

Green Technology Adoption and Sustainable Business Performance in Manufacturing Industries: An Integrative Literature Review

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Abstract. The growing pressure to improve environmental performance while maintaining competitiveness has encouraged manufacturing industries to adopt various forms of green technology. This study aims to synthesize the existing literature on the relationship between green technology adoption and sustainable business performance in manufacturing industries and to identify the organizational and environmental factors that influence this relationship. An integrative literature review was employed by examining peer-reviewed studies concerning green technology, cleaner production, green innovation, resource efficiency, environmental management, and sustainable business performance. The synthesis indicates that green technology adoption can contribute to sustainable performance through several mechanisms, including reduced energy and material consumption, waste minimization, improved operational efficiency, enhanced environmental compliance, and stronger innovation capability. These outcomes can further support financial, environmental, operational, and competitive performance. However, the effectiveness of green technology adoption is influenced by management commitment, technological capability, regulatory pressure, organizational readiness, employee competence, and access to financial resources. The review also shows that technology adoption alone is insufficient to generate sustainable business outcomes when it is not supported by appropriate environmental management practices and strategic integration. The study concludes that manufacturing firms can obtain greater long-term value from green technology when technological investments are aligned with organizational capabilities, environmental strategies, and continuous improvement practices.

Keywords: green technology adoption; sustainable business performance; manufacturing industries; cleaner production; green innovation

Abstrak. Meningkatnya tekanan untuk memperbaiki kinerja lingkungan sekaligus mempertahankan daya saing mendorong industri manufaktur untuk mengadopsi berbagai bentuk teknologi hijau. Penelitian ini bertujuan untuk menyintesis literatur mengenai hubungan antara adopsi teknologi hijau dan kinerja bisnis berkelanjutan pada

industri manufaktur serta mengidentifikasi faktor organisasi dan lingkungan yang memengaruhi hubungan tersebut. Penelitian menggunakan pendekatan *integrative literature review* dengan menelaah artikel *peer-reviewed* yang berkaitan dengan teknologi hijau, produksi bersih, inovasi hijau, efisiensi sumber daya, manajemen lingkungan, dan kinerja bisnis berkelanjutan. Hasil sintesis menunjukkan bahwa adopsi teknologi hijau dapat berkontribusi terhadap kinerja berkelanjutan melalui pengurangan konsumsi energi dan bahan baku, minimisasi limbah, peningkatan efisiensi operasional, peningkatan kepatuhan lingkungan, dan penguatan kapabilitas inovasi. Dampak tersebut selanjutnya dapat mendukung kinerja finansial, lingkungan, operasional, dan daya saing perusahaan. Namun, efektivitas adopsi teknologi hijau dipengaruhi oleh komitmen manajemen, kapabilitas teknologi, tekanan regulasi, kesiapan organisasi, kompetensi karyawan, dan akses terhadap sumber daya keuangan. Kajian ini juga menunjukkan bahwa adopsi teknologi saja belum cukup untuk menghasilkan kinerja bisnis yang berkelanjutan apabila tidak didukung oleh praktik manajemen lingkungan dan integrasi strategis yang memadai. Penelitian ini menyimpulkan bahwa perusahaan manufaktur dapat memperoleh nilai jangka panjang yang lebih besar dari teknologi hijau apabila investasi teknologi diselaraskan dengan kapabilitas organisasi, strategi lingkungan, dan praktik perbaikan berkelanjutan.

Kata Kunci: adopsi teknologi hijau; kinerja bisnis berkelanjutan; industri manufaktur; produksi bersih; inovasi hijau

1. Introduction

Manufacturing industries face increasing pressure to reconcile economic competitiveness with environmental responsibility and long-term sustainability. Production activities are closely associated with energy and material consumption, waste generation, emissions, and other environmental impacts, making the manufacturing sector an important context for the transition toward sustainable development. Consequently, firms are increasingly expected to redesign production processes, improve resource efficiency, reduce environmental burdens, and incorporate sustainability considerations into technological and strategic decisions. Recent literature shows that green innovation in manufacturing has developed into a multidimensional research field involving organizational, technological, market, environmental, policy, financial, and dynamic-capability factors (Ren & Mia, 2025).

Within this transition, green technology adoption represents an important mechanism through which manufacturing firms can transform conventional production systems into more environmentally sustainable operations. In the literature, closely related concepts include green technology innovation, green production technology, eco-innovation, low-carbon innovation, and green product and process innovation. Green technologies generally involve environmentally friendly and resource-efficient technologies, products, and production processes designed to reduce adverse environmental impacts while supporting organizational objectives. Green process innovation may include energy conservation, waste reduction, recycling, the

substitution of hazardous materials, and improvements in manufacturing efficiency, while green product innovation focuses on reducing environmental impacts throughout the product life cycle (Ren & Mia, 2025).

The adoption of green technology is increasingly viewed not only as an environmental response but also as a strategic business decision. Manufacturing firms invest in cleaner and more efficient technologies because such technologies can potentially reduce resource consumption, improve operational processes, support environmental compliance, strengthen innovation, and create new sources of competitive value. Shahzad et al. (2022), examining green innovation technology adoption in the manufacturing industry, demonstrate that green innovation adoption can support sustainable development when firms possess the organizational conditions required to implement environmentally oriented technological change. Their study reinforces the view that green technologies should be considered part of organizational strategy rather than isolated technical investments.

The performance implications of green technology adoption are particularly important because sustainable business performance extends beyond short-term financial outcomes. Sustainable performance is commonly examined through interconnected economic, environmental, and social dimensions. Evidence from Malaysian manufacturing companies shows that comprehensive green technology innovation significantly improves sustainability performance across these three dimensions. Mukhtar et al. (2025) further demonstrate that innovation capabilities strengthen the relationship between green technology innovation and sustainability performance, indicating that technological investment produces greater value when firms possess the capability to develop, assimilate, and exploit innovation effectively.

Evidence from manufacturing operations also supports the importance of combining technological resources with production capabilities. Serrano-García et al. (2023) examined green production capability and technology in manufacturing firms and found positive performance implications associated with their implementation. This suggests that green technology cannot be separated from the organizational routines through which production resources are managed. In other words, acquiring environmentally friendly technologies does not by itself guarantee superior outcomes; firms must possess the production, managerial, and organizational capabilities necessary to integrate those technologies into everyday operations.

Green innovation may also generate financial value through changes in products and production processes. Xie et al. (2019), using evidence from manufacturing companies, found that green process innovation positively influences green product innovation and that both forms of innovation can contribute to corporate financial performance. Their findings also indicate that green product innovation mediates the relationship between green process innovation and financial performance. This evidence is particularly relevant because it demonstrates that environmental innovation and financial objectives are not necessarily conflicting; under appropriate organizational conditions, greener production processes can contribute to business value creation.

Nevertheless, the relationship between green technology adoption and sustainable business performance is not automatic or uniform across firms. Technological readiness and organizational capabilities play important roles in determining whether firms can successfully convert green technologies into performance outcomes. Ullah et al. (2025), based on evidence from 418 manufacturing firms, found that technological readiness positively affects sustainability performance and that green dynamic capabilities serve as an important pathway through which this effect occurs. Employee green behavior further strengthens the contribution of green dynamic capabilities to sustainability performance. These findings indicate that sustainable outcomes depend on the interaction among technology, organizational capabilities, and human behavior rather than on technological adoption alone.

The organizational dimension is also evident in the Indonesian context. Indrawati et al. (2025), studying food-sector SMEs in Indonesia, identified technological, environmental, and organizational factors as determinants of green innovation adoption, with organizational factors emerging as the strongest category in their study. Although the research focused on SMEs rather than large manufacturing corporations, its findings provide relevant evidence that managerial readiness, organizational resources, and internal conditions are central to the implementation of green innovation, particularly in food-related production activities.

The existing literature therefore suggests that green technology adoption operates within a broader organizational system. Recent research has identified technological readiness, innovation capabilities, dynamic capabilities, organizational readiness, market conditions, environmental pressure, government policy, and financial resources

as relevant determinants of green innovation in manufacturing firms (Ren & Mia, 2025). At the same time, empirical studies examine different outcomes, ranging from environmental and operational performance to financial, social, and broader sustainability performance. The diversity of these constructs makes it difficult to explain the green technology–performance relationship through a single direct pathway.

This fragmentation also creates an important research opportunity. Previous studies frequently examine specific technologies, particular types of green innovation, individual organizational capabilities, or selected performance dimensions separately. For example, some research emphasizes green product and process innovation, while other studies focus on technological readiness, green dynamic capabilities, organizational determinants, or economic and environmental performance. Although these perspectives provide valuable evidence, a more integrated understanding is needed to explain how green technology adoption is translated into sustainable business performance and which organizational and environmental conditions strengthen or constrain this process. The recent systematic review by Ren and Mia (2025) similarly shows that green innovation research contains multiple determinant clusters and identifies technology, dynamic capabilities, energy, finance, government policy, and other areas as continuing directions for investigation.

Accordingly, this study aims to synthesize the existing literature concerning green technology adoption and sustainable business performance in manufacturing industries. Specifically, the review seeks to address three questions: (1) what organizational, technological, and environmental factors influence the adoption and effective implementation of green technologies in manufacturing firms; (2) through what mechanisms does green technology adoption contribute to economic, environmental, social, and operational performance; and (3) what organizational capabilities and contextual conditions strengthen or constrain the relationship between green technology adoption and sustainable business performance? By integrating evidence from green technology, green innovation, sustainable manufacturing, and organizational-performance research, this study seeks to provide a clearer framework for understanding green technology as both an environmental solution and a strategic business capability.

2. Method

2.1 Review Design

This study employed an integrative literature review to synthesize empirical and conceptual evidence concerning green technology adoption and sustainable business performance in manufacturing industries. The integrative approach was selected because research in this field involves heterogeneous technological applications, organizational contexts, theoretical perspectives, and performance measures. This method allows findings from diverse studies to be compared and integrated into a broader conceptual understanding (Whittemore & Knafl, 2005; Torraco, 2016).

The review process followed the general stages of integrative review methodology, including problem identification, literature search, data evaluation, data analysis, and presentation of findings. Methodological transparency was also guided by Snyder (2019), who emphasizes that literature reviews used as a research methodology should apply explicit procedures for identifying, evaluating, and synthesizing previous research.

2.2 Literature Search and Selection

The literature search focused primarily on peer-reviewed journal articles published between 2016 and 2026. Earlier publications were considered only when they provided important methodological or conceptual foundations. Search terms were developed around three main groups of concepts: green technology, manufacturing, and sustainable performance.

The principal keywords included “green technology adoption,” “green technology innovation,” “green innovation,” “green process innovation,” “cleaner production,” “sustainable manufacturing,” “manufacturing industry,” “sustainable business performance,” “environmental performance,” “operational performance,” “financial performance,” “green dynamic capability,” and “technological readiness.” Combinations of these terms were used to identify studies examining how environmentally oriented technologies and organizational capabilities contribute to manufacturing performance.

Studies were included when they: (1) were published in peer-reviewed journals; (2) examined green technology, green innovation, cleaner production, or closely related environmentally oriented technologies; (3) addressed manufacturing firms or organizational contexts relevant to manufacturing; and (4) reported implications for

environmental, operational, financial, social, competitive, or sustainability performance. Studies that focused exclusively on technical engineering processes without organizational or business implications, non-peer-reviewed sources, duplicate publications, and sources without verifiable bibliographic information were excluded.

Table 1. Literature Review Protocol

Component	Review Criteria
Review approach	Integrative literature review
Main focus	Green technology adoption and sustainable business performance
Main publication period	2016–2026
Source type	Peer-reviewed journal articles
Technological concepts	Green technology, green innovation, cleaner production, green process innovation
Organizational concepts	Technological readiness, dynamic capability, organizational readiness, management commitment
Performance dimensions	Environmental, operational, financial, social, competitive, and sustainability performance
Main context	Manufacturing industries
Exclusion criteria	Purely technical studies without business implications, non-peer-reviewed sources, duplicate or unverifiable publications
Synthesis method	Thematic and comparative synthesis

2.3 Data Extraction and Synthesis

Relevant information from each study was organized according to the publication year, manufacturing context, green technology or innovation construct, organizational factors, performance indicators, and principal findings. Particular attention was given to distinguishing technology adoption from the organizational capabilities required to obtain value from that technology.

The selected evidence was synthesized thematically into four main dimensions: (1) drivers of green technology adoption, (2) organizational mechanisms supporting implementation, (3) pathways linking green technology with sustainable business

performance, and (4) contextual conditions influencing the effectiveness of green technology adoption.

The synthesis compared evidence across studies rather than calculating a pooled statistical effect. A meta-analysis was not performed because the reviewed studies employed different constructs, industries, research designs, and measures of performance. The objective was therefore to identify recurring patterns, complementary explanations, and contextual differences in the green technology–performance relationship.

2.4 Source Verification

To maintain reliability and traceability, bibliographic information was cross-checked against official journal or publisher records before studies were incorporated into the review. Author names, article titles, publication years, journal information, and DOI details were examined for consistency. Findings were interpreted only within the context reported by the original studies, and no sample characteristics, statistical results, or causal effects were introduced unless explicitly supported by the source.

3. Results and Discussion

3.1 Drivers of Green Technology Adoption

The literature synthesis shows that green technology adoption in manufacturing industries is influenced by a combination of organizational, technological, environmental, market, regulatory, and financial factors. Green technology should therefore not be viewed merely as an equipment investment, but as part of a broader organizational transition toward environmentally responsible production.

Ren and Mia (2025) identify ten major groups of determinants of green innovation in manufacturing industries, including organizational factors, industrial collaboration, market conditions, environmental factors, government policies, technological factors, corporate social responsibility, finance and investment, dynamic capabilities, and energy-related factors. Their synthesis demonstrates that green innovation is shaped by interactions among internal capabilities and external pressures rather than by a single determinant.

Evidence from Indonesia reinforces the importance of organizational conditions. Indrawati et al. (2025), examining SMEs in the pineapple-based food sector, classify

determinants of green innovation adoption into technological, environmental, and organizational categories. Organizational factors were found to be the most important determinants in the studied context. This finding is particularly relevant to manufacturing and food-processing businesses because access to technology alone does not ensure adoption when managerial commitment, organizational resources, knowledge, and implementation capabilities remain limited.

Technological readiness is another important driver. Ullah et al. (2025) found that technological readiness positively influences sustainability performance and also contributes through the development of green dynamic capabilities. Their findings indicate that firms need the ability to absorb, configure, and utilize technological resources rather than merely purchase environmentally oriented technologies.

Overall, these findings suggest that successful green technology adoption depends on three interconnected conditions: the willingness of firms to pursue environmental objectives, their capacity to implement new technologies, and external conditions that provide incentives or pressures for change.

3.2 Green Technology and Sustainable Business Performance

The reviewed studies generally indicate that green technology and green innovation can contribute positively to sustainable business performance. However, performance should be understood as multidimensional, encompassing not only financial outcomes but also environmental, operational, and social performance.

Mukhtar et al. (2025) provide direct evidence from manufacturing companies that comprehensive green technology innovation improves economic, environmental, and social sustainability performance. Their findings further show that innovation capability strengthens this relationship, indicating that firms derive greater benefits from green technologies when they are able to continuously develop and exploit innovation.

Serrano-García et al. (2023) similarly demonstrate positive performance effects from the implementation of green production capability and technology in manufacturing firms. Their findings emphasize the complementary relationship between technological investments and production capabilities. Therefore, environmental technologies generate greater organizational value when they are integrated into production systems, process management, and continuous improvement activities.

The relationship with financial performance is also supported by evidence on green process and product innovation. Xie et al. (2019) found that green process innovation promotes green product innovation and that both contribute to corporate financial performance. Green product innovation also mediates the relationship between green process innovation and financial performance. These findings show that environmentally oriented process improvements may produce financial benefits indirectly by supporting the development of products that create additional market value.

Table 2. Selected Evidence on Green Technology and Sustainable Performance

Study	Context/Focus	Main Finding
Xie et al. (2019)	Manufacturing firms; green process and product innovation	Green process and product innovation contribute to financial performance
Shahzad et al. (2022)	Manufacturing industry; green innovation technology	Green innovation technology adoption supports sustainable development
Serrano-García et al. (2023)	Manufacturing firms; green production capability and technology	Green production capability and technology produce positive performance effects
Mukhtar et al. (2025)	Malaysian manufacturing companies	Green technology innovation improves economic, environmental, and social sustainability performance
Ullah et al. (2025)	Manufacturing firms	Technological readiness enhances sustainability performance through green dynamic capabilities
Indrawati et al. (2025)	Indonesian food-sector SMEs	Organizational, technological, and environmental factors influence green innovation adoption
Ren and Mia (2025)	Manufacturing-industry literature	Green innovation is influenced by multiple organizational, market, technological, financial, and institutional determinants

The evidence indicates that the business value of green technology can emerge through several pathways. Resource-efficient technologies may lower material and energy requirements, cleaner processes may reduce environmental burdens, innovation may improve product differentiation, and improved environmental practices may strengthen organizational competitiveness. Consequently, sustainable business performance is better interpreted as the cumulative outcome of several connected operational and strategic improvements rather than as a single financial effect.

3.3 Organizational Capabilities as a Link Between Technology and Performance

An important pattern emerging from the literature is that organizational capability acts as a bridge between technological adoption and performance outcomes. This explains why firms adopting similar technologies may obtain different results.

Mukhtar et al. (2025) show that innovation capabilities positively strengthen the relationship between green technology innovation and sustainability performance. Ullah et al. (2025) similarly demonstrate that green dynamic capabilities mediate the contribution of technological readiness to sustainability performance, while employee green behavior strengthens the effect of these capabilities.

These findings are consistent with the broader manufacturing literature synthesized by Ren and Mia (2025), which identifies dynamic capabilities and technological capabilities among the important determinants of green innovation. The review also notes that firms' ability to absorb and adopt new technologies is an important technological factor supporting green innovation.

For manufacturing firms, this means that investment in cleaner machinery, energy-efficient systems, waste-reduction technologies, or environmentally oriented production processes should be accompanied by managerial and organizational development. Employee competence, learning, technical knowledge, environmental management practices, and innovation routines influence whether green technologies become embedded in operations.

Therefore, green technology adoption should be understood as a capability-building process rather than a one-time purchasing decision.

3.4 Strategic Integration and Contextual Conditions

The synthesis also shows that green technology adoption generates stronger business value when it is integrated into organizational strategy. Firms that treat environmental technologies exclusively as compliance measures may fail to capture their broader operational and competitive potential.

The evidence from Xie et al. (2019) demonstrates that environmental innovation can contribute to financial outcomes through interactions between process and product innovation. Similarly, the findings of Mukhtar et al. (2025) show that green technology innovation simultaneously contributes to economic, environmental, and social performance, demonstrating that environmental investment can support multiple dimensions of organizational value.

However, the literature also indicates that external conditions matter. Ren and Mia (2025) identify government policy, market factors, environmental pressures, financing, industrial collaboration, and technological conditions as relevant determinants of green innovation. Their review also reports that the effects of some policy and financial mechanisms differ according to context. This means that the benefits of green technology adoption may vary according to regulatory systems, market demand, access to finance, industry characteristics, and the technological maturity of individual firms.

Based on the synthesis, the relationship can be summarized as follows:

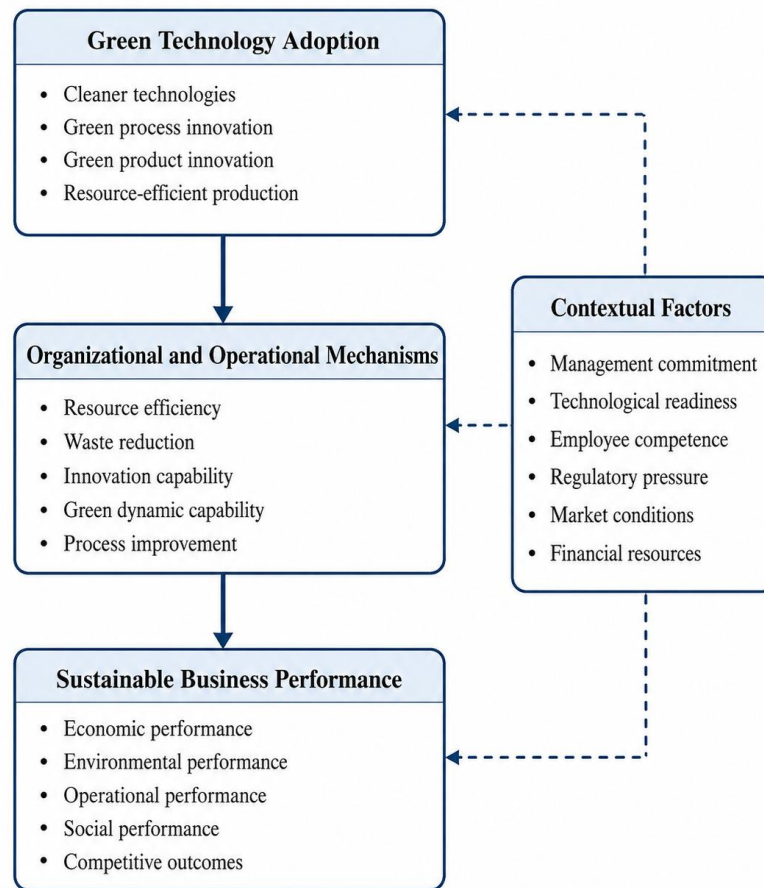


Figure 1. Integrative Framework of Green Technology Adoption and Sustainable Business Performance

This framework indicates that green technology does not directly and uniformly produce sustainable business performance. Instead, technological adoption alters production and innovation processes, while organizational capabilities determine how effectively those technologies are deployed. External conditions can further strengthen or restrict the resulting performance benefits.

From a managerial perspective, manufacturing firms should therefore evaluate green technologies not only according to acquisition costs or environmental compliance requirements but also according to their potential contribution to resource productivity, process improvement, innovation, and long-term competitiveness. Investments in technology should be supported by employee development, management commitment, innovation capability, and environmental management systems. Such integration enables green technology to function simultaneously as an environmental instrument and a strategic business resource.

4. Conclusion

This integrative literature review demonstrates that green technology adoption can play an important role in improving sustainable business performance in manufacturing industries. The reviewed evidence indicates that green technologies contribute to organizational outcomes through resource efficiency, waste reduction, cleaner production, green process and product innovation, and improvements in operational capability. These mechanisms can subsequently support economic, environmental, operational, social, and competitive performance.

However, the benefits of green technology adoption are not generated by technology alone. Organizational capabilities such as innovation capability, green dynamic capability, technological readiness, employee competence, and management commitment determine how effectively green technologies are integrated into manufacturing processes. External conditions, including regulatory pressure, market demand, access to finance, environmental requirements, and technological conditions, also influence the effectiveness of implementation. Therefore, the relationship between green technology adoption and sustainable business performance is conditional and depends on the interaction between technological resources, organizational capabilities, and the surrounding business environment.

The synthesis further suggests that manufacturing firms should position green technology as part of their long-term business strategy rather than merely as a response to environmental compliance. Greater value can be achieved when technological investments are integrated with continuous process improvement, employee development, environmental management, and innovation strategies. In this way, green technology can simultaneously support environmental responsibility and long-term organizational competitiveness.

Future research should further examine differences across manufacturing subsectors, firm sizes, and regulatory environments, as well as the role of emerging technologies in strengthening sustainable production. Longitudinal and comparative studies are also needed to provide stronger evidence regarding how green technology adoption influences sustainable business performance over time.

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