Green Innovation and Firm Performance: A Structured Literature Review and Narrative Synthesis

Mohammed Mansoor Ahmed Pillai[1] Samer Ali Hussein Al-Shami[2,] Ibrahim Bin Ahmad[3]

[123]Institut Teknologi Kelestarian, Universiti Teknikal Malaysia Melaka (UTeM), Melaka, Malaysia

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ABSTRACT

Green innovation is widely discussed as a means of reducing environmental impacts while supporting organizational competitiveness. However, the relationship between green innovation and firm performance is not uniform: studies examine different innovation types, industries, institutional settings, and performance outcomes. This paper presents a structured narrative synthesis of literature on green innovation and firm performance. The available manuscript did not include independently verifiable Scopus exports, screening logs, full-text exclusion records, a source-linked extraction workbook, or an analysis script. Therefore, the previously reported study counts, pooled correlation, heterogeneity statistic, and publication-bias diagnostics are not retained as findings. Instead, the review synthesizes theoretical perspectives and selected empirical studies represented in the reference list, distinguishes financial, operational, environmental, and competitive outcomes, and identifies the evidence-management steps required for a reproducible future meta-analysis. The discussion treats possible mechanisms as theoretical explanations unless they are directly demonstrated by individual studies. The paper concludes that the relationship should be evaluated by outcome, context, and time horizon rather than assumed to be universally positive.

Keywords: green innovation; firm performance; structured literature review; narrative synthesis; environmental management; sustainability

INTRODUCTION

Firms face growing pressure to reduce environmental harm while remaining financially and operationally competitive. Green innovation—including cleaner production processes, resource-efficient technologies, and environmentally improved products—is one response to these pressures. Yet the business value of green innovation is not automatic. Outcomes may depend on implementation costs, customer demand, regulatory conditions, organizational capabilities, and the time required for benefits to emerge.

Individual studies examine a range of outcomes, including financial returns, operational efficiency, environmental performance, sustainability performance, and competitive advantage. These outcomes are related but not interchangeable. Differences in measures, research designs, sectors, and national settings can make findings difficult to compare and may conceal the conditions under which green innovation is associated with better performance.

This paper organizes selected literature on green innovation and firm performance through a structured narrative synthesis. It has two aims: first, to clarify the theoretical arguments and empirical themes in the cited literature; and second, to identify the methodological requirements that must be met before a defensible quantitative meta-analysis can be reported.

Because the original search and extraction records were not available for independent checking, this version does not claim to reproduce a complete systematic search or validate a pooled effect.

CONCEPTUAL BACKGROUND

The natural resource-based view argues that capabilities related to pollution prevention, product stewardship, and sustainable development can contribute to organizational advantage (Hart, 1995). The resource-based view emphasizes the strategic value of resources and capabilities that competitors cannot easily replicate (Barney, 1991), while dynamic capabilities theory highlights the ability to sense changes, adapt resources, and reconfigure activities as conditions evolve (Teece, 2007). Institutional and stakeholder perspectives further suggest that regulation, social expectations, and relationships with customers, suppliers, investors, and communities can influence environmental strategy.

These perspectives offer plausible explanations for why green innovation might be associated with firm performance. Process innovation may reduce material waste or energy use, while product innovation may help firms respond to customer expectations or regulatory requirements. However, these mechanisms are theoretical explanations, not conclusions established by a pooled estimate in this paper. Their validity and importance need to be assessed in the individual studies and in future outcome-specific research.

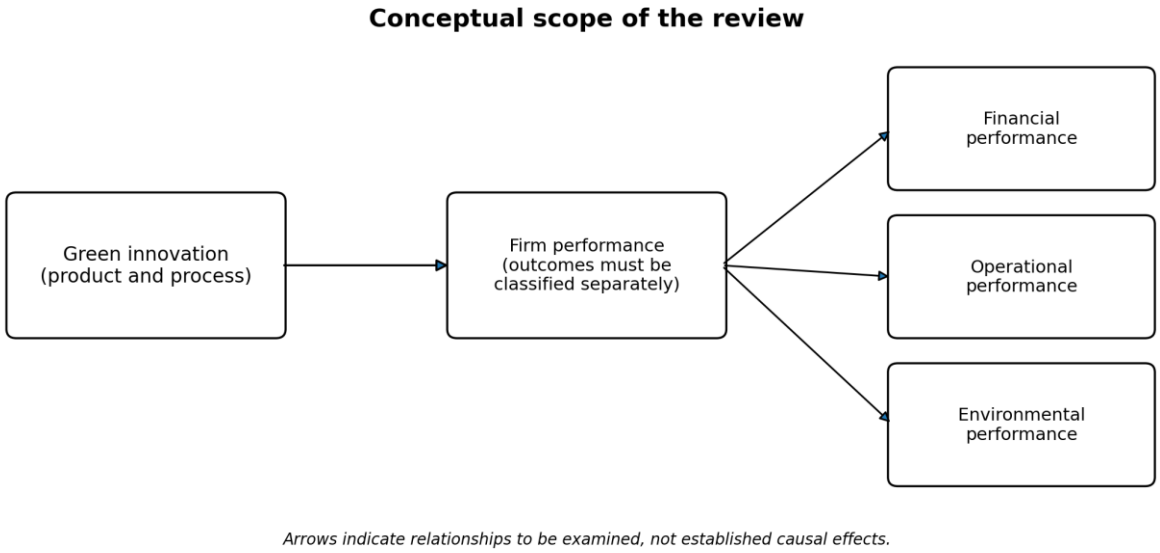


Figure 1. Conceptual scope of the review. The arrows indicate relationships to be examined, not established causal effects.

LITERATURE REVIEW AND RESEARCH GAP

Theoretical Foundations of Green Innovation

Green innovation can be understood as a strategic response through which firms seek to reduce environmental harm while developing capabilities that may support competitiveness. The natural-resource-based view identifies pollution prevention, product stewardship, and sustainable development as potential sources of advantage when they become embedded in firm-specific resources and routines (Hart, 1995). The resource-based view similarly emphasizes the importance of valuable and difficult-to-replicate capabilities (Barney, 1991). Dynamic capabilities theory extends this reasoning by highlighting how firms sense environmental and market changes, adapt resources, and reconfigure organizational activities over time (Teece, 2007). Together, these perspectives suggest that green innovation is not automatically profitable; its implications depend on how firms develop, implement, and capture value from environmental capabilities.

Evidence on Green Innovation and Organizational Outcomes

Prior research considers both potential benefits and costs of environmental innovation. Porter and van der Linde (1995) argue that appropriately designed environmental requirements can stimulate innovation and

resource productivity, although this is not a universal guarantee of improved performance. Ghisetti and Rennings (2014) distinguish innovation types and show why the profitability implications of resource-efficiency innovations may differ from innovations primarily aimed at reducing external environmental effects. These distinctions caution against treating all forms of green innovation or all performance measures as equivalent.

Asadi et al. (2020) examined green innovation in the Malaysian hotel industry in relation to sustainability performance, while Bag et al. (2022) considered eco-innovation alongside green supply chain management, circular-economy capability, and small- and medium-sized enterprise performance. Qiu et al. (2020) examined green innovation under environmental regulation and market turbulence, and Skordoulis et al. (2020) linked environmental innovation and open-innovation dynamics with competitive advantage. Fan et al. (2023) considered absorptive capacity in relation to firm green innovation and sustainable development, while Abbas et al. (2023) examined green knowledge management and green organizational culture. These studies illustrate the breadth of the field; they should not be interpreted as a homogeneous set of effects without checking their constructs, designs, samples, and reported statistics.

Firm-level studies in the reference set illustrate the diversity of settings and mechanisms investigated. Asadi et al. (2020) examined green innovation in the Malaysian hotel industry in relation to sustainability performance, while Bag et al. (2022) considered eco-innovation alongside green supply chain management, circular-economy capability, and small- and medium-sized enterprise performance.

Qiu et al. (2020) examined green innovation under environmental regulation and market turbulence, and Skordoulis et al. (2020) linked environmental innovation and open-innovation dynamics with competitive advantage. Other studies emphasize knowledge and organizational capabilities: Fan et al. (2023) considered absorptive capacity in relation to firm green innovation and sustainable development, while Abbas et al. (2023) examined green knowledge management and green organizational culture. Collectively, these studies suggest that the relationship between green innovation and performance may depend on organizational knowledge, sector conditions, external pressure, and the pathways through which innovation is implemented.

Why Performance Outcomes Should be Distinguished

Performance is multidimensional. Financial performance concerns outcomes such as profitability or returns; operational performance may include efficiency, productivity, and cost reduction; environmental performance concerns emissions, waste, or resource use; and competitive performance includes market position, differentiation, or competitive advantage.

These outcomes may influence one another, but they are not interchangeable. An environmental improvement may precede financial returns, and a cost-saving process innovation may affect operating performance more directly than reputation or market share. Studies such as Albitar et al. (2023), which examine environmental innovation and CO2 emissions, and Asadi et al. (2020), which investigate sustainability performance, illustrate why the operational definition of the dependent variable matters.

Research gap and contribution of the present study

The literature already contains reviews of green product innovation and environmental innovation, as well as meta-analytic work on eco-innovation and firm performance (Dangelico, 2016; Zheng & Iatridis, 2022). The present paper therefore does not claim to be the first synthesis of this relationship.

Its defensible contribution is to organize selected theoretical and empirical themes, highlight the need to separate performance domains, and specify the evidence-transparency requirements for a future reproducible quantitative synthesis. A quantitative contribution cannot be supported unless study eligibility, extracted effect sizes, sample independence, and the comparability of outcomes can be verified.

The review is guided by three questions: (1) What theoretical arguments and empirical themes connect firm-level green innovation with firm performance? (2) How should the relationship be distinguished across financial, operational, environmental, and competitive performance outcomes? (3) What documentation and analytical checks are required to support a transparent and reproducible quantitative synthesis?

RESEARCH QUESTION AND METHOD

Research Question

Review focus: How does the cited literature describe the relationship between green innovation and firm performance, how does the relationship vary across outcome domains, and what evidence is needed before quantitative pooling can be justified?

Review Approach and Evidence Status

This version uses a structured narrative synthesis of the literature represented in the manuscript's reference list. The previously stated counts of 329 records, 56 studies for qualitative synthesis, and 32 studies for quantitative synthesis could not be independently checked because the original database export, dated search strategy, screening log, full-text exclusion record, and deduplication decisions were not available.

These counts are therefore not presented as verified review results. Likewise, this document does not claim to be a fully reproducible PRISMA review. To support a future systematic update, the authors should archive the exact database query and search date, export all records, document duplicate removal, retain title/abstract and full-text decisions, and report each full-text exclusion with a reason.

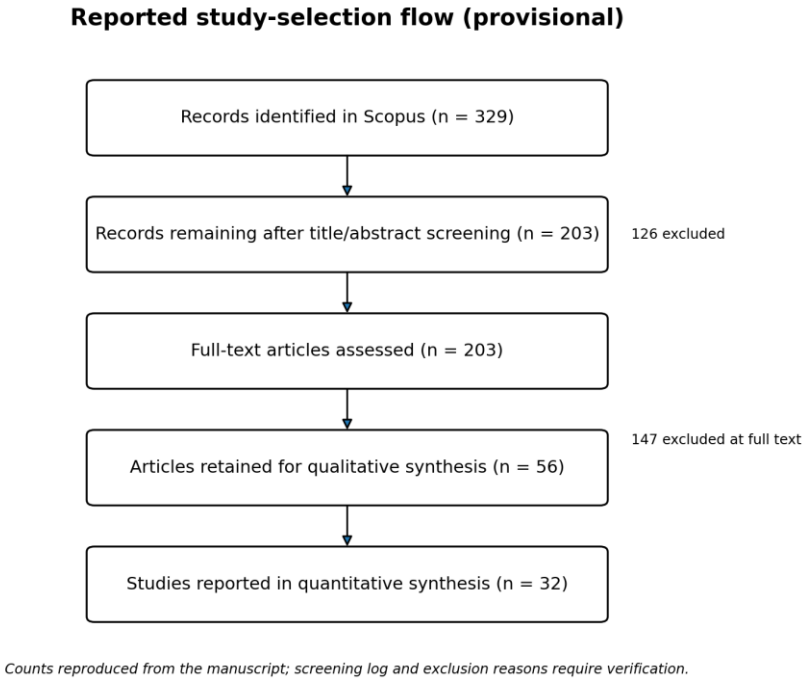


Figure 2. Reported study-selection flow. Counts and exclusion reasons must be checked against the original review records before publication.

Eligibility and Data Extraction

For a future quantitative synthesis, eligibility criteria should be specified before screening. Eligible studies should explicitly measure green innovation, report an identifiable firm-level performance outcome, define the sample, and provide sufficient statistics to calculate or convert an effect size. Reviews, conceptual papers, country-level analyses, and general ESG studies should not be treated as firm-level evidence unless

they meet the prespecified criteria. For every included study, the extraction record should capture the full citation, DOI or stable identifier, sample size, country and sector, green-innovation measure, performance measure, effect size, standard error or convertible statistics, source page/table/model, and any transformation applied.

The previous draft referred to Fisher's z transformation and a DerSimonian–Laird random-effects model, but the extraction workbook and analysis script were not available for independent verification. No pooled estimate is reported in this revised version.

Quantitative synthesis should only be reinstated after every effect size has been traced to the original publication, the calculations have been reproduced from the validated dataset, and decisions about dependent effects and sample overlap have been documented.

Narrative Synthesis of the Literature

Overall Evidence

The available literature provides theoretical and empirical reasons to investigate a positive association between green innovation and firm performance, but the evidence available for this draft does not support a verified pooled estimate. The numerical values previously reported—including $r = 0.432$, its confidence interval, the stated total sample size, and the heterogeneity statistic—are withdrawn from the findings because the study-level data and analysis cannot be independently reproduced. This is not evidence that the relationship is absent; it means that the magnitude and precision of an overall effect cannot responsibly be stated from the records currently available.

The cited studies suggest several pathways that may connect green innovation with organizational outcomes, including resource efficiency, waste reduction, regulatory adaptation, product differentiation, and the development of organizational knowledge.

These pathways should be described as potential mechanisms unless the relevant primary study directly measures and tests them. The direction and magnitude of any relationship may differ according to innovation type, performance domain, sector, and research design.

Contextual Variation and Performance Domains

Because the study-level dataset has not been verified, between-study heterogeneity cannot be reported as a confirmed statistic. Conceptually, variation is plausible given differences in definitions, measures, industries, countries, time horizons, and study designs. A future meta-analysis should report appropriate uncertainty estimates, a prediction interval where justified, and sensitivity analyses. Subgroup or moderator analyses should be prespecified and undertaken only where enough comparable, independent studies are available.

Publication Bias, Robustness, and Sample Overlap

No conclusion about publication bias or robustness is retained in this version. The previously reported Egger test contained an inconsistency between the test statistic and the stated p-value, and the original data and script needed to resolve it were unavailable. The test must be recalculated from verified study-level data rather than corrected by substituting a p-value inferred from the reported statistic.

Funnel plots, Egger-type tests, fail-safe N, trim-and-fill, and leave-one-out analyses should only be reported when their inputs and outputs can be reproduced and their assumptions are appropriate. The authors should also check whether multiple papers use the same firms, survey waves, datasets, or samples; dependent effect sizes must be handled explicitly rather than treated as independent observations.

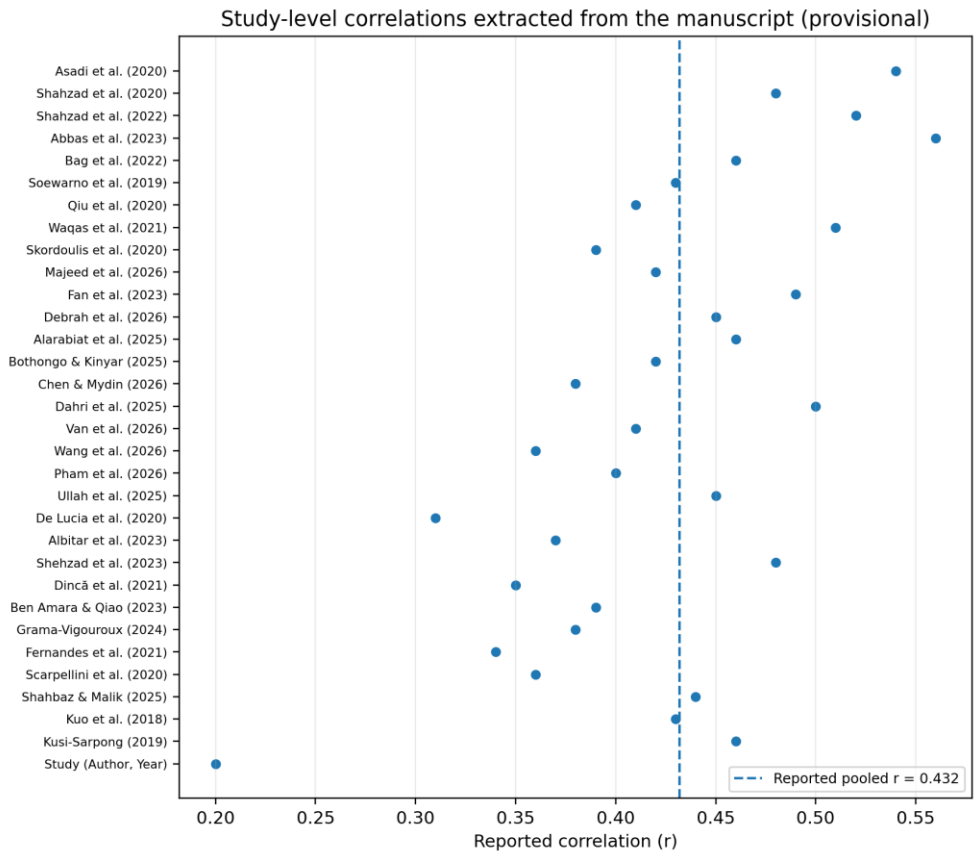


Figure 3. Forest-plot placeholder. Individual study confidence intervals are not displayed because they must be recalculated from verified study-level data before publication

DISCUSSION

The literature provides a reason to examine whether green innovation is associated with improved firm performance, but the current evidence record does not justify a numerical summary of the average effect. Resource efficiency, reduced waste, regulatory adaptation, and product differentiation are plausible mechanisms discussed in the literature; they should not be described as established explanations for an overall effect in this review. Theoretical accounts from the natural-resource-based view, resource-based view, and dynamic capabilities theory help frame hypotheses, but empirical confirmation depends on the design and findings of individual studies.

Context matters. The association may depend on innovation type, performance outcome, firm capabilities, regulatory conditions, industry, and the period over which outcomes are measured. The distinction between financial, operational, environmental, and competitive performance is especially important: a process innovation may reduce energy use but require substantial upfront investment, while an environmental improvement may not translate immediately into sales or profitability.

The principal methodological implication is that a reproducible evidence base must precede quantitative claims. If the original study-level information can be recovered, the review can be updated with a documented search, transparent screening, a source-linked extraction table, a verified analysis script, outcome-specific syntheses, and an explicit audit of sample overlap. If these records cannot be recovered, the appropriate contribution is a structured narrative review that clearly states its evidence limitations, as done here.

The relationship between green innovation and firm performance should be understood as context-dependent rather than uniform across all organizations. Firms may experience different outcomes depending on technological capabilities, financial resources, industry characteristics, regulatory environments, and market positioning. Organizations with established environmental management systems and strong research and

development capabilities may be better positioned to convert green innovation into operational efficiencies or market differentiation. Firms facing high implementation costs or limited access to green technologies may experience delayed or uncertain returns. These are plausible propositions for future testing, not conclusions established by a pooled analysis in this paper.

Financial, operational, environmental, and competitive outcomes should be analyzed separately whenever the available studies permit. Combining these domains into a single overall measure can obscure meaningful differences and may produce a summary that is difficult to interpret. Future research should use consistent construct definitions, report effect sizes and uncertainty transparently, and investigate moderators only when the number and comparability of studies justify doing so.

Implications

For managers, the literature is a reason to evaluate green innovation strategically, not a guarantee of higher profit. Business cases should specify expected environmental and operational outcomes, upfront investment, implementation risks, time horizon, and relevant financial measures.

Green innovation should be integrated into strategic planning, operational management, and performance evaluation rather than treated solely as an environmental compliance activity. Managers can monitor indicators such as energy consumption, material efficiency, waste reduction, production costs, product quality, customer response, and financial returns. Baseline measures and an appropriate monitoring period can help distinguish realized improvements from anticipated benefits. Collaboration among research and development, operations, finance, marketing, and sustainability teams may help align environmental objectives with commercial priorities. These are practical recommendations whose effectiveness should be assessed in context.

For policymakers, access to technical expertise, innovation infrastructure, financing, and knowledge-sharing networks may help organizations overcome adoption barriers and technological uncertainty. However, policy interventions should be evaluated using measurable environmental and economic outcomes rather than assuming that support for green innovation automatically improves firm performance. For researchers, priorities include consistent measurement, transparent reporting of sample characteristics, and longitudinal designs capable of examining how outcomes develop over time.

LIMITATIONS

This paper has important evidence limitations. The database search strategy and date, original Scopus export, duplicate-removal record, screening decisions, full-text exclusion reasons, and extraction workbook were not available for independent verification. Accordingly, the previously reported study counts and quantitative estimates have been withdrawn rather than treated as confirmed findings. The cited studies also differ in how they define green innovation and firm performance, and potential overlap between samples has not been audited. Publication-bias and sensitivity analyses cannot be validated without the original study-level data and code. The reference list itself should be checked against the original publications before submission. These constraints mean that this paper is a structured narrative synthesis of the cited literature, not a reproducible systematic review or a validated meta-analysis.

CONCLUSION

This revised paper synthesizes selected literature on green innovation and firm performance and explains why the relationship should be examined across different performance domains and organizational contexts. It does not retain the previously reported pooled correlation, confidence interval, sample total, heterogeneity statistic, or publication-bias conclusions because the underlying search, extraction, and analysis records were not available for independent verification. Their removal reflects an evidence-verification limitation, not a conclusion that green innovation has no relationship with firm performance.

The literature offers plausible reasons why green innovation may support resource efficiency, environmental outcomes, organizational learning, or competitive positioning. Whether these benefits translate into financial or operational gains depends on the innovation adopted, the firm's capabilities, the relevant market and regulatory setting, the outcome measure, and the time horizon. These propositions should be tested with verified primary-study evidence and should not be interpreted as causal findings of the present synthesis.

Future research should reconstruct a transparent evidence base by preserving the full search strategy and date, database exports, duplicate decisions, screening records, full-text exclusion reasons, and a table of all included studies. Each extracted effect should be linked to its original publication, sample size, green-innovation measure, performance outcome, source location, and calculation. Researchers should reproduce analyses using an available workbook and script, resolve the Egger-test discrepancy from verified inputs, assess sample overlap and dependent effects, and provide complete forest plots and appropriate uncertainty estimates. Where comparable evidence is sufficient, separate syntheses should be conducted for financial, operational, environmental, and competitive outcomes. The central question is not simply whether going green pays off, but under what conditions, for which outcomes, and over what time horizon the relationship is most evident.

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