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INTEGRATING GREEN FINANCE AND GREEN TECHNOLOGY ADOPTION FOR SUSTAINABLE OPERATIONS: A CONCEPTUAL FRAMEWORK

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Abstract: *Green finance and green technology adoption are important for businesses seeking to reduce environmental impacts while maintaining operational efficiency. Yet financial access, knowledge of financing opportunities and the installation of environmentally friendly technologies may not produce sustainable outcomes unless they are translated into effective operational routines. This conceptual paper develops an integrated framework linking green finance accessibility, green finance awareness and green technology adoption with sustainable operational performance through green operations practices. Drawing primarily on the resource-based view and natural-resource-based view, and using the technology–organization–environment framework as a supporting perspective, the paper distinguishes financial resources, managerial financing knowledge, technological implementation and environmental-operational capabilities. Seven propositions describe three proposed relationships with green operations practices, their relationship with sustainable operational performance and three indirect pathways. The conceptual contribution is a technology-enabled extension of a previously published finance–operations model, with particular attention to the difference between adopting a green technology and using it within established environmental routines. The framework offers implications for business managers, financial institutions and policymakers regarding financing support, technology implementation and performance monitoring. The propositions have not been empirically tested; further research should validate the constructs, examine the indirect relationships and investigate variation across firms and industries.*

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Keywords: *Green Finance Accessibility; Green Finance Awareness; Green Technology Adoption; Green Operations Practices; Sustainable Operational Performance*

Introduction

Sustainability is an important consideration in contemporary operations management. Businesses are expected to reduce resource consumption, emissions and waste while maintaining reliable and efficient processes. Energy-saving equipment, renewable energy systems, cleaner production technologies and environmental information systems can support these objectives, but their implementation often requires substantial investment and organizational changes (Yu & Ramanathan, 2015; Hsu, Tan, Hathaway, & Zailani, 2023).

Green finance can help businesses fund environmental investments. Financing arrangements include green loans, green credit, sustainability-linked financing and incentives intended to support eligible sustainability projects. Research connects green finance with environmental investment, corporate environmental, social and governance (ESG) outcomes, and supply-chain-related improvements (Flammer, 2021; Gao, Hua, & Huo, 2024). However, financing availability is only one part of the transformation process. Managers must also understand available schemes and identify appropriate operational uses for financial support.

Studies on green finance have shown that financing arrangements and managerial financial knowledge can support environmental investment and process improvements (Gao et al., 2024; Kumar et al., 2022; Molina-García, Galache-Laza, González-García, & Diéguez-Soto, 2025). Access to funding and knowledge of financing schemes do not by themselves explain whether firms develop effective green operational routines. The present study considers technology adoption alongside these finance-related factors, while recognising that the earlier finance–operations framework has already been published.

Technology adoption adds an important, but distinct, perspective. A manufacturing firm may install an energy-monitoring system while failing to routinely review the data or modify its production schedule. In that situation, technology is present, but the practices needed to achieve operational savings remain weak. Evidence from manufacturing firms shows that green technologies and production capabilities can make different contributions to environmental and financial outcomes (Serrano-García, Llach, Bikfalvi, & Arbeláez-Toro, 2023). Research in Malaysia also links green technology innovation and innovation capabilities with sustainability performance (Mukhtar, Shad, & Lai, 2025).

This paper proposes an integrated conceptual framework involving green finance accessibility, green finance awareness, green technology adoption, green operations practices and sustainable operational performance. It offers a focused theoretical explanation for the relationships among these constructs and proposes seven relationships for future testing. The analysis is conceptual; no field data are collected, and no causal effects are claimed as established findings.

Problem Statement

Sustainable operations require financial support, relevant knowledge, technological resources and effective operational practices. Previous research on green finance examines financing constraints, credit policies, environmental innovation and ESG outcomes (Flammer, 2021; Gao & Liu, 2023; Gao et al., 2024). Research on green operations demonstrates associations between environmentally responsible practices and organizational performance (Yu &

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Ramanathan, 2015; Hsu et al., 2023). Nevertheless, an integrated explanation of how managers combine financial opportunities and technology implementation within operational routines remains useful.

The first challenge concerns access and awareness. Firms may be unable to obtain appropriate financing or may not understand eligibility conditions, documentation requirements and relevant support programmes. These difficulties can discourage investment in sustainability projects, particularly among resource-constrained SMEs (Kumar et al., 2022). Managerial financial knowledge may support environmental decisions, but knowledge alone does not ensure that operational changes occur (Molina-García et al., 2025).

The second challenge concerns the distinction between purchasing green technologies and integrating them into business practice. Technology may provide monitoring data, energy-saving capacity or pollution-control functions, but its practical effects depend on implementation, maintenance and daily use. Serrano-García et al. (2023) found that green production capabilities and technology implementation exhibit differentiated performance relationships. Therefore, the theoretical roles of technology adoption and operational practices should not be treated as interchangeable.

The central conceptual question is whether green technology adoption provides a distinct pathway to green operations practices beyond financial access and awareness. Existing work examines green finance and supply chain mechanisms (Gao et al., 2024), financial literacy and process innovation (Molina-García et al., 2025), and green production technologies and capabilities (Serrano-García et al., 2023). However, these studies do not directly establish the three parallel antecedents and the particular mediation pathway proposed here. This paper therefore advances a focused conceptual integration rather than claiming that technology or finance has been neglected generally.

Research Objectives

The main objective of this study is to develop a conceptual framework explaining how green finance accessibility, green finance awareness and green technology adoption may contribute to sustainable operational performance through the mediating role of green operations practices. Specifically, the study aims to:

i. Explain the relationship between green finance accessibility and green operations practices.
ii. Explain the relationship between green finance awareness and green operations practices.
iii. Explain the relationship between green technology adoption and green operations practices.
iv. Explain the relationship between green operations practices and sustainable operational performance.
v. Conceptualize the mediating role of green operations practices in the relationships between the three independent variables and sustainable operational performance.

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Literature Review

Green Finance Accessibility

Green finance accessibility describes the extent to which firms can obtain financing designed for environmentally beneficial projects, including green credit, green loans and applicable incentives. Its importance lies in the fact that renewable energy systems, resource-saving equipment and cleaner production investments may require funding before environmental improvements are feasible (Kumar et al., 2022; Gao et al., 2024). The conditions attached to financial products, administrative requirements and the availability of appropriate instruments may influence access.

Flammer (2021) showed that corporate green bonds can be associated with environmental investment and performance outcomes. Gao et al. (2024) examined how green finance policies, financing constraints and supply chain-related processes contribute to corporate ESG performance. These findings indicate that financing can be a relevant enabler, but do not mean that obtaining financing necessarily improves the firm's daily operations.

For smaller businesses, financial constraints and difficulties meeting application requirements may impede progress toward environmental investment (Kumar et al., 2022). Within the proposed model, finance accessibility is conceptualised as the ability to mobilise funds for environmental initiatives. Green operations practices, rather than finance alone, are expected to explain how that support can contribute to lower waste, better resource use and operational performance.

Green Finance Awareness

Green finance awareness refers to managers' understanding of green finance schemes, eligibility criteria, sustainability documentation and application processes. It differs from general financial literacy because it concerns financing mechanisms specifically directed toward environmentally beneficial activities. A manager may be financially capable but unaware of particular green financing products or environmental requirements (Kumar et al., 2022).

Molina-García et al. (2025) linked financial literacy to environmental sustainability through process innovation among SMEs. Their study concerns financial literacy rather than exactly the green finance awareness construct proposed here, but it supports the broader explanation that finance-related knowledge can help decision-makers recognise and implement sustainability opportunities. Awareness may also enable organisations to align financing proposals with operational needs.

However, awareness alone should not be confused with action. Knowledge of a green loan does not ensure that a firm develops an energy management programme or changes its procurement criteria. This paper therefore treats green finance awareness as an informational resource that may support green operations practices, while recognising that further evidence is needed to establish the strength and boundary conditions of the relationship.

Green Technology Adoption

Green technology adoption refers to the implementation and organizational integration of environmentally beneficial technologies. Examples include energy-efficient machinery, renewable energy installations, environmental monitoring platforms and pollution-control

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technologies. Adoption concerns the presence, use and technical integration of the systems, rather than all the management practices that surround them. This distinction is necessary because some technology-related measures have previously been included within broad definitions of green operations practices.

Serrano-García et al. (2023), using data from European manufacturers, found that green production capabilities and technology do not have identical relationships with environmental and financial performance. Their evidence suggests that simply expanding technological investment without considering production capabilities may not yield the expected results. Mukhtar et al. (2025) found an association between green technology innovation, innovation capabilities and sustainability performance among Malaysian manufacturing companies. Green technology innovation and green technology adoption are related but not identical; innovation research is used here as contextual evidence rather than proof of the specific adoption pathway.

This conceptual paper positions technology adoption before green operations practices. A firm may install an automated energy meter, whereas routine energy audits and decisions based on its readings belong to green operations practices. In the same way, adopting water-recycling equipment differs from maintaining systematic water-use reduction procedures. Such a distinction helps preserve conceptual clarity and makes a new technology-to-operations pathway theoretically plausible.
Technology–organization–environment thinking can help identify external and internal conditions surrounding technology adoption (Tornatzky & Fleischer, 1990), although its complete three-context model is not tested here. The framework proposes that adoption strengthens operational capability when tools are translated into regular environmental routines.

Green Operations Practices

Green operations practices comprise recurring managerial and operational activities intended to reduce environmental harm while preserving production and service efficiency. They include green procurement, resource-conservation procedures, waste separation, employee environmental routines, green logistics and cleaner production management (Yu & Ramanathan, 2015; Hsu et al., 2023). Unlike a technological asset, a practice represents what a firm does repeatedly to achieve an environmental objective.

Yu and Ramanathan (2015) related stakeholder pressures, green operations practices and environmental outcomes. Hsu et al. (2023) examined green operations practices in relation to firm performance; El Mokadem and Khalaf (2024) also considered the contribution of green supply chain management to sustainable performance. These studies provide support for treating green operations practices as capabilities relevant to organizational outcomes, while leaving room for differences across sectors and implementation maturity.

The proposed mediator explains why access to finance, awareness of finance and technology adoption may not be enough on their own. Finance must be allocated and monitored; managers must turn awareness into environmental plans; and technologies must be incorporated into routines and operating decisions. Defining these practices separately from technology adoption reduces the risk of measuring the same activity twice and supports the proposed indirect pathways.

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Sustainable Operational Performance

Sustainable operational performance concerns efficient and environmentally responsible operational outcomes. Indicators can include reduced resource use, energy consumption, emissions, production waste and operating costs, together with better process efficiency and environmental compliance (Green, Zelbst, Meacham, & Bhadauria, 2012; Yu, Chavez, Feng, & Wiengarten, 2014; Hsu et al., 2023). It is narrower than overall sustainable business performance because the emphasis remains on results from operations rather than every dimension of firm performance.

Studies of green operations and green supply chains show that environmental practices may contribute to improved organizational outcomes, although the dimensions and magnitudes of these relationships vary (Yildiz Cankaya & Sezen, 2019; El Mokadem & Khalaf, 2024). Serrano-García et al. (2023) further suggest that technological resources and production capabilities can have differentiated performance effects. The present framework therefore treats operational performance as an outcome that follows from effective practices, rather than assuming that financing or technologies directly ensure results.
For future measurement, a firm should distinguish reductions in energy or material use attributable to operational changes from broader market or financial effects. Ideally, indicators should account for output volumes and operational context. This construct is proposed as the dependent variable, with green operations practices as its immediate conceptual antecedent.

Synthesis of the Research Gap

Examining these five constructs together raises two questions that are not resolved simply by placing them in the same diagram. The first concerns additional explanatory value. Green finance accessibility and awareness may help managers obtain funding and identify investment opportunities, but they do not show whether a firm has installed and integrated a technology. Green technology adoption captures a different organizational condition: investment in and implementation of environmental technologies. The framework accordingly treats these dimensions as parallel antecedents of operational practice, rather than treating awareness as equivalent to adoption.

The second question concerns the mechanism connecting technology and performance. A business can buy an efficient machine without establishing the procedures needed to operate it efficiently over time. Conversely, environmental routines may improve performance even in firms with modest technological investments. The central theoretical issue is thus whether green operations practices explain the contribution of technology adoption over and above the previously proposed finance-related pathways. This argument is compatible with research differentiating green production technologies and capabilities (Serrano-García et al., 2023), but the precise indirect effect remains to be tested.

The proposed framework does not assume that the three antecedents are independent in real organizations. Financing may make technology adoption more feasible, and existing routines may encourage subsequent technology investment. Those alternative sequences are plausible, but modelling them here without separate theory and propositions would obscure the paper's focused contribution. The present model deliberately tests the conceptual usefulness of technology adoption as an additional parallel explanatory construct; future empirical work should compare this specification with competing causal models. Existing studies provide complementary rather than interchangeable evidence. Green finance research emphasises investment resources, financing conditions and ESG outcomes (Flammer, 2021; Gao et al.,

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2024). Financial literacy research connects knowledge with process innovation and environmental sustainability (Molina-García et al., 2025). Green production research differentiates technologies from production capabilities (Serrano-García et al., 2023). These studies support the separate elements of the proposed argument, but do not establish all seven relationships in the exact model. Accordingly, its originality claim should be understood as an integration and proposed explanation, subject to broader literature review and empirical assessment.

Theoretical Underpinning

The Resource-Based View (RBV) and Natural-Resource-Based View (NRBV) form the primary theoretical foundations of this paper. The Technology–Organization–Environment (TOE) framework is used as a supporting lens to explain issues surrounding technology adoption. Each perspective offers a different but complementary explanation; they should not be represented as three independent theories tested by the present conceptual paper.

Resource-Based View

The RBV argues that resources and capabilities can help firms achieve sustained advantage when they are valuable and difficult to replicate (Barney, 1991). Here, access to green finance represents financial opportunity, green finance awareness represents specific managerial knowledge, and green technology adoption reflects technological resource deployment. None of these resources automatically creates a sustainability outcome. Their value depends on how they are mobilised within activities and capabilities.

Green operations practices are treated as capabilities through which resources can be put to use. For example, an energy-saving machine can support resource efficiency only when it is appropriately operated, maintained and monitored. RBV therefore informs the distinction between enabling resources and the routines that convert them into observable performance.

Natural-Resource-Based View

NRBV places the natural environment at the centre of the resource-capability argument. Hart (1995) highlighted pollution prevention, product stewardship and sustainable development as sources of potentially valuable environmental capability. Hart and Dowell (2011) further developed the relevance of NRBV to environmental strategy.

The present framework views green operations practices as environmental-operational capabilities that help businesses use financial and technological resources for cleaner production, resource conservation and reduced pollution. Through these capabilities, environmental investments may be translated into operational outcomes. NRBV thus strengthens the logic for treating green operations practices as a mediator rather than an additional financial or technology resource.

Technology–Organization–Environment Framework

The TOE framework explains organizational technology adoption through technological, organizational and external environmental contexts (Tornatzky & Fleischer, 1990). In this article, TOE provides background for understanding technology choice and integration. The proposed constructs do not represent a full operationalisation of all three TOE contexts; consequently, the framework does not claim to test TOE directly. TOE complements RBV and NRBV by highlighting that organisations adopt technologies within practical constraints, including technological suitability, internal capability and external support. It also motivates

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future studies that might add organizational readiness or regulatory influences as boundary conditions for the adoption-to-practice pathway.

Proposed Conceptual Framework and Research Propositions

The proposed framework contains three independent variables (green finance accessibility, green finance awareness and green technology adoption), one mediator (green operations practices) and one dependent variable (sustainable operational performance). Each independent variable is proposed to influence green operations practices, and the latter is proposed to influence sustainable operational performance. Three additional propositions address the resulting indirect relationships. The model does not assume a direct causal arrow from green finance to technology adoption, nor does it include direct finance-to-performance effects.

The framework treats financial accessibility, finance awareness and technology adoption as three different factors that may influence environmental-operational routines. Its additional contribution is the proposed technology-adoption pathway, together with a clear separation between acquiring or integrating a technology and using it through repeated operational practices. The indirect propositions are theoretical and require empirical validation.

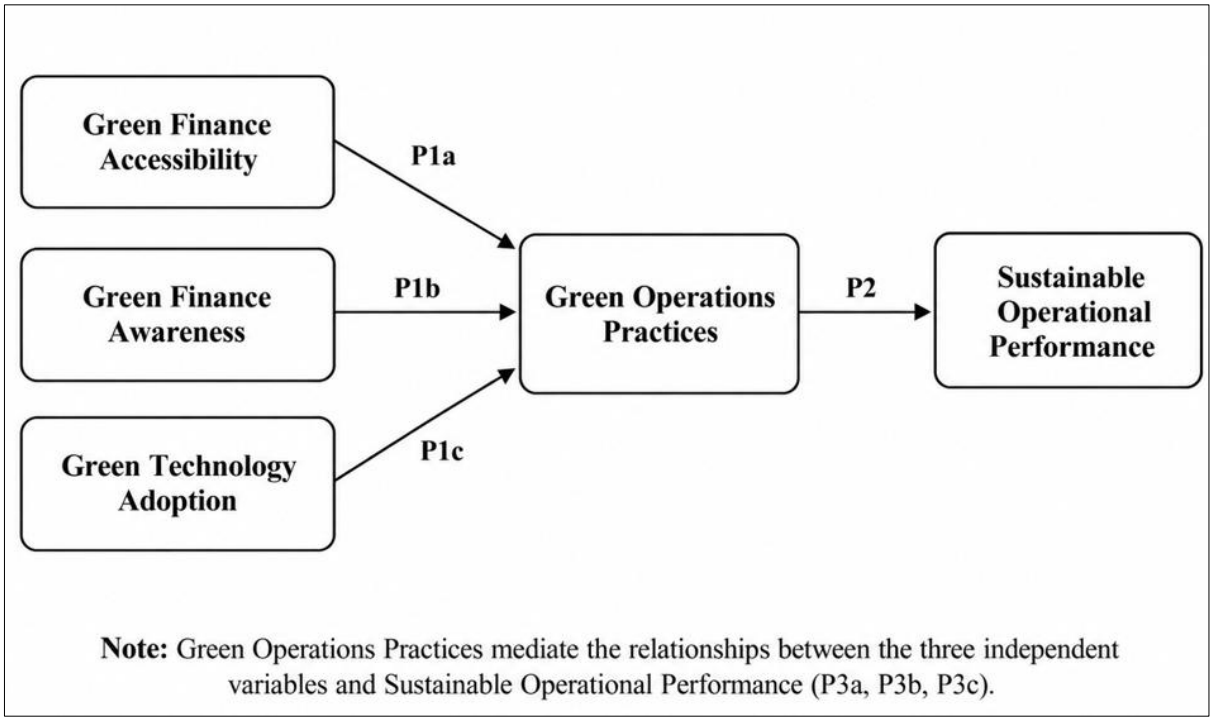


Figure 1: Proposed Conceptual Framework

Green Finance Accessibility and Green Operations Practices

Green finance can make environmental investment financially feasible, especially when firms face initial capital costs. Gao et al. (2024) link green finance policies with ESG-related outcomes and supply chain mechanisms, while Kumar et al. (2022) emphasise SME financing needs. Based on RBV, financial access is proposed to support environmentally responsible routines when resources can be assigned to specific improvements.

P1a: Green finance accessibility positively influences green operations practices.

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Green Finance Awareness and Green Operations Practices

Green finance awareness may help managers identify relevant funding opportunities and plan projects that meet sustainability requirements. Molina-García et al. (2025) connect financial literacy with environmental sustainability through process innovation, although their financial literacy construct is not identical to green finance awareness. This evidence motivates, rather than proves, the proposed knowledge-to-practice pathway.

P1b: Green finance awareness positively influences green operations practices.

Green Technology Adoption and Green Operations Practices

Green technologies can provide the tools needed for monitoring, cleaner processing and resource efficiency. The daily procedures through which those tools generate environmental results constitute a separate capability. Serrano-García et al. (2023) report differentiated effects of green production capabilities and technologies; Mukhtar et al. (2025) connect green technology innovation and capabilities with sustainability performance. These related findings support the relevance of a distinct technology-to-practice proposition.

P1c: Green technology adoption positively influences green operations practices.

Green Operations Practices and Sustainable Operational Performance

Green operations practices may reduce waste, energy use and process losses through routine changes and environmental management. Empirical work has linked green operations and supply chain practices with environmental and operational outcomes (Yu & Ramanathan, 2015; Hsu et al., 2023; El Mokadem & Khalaf, 2024). NRBV explains how environmentally responsible routines may become capabilities that support better operating outcomes.

P2: Green operations practices positively influence sustainable operational performance.

Mediating Role of Green Operations Practices in the Finance Accessibility Pathway

Finance access can enable environmental investment, but operational outcomes depend on implementation. In the proposed model, firms use funding to establish green procurement, resource-saving and cleaner production routines, which may improve operational performance. This indirect effect is conceptually motivated by RBV and NRBV and has not been directly established by the cited finance-policy studies.

P3a: Green operations practices mediate the relationship between green finance accessibility and sustainable operational performance.

Mediating Role of Green Operations Practices in the Finance Awareness Pathway

Awareness can support the identification and planning of green investments, but operational improvements occur only when knowledge is translated into action. Related evidence on financial literacy and process innovation among SMEs (Molina-García et al., 2025) motivates this logic without directly testing the specific awareness construct proposed here.

P3b: Green operations practices mediate the relationship between green finance awareness and sustainable operational performance.

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Mediating Role of Green Operations Practices in the Technology Adoption Pathway

Technological implementation can increase the potential for cleaner production, but its benefits may depend on monitoring, maintenance, staff routines and management processes. The findings of Serrano-García et al. (2023) emphasise the distinction between technology and capability. Accordingly, green operations practices are proposed to explain how adopted technologies become measurable operational improvements.

P3c: Green operations practices mediate the relationship between green technology adoption and sustainable operational performance.

Table 1: Summary of the Proposed Research Propositions

Proposition	Proposed relationship
P1a	Green finance accessibility positively influences green operations practices.
P1b	Green finance awareness positively influences green operations practices.
P1c	Green technology adoption positively influences green operations practices.
P2	Green operations practices positively influence sustainable operational performance.
P3a	Green operations practices mediate the relationship between green finance accessibility and sustainable operational performance.
P3b	Green operations practices mediate the relationship between green finance awareness and sustainable operational performance.
P3c	Green operations practices mediate the relationship between green technology adoption and sustainable operational performance.

Table 2: Suggested Construct Boundaries for Future Empirical Testing

Construct	Illustrative indicators	Exclude to avoid overlap
Green finance accessibility	Availability of suitable schemes; financing conditions; ability to secure eligible funding	Managers' knowledge of schemes
Green finance awareness	Knowledge of scheme eligibility; procedures; documentation and sustainability requirements	Actual receipt of funds
Green technology adoption	Implementation of renewable-energy, low-emission, resource-saving or environmental monitoring technologies	Frequency of operational monitoring and improvement routines
Green operations practices	Green procurement procedures; waste-management routines; resource-use review; environmental process controls	Mere ownership or installation of environmental equipment
Sustainable operational performance	Changes in energy use, waste, resource productivity, operational cost and compliance	Inputs and practices used to pursue these outcomes

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The examples in Table 2 are conceptual measurement guidance, not a validated instrument. Researchers should adapt them to the industry context, check content validity with domain experts, and test discriminant validity before estimating the structural relationships. In particular, a survey should not ask whether a firm "uses energy-efficient technology" under both adoption and operational practice, because that would make the two constructs difficult to distinguish.

Discussion and Implications

The framework brings together financial resources, financing knowledge and adopted green technologies as distinct potential inputs to environmental-operational routines. Gao et al. (2024) demonstrate the relevance of financing and supply chain mechanisms to ESG outcomes, whereas Serrano-García et al. (2023) show that green production technology and production capabilities may have different performance associations. These studies motivate, but do not empirically confirm the proposed mediating role of green operations practices.

The distinction matters for both theory and measurement. Green technology adoption should be assessed through the implementation and integration of technical systems, whereas green operations practices should be measured through regular actions such as procurement rules, maintenance routines, waste reduction procedures and use of energy data. Indicators such as "uses energy-efficient equipment" should not be placed in both constructs without careful operational definitions. Otherwise, relationships might be inflated by construct overlap.

The model proposes parallel effects of accessibility, awareness and technology adoption on green operations practices. It does not claim that finance directly causes technology adoption; this separate possibility could be evaluated in future studies. It also does not assert causal findings because the paper develops propositions from literature rather than collecting primary data.

Theoretical Implications

The theoretical contribution proposed here is to connect financial accessibility, finance awareness and actual technological implementation to the same operational-capability mechanism. RBV helps explain resource mobilisation (Barney, 1991), and NRBV explains the environmental significance of operational routines (Hart, 1995; Hart & Dowell, 2011). The technology pathway adds a distinct theoretical question: whether introducing technical tools contributes to performance through routineised environmental management, over and above financing-related explanations.

A second implication concerns the mediating mechanism. Rather than assuming that environmental finance or technology directly creates results, the framework proposes that green operations practices connect resources with measurable outcomes. This interpretation is consistent with literature on environmental operational practices and performance (Hsu et al., 2023; El Mokadem & Khalaf, 2024), but the three proposed indirect effects still require empirical examination.

Third, TOE provides a supporting explanation of organizational conditions that might shape technology implementation (Tornatzky & Fleischer, 1990). Because the current model does not include all TOE contexts, future work could investigate them as antecedents or boundary conditions instead of claiming the complete TOE framework is tested in this paper.

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Practical Implications

For managers, the framework encourages joint planning of financing, technology implementation and operating routines. A firm considering new equipment should not evaluate the purchase only by acquisition cost or technical specifications. It should also consider whether employees are trained, operating procedures are revised and performance data are monitored. For example, digital energy metering should be linked to regular analysis and specific corrective actions.

Businesses may also benefit from connecting finance-awareness activities with project selection. Managers should understand financing eligibility and reporting requirements before committing to projects, then set measurable targets such as energy consumption per unit of output or waste per production batch. Because the framework is conceptual, these recommendations are proposed actions rather than verified interventions.

Policy Implications

Policymakers and financial institutions may consider green financing schemes that are accompanied by information support and technical guidance. Making products available is important, but organisations may require help interpreting eligibility criteria and selecting appropriate technology. For resource-constrained SMEs, advisory programmes and operational implementation support could complement financial incentives (Kumar et al., 2022).

Green investment programmes may also encourage post-investment performance measurement. Indicators such as resource use, waste and operational efficiency could help firms assess whether financed technologies are generating expected improvements. The conceptual model implies that successful policies should consider the adoption-to-practice transition, but its effectiveness must be tested empirically.

Conclusion

This paper proposes an integrated conceptual framework in which green finance accessibility, green finance awareness and green technology adoption may support sustainable operational performance through green operations practices. The framework distinguishes technology implementation from the recurring managerial and operational routines needed to realise environmental benefits. This distinction offers a more specific account of why technology investments do not necessarily produce comparable operational results across firms.

Guided principally by RBV and NRBV, with TOE used as a supporting perspective, the framework develops seven propositions: three relationships involving the proposed drivers of green operations practices, one relationship with sustainable operational performance and three indirect pathways. The new technology pathway extends a previously published conference model and creates an opportunity to examine the difference between environmental technology implementation and continuing managerial practice.

The framework provides a basis for research and offers tentative guidance for firms and institutions seeking to coordinate green finance and technology support. Its relationships remain theoretical; empirical testing and detailed construct validation are necessary before conclusions can be reached about their magnitude or causal direction.

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Future Research Directions

Future studies could test the seven propositions using survey data from firms that vary in size, sector and technology maturity. Structural equation modelling may be suitable for evaluating mediation if the measurement model, sampling and assumptions are appropriate. Longitudinal designs could help distinguish technology installation from the subsequent development of environmental routines and eventual performance changes.

Construct measurement requires special attention. Green technology adoption should be separated from green operations practices, and sustainable operational performance should use indicators appropriate to the firm's processes. Studies might also examine whether sector, organizational readiness, regulatory pressure or managerial commitment strengthen or weaken the proposed relationships.

Further work could consider alternative causal models. Green finance may itself promote technology adoption, and firms with strong environmental routines may be more willing to adopt technology. Comparing these competing explanations would extend the framework beyond the present set of parallel antecedents.

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