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Green Financial Management: Environmentally Friendly Financing Strategies in Manufacturing Companies

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ABSTRACT

The manufacturing industry plays a central role in economic growth but remains one of the largest contributors to carbon emissions, energy consumption, and environmental degradation. In response to growing sustainability pressures, this study investigates the development of a contextualized green financial management (GFM) framework for Indonesian manufacturing firms, emphasizing the integration of green financing instruments and technological innovation. A descriptive qualitative approach was employed, involving in-depth interviews with financial managers and environmental stakeholders, complemented by analysis of annual reports, sustainability disclosures, and government regulations. Data were processed through reduction, thematic categorization, and triangulation to ensure validity. The findings reveal that the adoption of green financial instruments such as green bonds, green loans, and sustainability-linked credits remains limited due to high issuance costs, regulatory uncertainty, and weak institutional support. However, firms implementing technological innovations—including cleaner production technologies, renewable energy, and digital monitoring systems—showed greater eligibility for green financing. Weaknesses in sustainability reporting and fragmented disclosure frameworks further hinder investor trust, while collaborative partnerships with government agencies, NGOs, and multilateral banks significantly improve access to sustainable capital. In conclusion, a GFM framework for Indonesian manufacturing firms should be built upon three pillars: accessible financing instruments, integration of technological innovation, and strengthened institutional ecosystems. This framework is expected to enhance competitiveness, attract sustainable investment, and accelerate the transition toward a low-carbon economy.
Keywords: *Green financial management, Green bonds, Sustainable financing, Technological innovation, Manufacturing firms*

INTRODUCTION

The global manufacturing industry is currently at a critical juncture in managing the pressure to transform towards sustainability. This sector is widely recognized as one of the largest contributors to global carbon emissions, energy consumption, and environmental waste. Although eco-friendly technologies, such as energy efficiency improvements and green innovations, are available, their adoption in large-scale industries remains limited due to significant financial and structural barriers (Vogue Business, 2024). This phenomenon highlights the urgent need for financing strategies that not only address capital requirements but also encourage the implementation of green practices marking a paradigmatic shift towards environmentally conscious financial management (green financial management). Previous studies have explored the correlation between green finance (GF) and industrial performance. For instance, Xu, Zhu, and Chen (2024) demonstrated that GF facilitates industrial structure upgrading in China through the coupling coordination degree model (Xu et al., 2024). Similarly, Sun (2024) emphasized the positive impact of GF on manufacturing transformation, including spatial spillover effects across the Yangtze River Economic Belt (Sun, 2024). However,

most of these studies tend to focus on macro-level impacts (such as industrial upgrading), whereas the direct application of GF within corporate financial management in manufacturing firms remains underexplored.

A systematic literature review conducted by Pasupuleti et al. (2023) revealed that GF research in high-polluting industries such as manufacturing is still limited, primarily focusing on green credit, innovation, and energy efficiency, without offering a comprehensive framework for integrating green finance into corporate financial strategies (Pasupuleti et al., 2023). Furthermore, the formulation of green innovation models in manufacturing that combine green finance, technology, and logistics synergistically is scarce. Wang et al. (2024) pointed out a research gap in the absence of multimethod approaches that explicitly examine technology as a mediator of sustainable innovation outcomes (Wang et al., 2024). At the policy level, the NGFS (Network for Greening the Financial System) highlights that despite the rapid growth of GF instruments, there remains a substantial investment gap between the public and private sectors, coupled with the urgent need for regulatory coherence, incentives, and better coordination (NGFS, 2022). Additionally, Yardımcı and Oskay (2025) provided empirical evidence from Turkey that the relationship between GF and environmental sustainability follows a non-linear U-shaped curve, meaning that GF may initially have neutral or even negative effects, but over time, as institutional capacity develops, its long-term impact turns positive (Yardımcı & Oskay, 2025). This raises an important question about the short-term versus long-term dynamics of GF in manufacturing firms, particularly in emerging economies such as Indonesia.

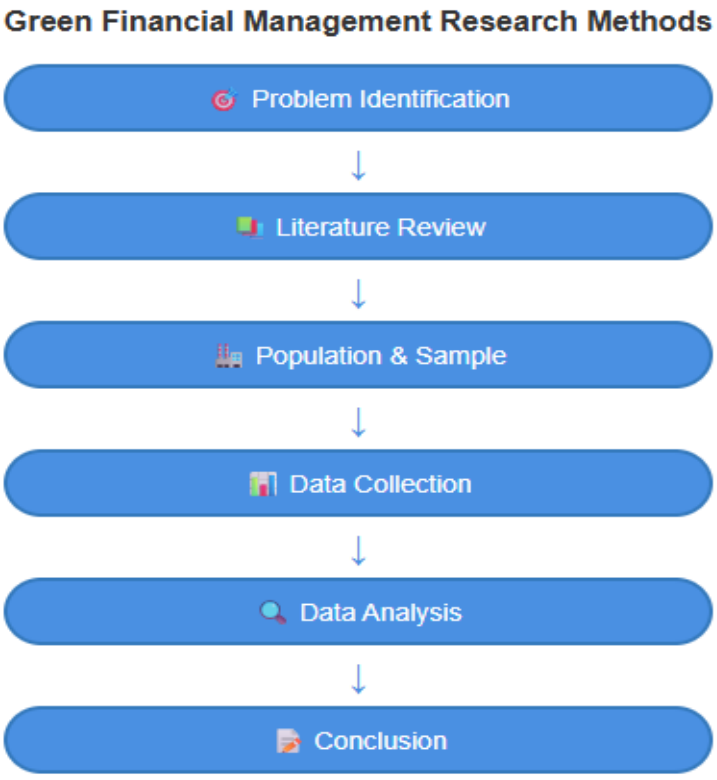
From a theoretical standpoint, Zhao et al. (2024) highlighted the role of corporate management and green financial markets in driving sustainable development indices in China, showing that corporate restructuring and GF use contributed positively to long-term performance. Paradoxically, however, green tax policies had a negative effect, suggesting complex trade-offs in policymaking (Zhao et al., 2024). Meanwhile, Hu (2025), through a bibliometric review, found that although GF research has grown significantly, there is still a lack of studies that map the evolution of GF instruments and their practical implications in sector-specific corporate finance, such as manufacturing . Globally, the establishment of sustainable finance hubs in London, Abu Dhabi, and Singapore demonstrates how financial institutions can accelerate capital flows toward green sectors, providing institutional blueprints that may inspire replication in manufacturing firms of emerging markets . Yet, how such models can be adapted and applied within Indonesian manufacturing companies remains insufficiently examined. In light of the discussion above, this study addresses several research gaps is: 1) The lack of studies that integrate corporate financial management with green financing strategies in manufacturing. 2) Limited frameworks that position technology as a mediator in the green innovation process. 3) The scarcity of localized studies in developing economies, particularly Indonesia, where manufacturing is a key contributor to GDP yet simultaneously a source of environmental degradation.

The novelty of this study lies in developing a contextualized green financial management framework for manufacturing firms in Indonesia, focusing on the integration of green financing instruments and the mediating role of technology. Moreover, this study seeks to analyze the dynamic effects of GF in both the short and long term, thereby contributing a more nuanced understanding of how financial sustainability transitions occur in the real-world context of emerging markets. The objective of this research is to formulate a relevant green financial management framework for manufacturing firms in Indonesia by emphasizing the integration of green financing instruments and technological innovation to support sustainable transformation.

METHODS

The data obtained in this study were analyzed using a descriptive qualitative approach through three main stages: data reduction, data presentation, and conclusion drawing. Data reduction was carried out by filtering, categorizing, and selecting information relevant to the research focus from in-depth interviews with financial managers, environmental managers, and key stakeholders in manufacturing firms. Irrelevant data were eliminated, while essential information related to green financial management practices, barriers to green financing, and implementation strategies was systematically coded. The reduced data were then organized into thematic narratives, which facilitated the identification of recurring patterns concerning the use of green financing instruments, technological innovation, sustainability impacts, and regulatory challenges encountered by manufacturing companies.

The next stage was data presentation, where the organized findings were described narratively to portray the actual conditions of manufacturing firms in adopting green financing. Primary data from interviews were compared and cross-checked with secondary data such as annual reports, corporate sustainability reports, government regulations, and publications from financial institutions. This triangulation process was conducted to strengthen the validity and reliability of the analysis. Finally, in the conclusion drawing stage, the researcher interpreted the identified patterns to formulate a conceptual framework of green financial management suitable for the context of Indonesian manufacturing firms. By employing this descriptive qualitative approach, the study focuses on in-depth interpretive understanding rather than statistical generalization, thereby providing a comprehensive picture of environmentally friendly financing strategies that can support the sustainable transformation of the manufacturing sector.



Picture 1. Graph of Research Methods

RESULTS AND DISCUSSION

The qualitative analysis conducted in this study yielded five central themes related to the implementation of green financial management (GFM) in Indonesian manufacturing firms: (1) the limited penetration of green financial instruments, (2) the mediating role of technological innovation, (3) weaknesses in sustainability reporting, (4) regulatory and institutional barriers, and (5) the importance of collaborative partnerships. First, the adoption of green financial instruments remains modest across the sample. Although awareness of green bonds, green loans, and sustainability-linked financing is growing, most manufacturers still rely heavily on conventional credit lines. Interviews revealed that while large firms with international exposure have begun issuing green bonds or seeking loans tied to sustainability performance, smaller and medium-sized enterprises struggle to access such instruments. This finding aligns with Shishlov et al. (2022), who noted that green bonds are concentrated in larger corporations, leaving SMEs behind due to high issuance costs and complex verification requirements. Second, technological innovation consistently emerged as a key determinant of whether firms could successfully leverage green financing. Firms that adopted cleaner production technologies, renewable energy, and digital monitoring tools reported easier access to sustainability-linked financing. One respondent noted that "without demonstrable technological upgrades, banks do not consider our projects bankable in green finance terms." This resonates with Huang and Zhang (2021), who found that technological modernization directly enhances firms' eligibility for green credit by improving environmental performance metrics.

Third, sustainability reporting remains a significant challenge. While nearly all companies surveyed produced some form of reporting, only a handful adhered to internationally recognized frameworks such as GRI or TCFD. Many sustainability reports were narrative in nature, lacking measurable indicators or third-party verification. This undermines investor trust and reduces the attractiveness of firms seeking green capital. Similar trends were observed in the study by La Torre et al. (2020), which showed that inconsistent disclosure practices across industries are a key bottleneck in sustainable investment flows. Fourth, regulatory uncertainty and institutional weaknesses emerged as critical barriers. Respondents highlighted the absence of a unified national taxonomy of sustainable finance, inconsistencies in fiscal incentives, and limited expertise within banks to evaluate environmental risks. These findings echo those of Tanaka (2022), who argued that fragmented regulatory environments in Southeast Asia hinder the expansion of green finance despite strong political commitments. Finally, collaborative partnerships proved instrumental in improving access to green financing. Companies that partnered with government agencies, international organizations, or NGOs reported enhanced credibility and reduced transaction costs. For example, one firm secured concessional financing through collaboration with a multilateral development bank, while another received capacity-building support from an international NGO. This aligns with Castaneda and Guerrero (2023), who highlighted that cross-sectoral collaboration significantly improves firms' ability to access sustainable finance and ensures better monitoring of environmental outcomes.

Limited Penetration of Green Financing Instruments

The finding that green financing instruments are still underutilized in Indonesian manufacturing reflects broader structural weaknesses in emerging markets. As Shishlov et al. (2022) and Banga (2021) observed, the global green bond market is expanding rapidly but remains highly concentrated in developed countries and large corporations. For Indonesian manufacturers, particularly SMEs, barriers such as high issuance costs, limited investor demand, and lack of domestic verification standards reduce the feasibility of adopting green financial instruments. This suggests that policies to subsidize issuance costs and build domestic verification frameworks are urgently needed.

The Mediating Role of Technological Innovation

Technological innovation is a crucial mediator between financial resources and sustainability outcomes. Firms that integrate energy-efficient machinery, renewable energy systems, or digital monitoring are more attractive to investors because they can demonstrate measurable environmental benefits. Huang and Zhang (2021) and Fang et al. (2022) confirmed that firms with technological upgrades not only improve environmental outcomes but also gain competitive advantages in attracting green financing. In the Indonesian context, this implies that industrial modernization policies must be closely aligned with financial sector reforms, creating synergies between Industry 4.0 initiatives and green finance programs.

Challenges in Sustainability Reporting

Weak sustainability reporting practices reduce investor trust and impede capital flows into green projects. This study found that most firms fail to adopt standardized frameworks, a pattern echoed by La Torre et al. (2020) and Krueger et al. (2021), who showed that inconsistent reporting is one of the primary reasons global investors hesitate to engage in emerging market green finance. To address this gap, Indonesia must promote mandatory sustainability disclosure aligned with global standards. Such a step would not only enhance transparency but also improve comparability across firms, thus reducing information asymmetry for investors.

Regulatory and Institutional Barriers

Institutional weakness remains one of the most formidable obstacles to GFM in Indonesia. Respondents pointed out the absence of a comprehensive green taxonomy, limited fiscal incentives, and inadequate expertise within banks. Tanaka (2022) and Beckmann et al. (2023) highlighted that without supportive institutional frameworks, green finance adoption will remain slow regardless of market demand. For Indonesia, establishing a green taxonomy, enhancing bank capacity for environmental risk assessment, and providing fiscal incentives such as tax rebates or lower interest rates for green loans are critical steps.

Collaborative Partnerships as Catalysts

The importance of partnerships identified in this study reflects global evidence that multi-stakeholder collaboration enhances the success of green finance initiatives. Castaneda and Guerrero (2023) and Okafor et al. (2022) emphasized that partnerships with multilateral banks, NGOs, and government agencies reduce risks, provide technical assistance, and increase investor confidence. For Indonesian manufacturers, collaboration with regional development banks and international institutions could serve as a pathway to overcome financial and technical barriers.

Toward a Conceptual Framework of Green Financial Management

Synthesizing the findings, a contextualized GFM framework for Indonesian manufacturing firms should rest on three pillars:

a. Development of tailored green financing instruments: Instruments such as simplified green loans for SMEs, supported by government guarantees or credit enhancements, should be developed to expand accessibility (Banga, 2021; Shishlov et al., 2022).
b. Integration of technological innovation: Policies must encourage firms to adopt environmentally friendly technologies that simultaneously improve competitiveness and enhance their attractiveness to investors (Huang & Zhang, 2021; Fang et al., 2022).
c. Strengthening of institutional ecosystems: Establishing a national green taxonomy, mandating standardized sustainability reporting, and providing fiscal incentives are critical to fostering a supportive environment for GFM (Tanaka, 2022; Beckmann et al., 2023).

Such a framework not only addresses immediate challenges but also aligns with Indonesia's long-term industrial and environmental policy objectives. By embedding financial, technological, and institutional reforms, Indonesian manufacturing firms can transition toward sustainable practices while securing access to global capital markets.

CONCLUSIONS

This study concludes that the implementation of green financial management (GFM) in Indonesian manufacturing firms is still at an early stage but holds significant potential to drive sustainable industrial transformation. The results show that the adoption of green financing instruments such as green bonds, green loans, and sustainability-linked credits remains limited, primarily due to regulatory uncertainty, high issuance costs, and weak institutional support. Nevertheless, firms that integrate technological innovation including cleaner production technologies, digital monitoring systems, and renewable energy solutions demonstrate stronger eligibility for green financing and greater trust from investors. This confirms the mediating role of technology in linking financial strategies to environmental outcomes. Furthermore, the study highlights that weaknesses in sustainability reporting and the absence of standardized disclosure frameworks continue to hinder investor confidence. Addressing these issues through mandatory, harmonized reporting standards aligned with international frameworks such as GRI and TCFD will be essential to attract global sustainable capital. At the institutional level, the establishment of a national green taxonomy, capacity building for financial institutions, and fiscal incentives such as tax reductions or subsidized interest rates are necessary to enhance the attractiveness of green projects compared to conventional financing. In addition, collaborative partnerships with government agencies, NGOs, and multilateral banks have proven to be effective mechanisms in reducing transaction costs and improving firms' credibility in the eyes of investors. In line with the research objective, the study proposes a contextualized Green Financial Management framework for Indonesian manufacturing firms, built upon three pillars: (1) the development of accessible and tailored green financing instruments, especially for SMEs; (2) the integration of technological innovation as a mediator to strengthen both environmental performance and financial credibility; and (3) the reinforcement of institutional and regulatory ecosystems through standardized sustainability reporting, fiscal incentives, and a unified green taxonomy. By embedding these pillars, manufacturing firms in Indonesia can align financial strategies with sustainable practices, enhance competitiveness, and contribute more effectively to the country's transition toward a low-carbon and sustainable economy.

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