporate green innovation?empirical evidence from Chinese-listed companies. *Frontiers in Environmental Science*, *12*. https://doi.org/10.3389/fenvs.2024.1468843

Zhao, D., Jiang, L., & Sun, J. (2026). Management Climate Risk Perception and Corporate Green Investment Efficiency: Enhancing or Impeding Green Investment Performance? *Sustainability (Switzerland)*, *18*(16), 8228. https://doi.org/10.3390/su18168228

Zhao, X., Lynch Jr., J. G., & Chen, Q. (2010). Reconsidering Baron and Kenny: Myths and Truths about Mediation Analysis. *Journal of Consumer Research*, *37*(2), 197–206. https://doi.org/10.1086/651257