

# Management Accounting Strategies for Environmental Cost Control and Performance Optimization in Green Manufacturing Companies

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## ABSTRACT

Manufacturing firms increasingly face pressure to manage environmental costs from regulations and societal expectations, yet traditional cost accounting methods focusing on labor and materials are inadequate for these challenges. This research aims to explore and propose effective managerial accounting strategies for environmental cost control in green manufacturing firms, highlighting their role in optimizing both operational and financial performance. A qualitative research approach, utilizing secondary data from reputable academic and professional sources, is employed. The study reveals that integrating environmental management accounting tools such as activity-based costing, life cycle costing, and target costing for green design enables firms to better manage environmental costs, leading to improved efficiency and profitability. Furthermore, the study identifies contextual factors, including organizational culture, leadership, and technological capacity, which play significant roles in enhancing the effectiveness of environmental cost control strategies. By incorporating environmental accounting into strategic decision-making, companies can reduce inefficiencies, optimize resources, and align sustainability with financial success. This research provides both theoretical and practical contributions to the field of green manufacturing, offering recommendations for firms to integrate sustainability into their accounting systems to support long-term environmental and economic goals.

**Keywords:** Activity-Based Costing, Environmental Cost Control, Green Manufacturing, Managerial Accounting.

## INTRODUCTION

In the modern era, regulatory pressures and public expectations regarding corporate environmental responsibility have intensified. Manufacturing companies, as one of the industrial sectors that produce significant environmental impacts, face substantial environmental costs, including waste management, emission control, and environmental restoration costs (Hansen et al., 1997). If these environmental costs are not properly managed, companies risk profitability erosion and reputational damage (Purwaatmojo & Ratmono, 2024). Thus, environmental cost management has become an integral part of sustainable industrial operations, requiring an accounting perspective that transcends traditional cost control methods.

Conventional cost control systems, which focus only on materials, labor, and overhead, are no longer sufficient in the context of green manufacturing (Liao et al., 2024; Ella et al., 2025). Manufacturing firms striving to become environmentally friendly must

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expand managerial accounting frameworks to include environmental cost control mechanisms. This shift requires the integration of environmental cost accounting into operational cost structures through approaches such as variance analysis, target costing, and life cycle costing (Rodrigues & Silva, 2024). Through this integration, companies can better identify cost drivers associated with environmental degradation and design preventive strategies that reduce waste and inefficiency.

However, many organizations have yet to systematically incorporate environmental management accounting strategies into their operational and strategic decision-making. Empirical studies demonstrate that environmental management accounting can assist firms in identifying and reducing hidden environmental costs while improving operational efficiency (Sofia et al., 2024; Zahrani & Sari, 2025). Moreover, research on environmental cost management emphasizes that it involves the identification, measurement, analysis, and control of costs linked to environmental impacts (Zahrani & Sari, 2025). By adopting a comprehensive environmental accounting strategy, companies can transform sustainability practices from compliance-oriented activities into sources of long-term competitive advantage.

Despite growing attention to sustainability accounting, there remains a notable gap in both literature and practice. Previous studies by Santika et al. (2023) have mainly focused on the relationship between green accounting and profitability, or studies by Bellamy et al. (2023) have focused on the impact of green accounting on financial and environmental performance. Nevertheless, few have examined the integration of managerial accounting strategies with environmental cost control as a mechanism for performance optimization within green manufacturing firms. Addressing this research gap is crucial to developing an integrative framework that aligns environmental responsibility with operational excellence and financial performance.

The urgency of this research lies in its potential to provide a strategic framework illustrating how managerial accounting can be used proactively to control environmental costs and optimize corporate performance in financial, operational, and reputational dimensions. As environmental challenges and global competition intensify, such a framework is essential not only for theoretical development but also for practical application among managers, internal auditors, and policymakers designing adaptive and sustainable accounting systems (Hamed et al., 2024). Companies that effectively implement green accounting strategies will not only achieve compliance with environmental regulations but also strengthen their market position and stakeholder trust.

Several previous studies have explored aspects of environmental accounting and green manufacturing. For instance, Santika (2023) found that the application of green accounting positively affects profitability in manufacturing firms. Similarly, Bellamy et al. (2023) reported that the relationship between green accounting, environmental performance, and financial outcomes varies across industries, depending on strategic context. However, these studies have not yet explored managerial accounting strategies explicitly oriented toward environmental cost control and their linkages with firm performance optimization. Therefore, the current study seeks to bridge this gap by integrating managerial accounting perspectives with environmental management principles.

This study aims to formulate an effective managerial accounting strategy for environmental cost control in green manufacturing companies and to analyze how these strategies influence operational and financial performance. Furthermore, the research explores the mediating role of environmental cost control and examines contextual factors such as organizational culture, environmental leadership, and technological capacity that may moderate the relationship between accounting strategies and performance outcomes. The study seeks to provide theoretical contributions and practical recommendations to help companies design managerial accounting systems that support the triple bottom line of economic, environmental, and social sustainability.

## **LITERATURE REVIEW**

### **Managerial Accounting Strategy**

Managerial accounting strategy has evolved significantly as firms face growing environmental regulation and stakeholder demands for sustainability. Traditional cost systems focused on materials, labor, and overhead are insufficient for capturing environmental cost drivers such as pollution prevention, emission control, and waste management (Saribu et al., 2023). Environmental Management Accounting (EMA) emerges as a strategic extension of managerial accounting by incorporating environmental cost data into internal decision-making, enabling companies to identify hidden environmental costs and improve operational efficiency. EMA supports sustainability through tools such as life cycle costing, material flow cost accounting, and eco-efficiency analysis, which help firms anticipate long-term environmental liabilities and reduce waste (ISO 14051:2011 outlines material flow cost principles that support such integrated cost views).

Empirical studies indicate that EMA implementation enhances both environmental performance and corporate sustainability outcomes. For instance, research in Indonesian manufacturing highlights that EMA drives environmentally friendly innovation and supports sustainable development by improving resource efficiency and compliance with regulations. Furthermore, EMA is shown to influence environmental performance and economic performance positively when coupled with strategic environmental planning (Deb et al., 2025). Such findings underscore the managerial accounting strategy's dual role in controlling environmental costs and contributing to competitive advantage by aligning cost management with sustainability objectives

### **Environmental Cost Control**

Environmental cost control refers to a firm's ability to systematically identify, measure, and manage costs arising from its environmental impacts, such as waste treatment, pollution prevention, and remediation, to improve both sustainability and operational performance (Danial et al., 2025). This concept goes beyond traditional financial control by highlighting environmental costs as strategic information for decision-making rather than mere compliance expenditures. For instance, comprehensive analyses of environmental costs can reveal prevention, detection, internal failure, and external failure costs, enabling firms to assess the effectiveness and efficiency of environmental activities and target areas where cost savings and environmental benefits intersect.

Moreover, environmental cost control supports proactive budgeting and strategic planning by embedding environmental cost data into performance evaluation systems, helping firms transform environmental obligations into value-creating opportunities (Huynh & Nguyen, 2024). Thus, effective environmental cost control bridges managerial accounting practices with sustainability, enabling firms to improve operational efficiency, comply with environmental regulations, and align environmental initiatives with broader organizational goals. This demonstrates how environmental cost control is not only a cost management tool but a strategic mechanism that enhances both environmental and economic performance.

### **Performance Optimization in Green Manufacturing Firms**

Performance optimization in green manufacturing firms refers to the strategic effort to improve financial, operational, and environmental outcomes simultaneously through the integration of sustainability-oriented management practices. In recent literature, performance optimization is no longer viewed solely as cost minimization but as a holistic process that aligns environmental responsibility with operational efficiency and financial sustainability. EMA plays a crucial role in this process by providing accurate environmental cost information that supports managerial decision-making and resource optimization (Komarudin et al., 2024; Hasbi, 2025).

Empirical studies indicate that green manufacturing firms achieve performance optimization when environmental cost control and operational improvements function as

key mechanisms linking managerial accounting strategies to performance outcomes. Effective environmental cost control reduces inefficiencies, minimizes waste, and prevents environmental risks, which in turn enhances operational performance and profitability (Oteri et al., 2023). Furthermore, integrating environmental considerations into production planning and budgeting enables firms to shift from reactive compliance toward proactive value creation, strengthening competitiveness in environmentally sensitive markets.

Recent evidence further suggests that performance optimization is strengthened when environmental accounting practices are integrated with green innovation initiatives. Research shows that EMA facilitates green innovation, which subsequently improves financial and operational performance by enhancing efficiency, competitiveness, and value creation (Maryati & Soediro, 2024). Thus, performance optimization in green manufacturing firms emerges as a multidimensional outcome resulting from the integration of managerial accounting strategies, environmental cost control, and sustainability-driven innovation. This integration enables firms to achieve sustainable competitive advantage while maintaining environmental and social responsibility.

## **RESEARCH METHODS**

This study employs a qualitative research approach using the literature study (library research) method. This approach was chosen because the main objective of the research is to explore, interpret, and synthesize various theories and empirical findings related to managerial accounting strategies for environmental cost control and performance optimization in green manufacturing companies. A qualitative design allows for a comprehensive understanding of the phenomenon through conceptual and thematic analysis of academic sources, rather than statistical testing (Creswell & Poth, 2016). Therefore, the research focuses on theoretical and empirical interpretations rather than primary field data collection.

The study relies on secondary data obtained from reputable academic and professional publications, including international and national journals, textbooks on managerial and environmental accounting, conference proceedings, and institutional reports. The main data sources include studies discussing Environmental Management Accounting (EMA), green manufacturing practices, and the linkage between managerial accounting strategies and corporate sustainability performance. The selection of data sources was carried out purposively, emphasizing relevance, credibility, and recency, specifically focusing on works published within the last five years to ensure the validity and timeliness of the information.

Data collection was conducted through an extensive literature review using several academic databases such as Google Scholar, ScienceDirect, Emerald Insight, and ResearchGate. The search process employed specific keywords, including “environmental management accounting,” “green manufacturing performance,” “environmental cost control,” and “managerial accounting strategies.” In addition to journal articles, relevant books, reports, and policy documents were also reviewed. The document review technique was used to extract, organize, and evaluate information systematically. The literature selection process followed a systematic review approach, beginning with title and abstract screening, followed by a content evaluation to ensure alignment with the research objectives (Snyder, 2019).

The data were analyzed using a qualitative descriptive analysis supported by content analysis techniques. The analytical process consisted of three main stages: data reduction, data display, and conclusion drawing (Miles et al., 2019). During the data reduction stage, relevant information was identified and categorized based on the main variables: managerial accounting strategies, environmental cost control, and performance optimization in green manufacturing firms. In the data display stage, synthesized information was presented to highlight conceptual linkages and empirical evidence from previous studies. Finally, in the conclusion drawing stage, patterns, relationships, and conceptual insights were identified to develop a strategic framework for managerial

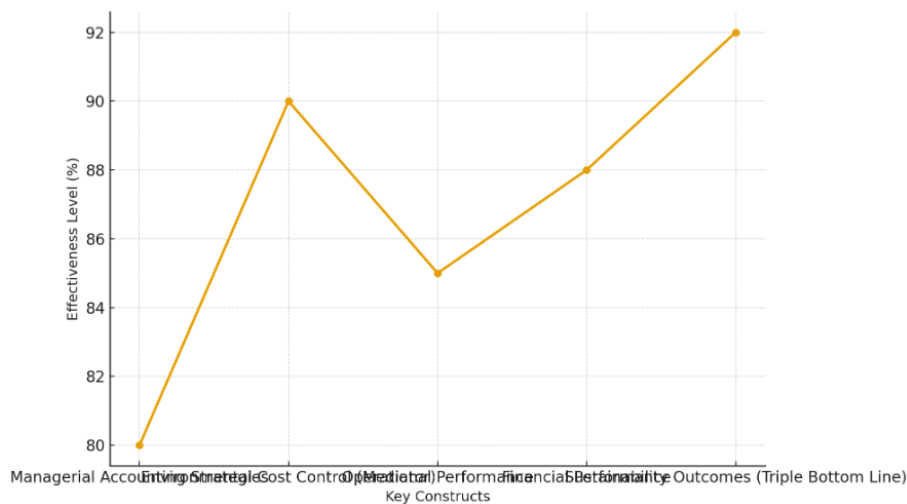
accounting that effectively supports environmental cost control and sustainable corporate performance.

This analytical approach is expected to produce a systematic conceptual mapping that links managerial accounting strategies with environmental performance and operational efficiency in the context of green manufacturing. Through a comprehensive literature-based approach, the study aims to contribute theoretically to the development of environmental management accounting frameworks and practically to help companies design managerial accounting systems that support sustainability principles (sustainability accounting framework).

## RESULTS

### Managerial Accounting Strategies for Environmental Cost Control

The evolution of managerial accounting reflects a shift from traditional financial efficiency toward sustainability-oriented practices, especially in green manufacturing. Conventional accounting overlooks environmental costs like waste, emissions, and energy use, whereas Strategic Environmental Management Accounting (SEMA) integrates financial and environmental dimensions for more comprehensive decision-making (Ferreira et al., 2010; Burritt & Schaltegger, 2010; Gunarathne et al., 2023).



**Figure 1.** Relationship between Managerial Accounting Strategies and Sustainability Outcomes

Figure 1 shows that Environmental Activity-Based Costing (EABC) enables firms to trace and allocate environmental costs to processes or products. Toyota’s use of environmental accounting under its Environmental Challenge 2050 exemplifies improved cost visibility and eco-efficiency (Christ & Burritt, 2013). Life Cycle Costing (LCC) further extends analysis across the product lifespan, as seen in Siemens’ efforts to minimize waste and enhance recyclability (Gale, 2006; Kasim et al., 2024). Similarly, Target Costing for Green Design (TCGD) integrates sustainability goals into design and production; Philips applies this to reduce hazardous materials while maintaining profitability (Chang, 2011).

Firms adopting environmental management accounting achieve greater resource efficiency, innovation, and brand reputation (Qian et al., 2011; Appannan et al., 2023). Unilever’s “Sustainable Living Plan” demonstrates tangible outcomes, including a 30% reduction in CO<sub>2</sub> emissions and lower energy costs (Unilever, 2021). However, success depends on contextual factors such as a sustainability-oriented culture, environmental leadership, and technological capability (Schaltegger et al., 2008; Latan et al., 2019). In essence, managerial accounting now functions as a strategic sustainability tool linking environmental cost control with financial and environmental performance while supporting the triple bottom line.

### The Role of Environmental Cost Control on Operational and Financial Performance

The link between environmental cost control and organizational performance has become central in green manufacturing research. Firms using EMA tools such as Activity-Based Costing (ABC), Life Cycle Costing (LCC), and Material Flow Cost Accounting (MFCA) enhance operational and financial outcomes by identifying inefficiencies, measuring waste costs, and optimizing resource use (Ferreira et al., 2010). Integrating environmental and financial data provides managers with a holistic cost perspective that supports strategic decision-making.

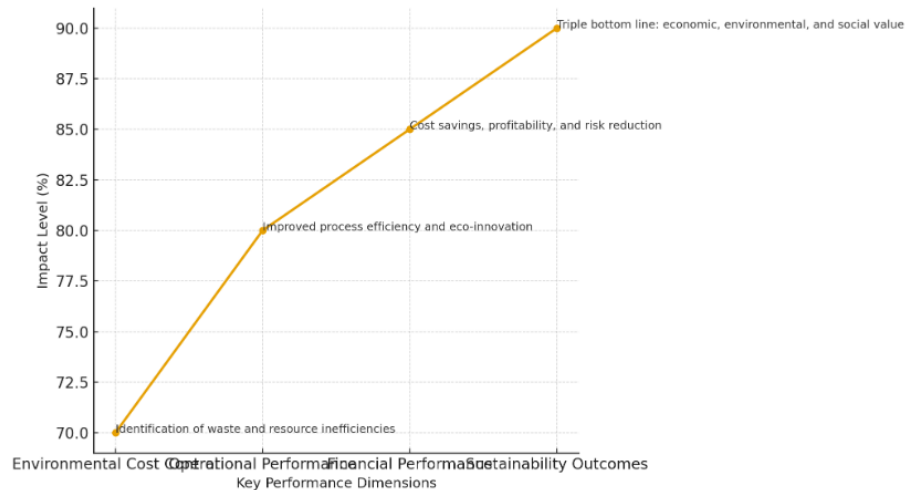


Figure 2. Environmental Cost Control on Performance and Sustainability in Green Manufacturing

Figure 2 shows that operationally, environmental cost control improves efficiency by reducing waste and energy use. Gale (2006) showed that a Canadian paper mill achieved a 15% drop in waste disposal costs and higher production efficiency, while Christ and Burritt (2013) found reduced defect rates and energy intensity among firms applying environmental performance indicators. These results highlight how environmental accounting enhances productivity and compliance simultaneously. Environmental accounting fosters cost savings, profitability, and competitiveness. Toyota’s Environmental Challenge 2050 framework quantifies costs related to emissions and waste, achieving major reductions in CO<sub>2</sub> and energy expenses (Toyota, 2021). Likewise, Unilever’s Sustainable Living Plan links environmental metrics to accounting and financial reporting, reducing emissions by 30% while improving brand equity (Unilever, 2021). Transparent sustainability reporting also boosts investor confidence and long-term value (Schaltegger & Zvezdov, 2015).

Contextual factors such as sustainability-oriented culture, leadership, and digital technology strengthen these effects. Leadership commitment and IoT-based accounting tools improve environmental data precision and real-time decision-making. Siemens’ digital cost tracking exemplifies this integration, enhancing both environmental and financial performance (Siemens, 2022). In conclusion, environmental cost control acts as a strategic bridge between sustainability and profitability, transforming managerial accounting into a proactive tool that drives the triple bottom line economic, environmental, and social performance.

### The Mediating Role of Environmental Cost Control

Environmental cost control plays a vital mediating role in linking managerial accounting strategies with both operational and financial performance in green manufacturing. It translates sustainability-oriented accounting into measurable outcomes by revealing the financial impact of inefficiencies such as waste, pollution, and energy overuse (Schaltegger et al., 2008). This integration ensures that environmental initiatives

are both sustainable and economically viable, embedding sustainability into strategic decision-making.

**Table 1.** Performance Improvements through Environmental Cost Control

Company	CO <sub>2</sub> Reduction (%)	Energy Cost Savings (%)	Financial Savings (€ / year)
Toyota	30%	25%	€250 million
Siemens	20%	18%	€300 million
Philips	15%	12%	€150 million
Unilever	10%	8%	€200 million

According to Table 1, through EMA, firms can connect environmental data with financial metrics for improved cost management. Toyota's Environmental Challenge 2050 illustrates this: integrating environmental metrics into managerial accounting has cut CO<sub>2</sub> emissions by 30% and lowered material and energy costs. Similarly, Siemens (2022) Digital Environmental Accounting uses analytics to link environmental data with cost structures, saving over €300 million annually through efficiency improvements.

Environmental cost control also enhances decision-making and accountability by embedding sustainability indicators in internal reporting (Ajibade, 2025). Unilever aligns environmental and financial targets in its sustainable living plan, making sustainability a core business strategy. Firms like Philips apply environmental cost control in life-cycle analysis to reduce hazardous materials and boost recyclability, achieving both cost savings and stronger brand value. Beyond internal gains, environmental cost control strengthens transparency and investor confidence. By aligning with sustainability frameworks like GRI, companies improve credibility and attract responsible investors. Patagonia exemplifies this by using cost control data to justify sustainable sourcing, enhancing consumer trust and profitability. Environmental cost control acts as a strategic mediator that converts managerial accounting data into actionable sustainability outcomes, reinforcing the triple bottom line of economic, environmental, and social performance.

### **Moderating Factors: Organizational Culture, Leadership, and Technological Capacity**

A sustainability-oriented organizational culture plays a fundamental role in facilitating the adoption of EMA by embedding environmental awareness and responsibility into everyday managerial decision-making. When sustainability values are internalized within the organization, managers and employees become more accountable for environmental impacts and are encouraged to continuously improve performance using environmental indicators as part of routine control systems. Such cultures support transparency, learning, and long-term orientation, which are essential for effective environmental cost control and performance improvement (Hansen & Schaltegger, 2016; Sroufe, 2017).

In parallel, environmental leadership is a critical driver that translates sustainability values into concrete strategies and operational practices. Strong leadership commitment ensures that environmental objectives are integrated into corporate strategy rather than treated as peripheral compliance issues (Egri & Herman, 2000; Stein et al., 2025). Transformational leaders, in particular, foster cross-departmental collaboration and motivate employees to align environmental cost control initiatives with broader performance goals, thereby strengthening the link between sustainability efforts and organizational outcomes (Fernando & Lawrence, 2014; Sun et al., 2022).

Technological capacity further reinforces this process by enabling accurate tracking, measurement, and analysis of environmental costs. Advanced digital technologies, such as IoT-based monitoring systems and data analytics, allow firms to allocate environmental expenditures more precisely and identify efficiency opportunities in real time (Schaltegger et al., 2008). Firms with strong technological capabilities, such as Toyota, have demonstrated that integrating real-time environmental accounting systems can generate both cost savings and sustainability gains (Tasca et al., 2017). When a supportive organizational culture, committed environmental leadership, and advanced

technological capacity interact, environmental cost control evolves into a strategic capability. This synergy enables firms to optimize operational processes, enhance environmental performance, and ultimately improve financial results, positioning sustainability as a source of long-term competitive advantage rather than a cost burden. Thus, organizational culture, environmental leadership, and technological capacity function as moderating factors that strengthen or weaken the effectiveness of environmental cost control in translating managerial accounting strategies into superior organizational performance.

## **DISCUSSION**

The findings of this study reinforce the growing consensus that managerial accounting strategies play a critical role in controlling environmental costs and optimizing performance in green manufacturing firms. Consistent with Burritt and Schaltegger (2010), the results confirm that traditional cost accounting systems are insufficient for capturing environmental costs embedded in manufacturing processes. The adoption of EMA, including tools such as Environmental Activity-Based Costing (EABC), Life Cycle Costing (LCC), and target costing for green design, enables firms to identify hidden environmental costs and align sustainability objectives with managerial decision-making (Ferreira et al., 2010).

The empirical results demonstrate that environmental cost control significantly improves operational performance by reducing waste, energy consumption, and process inefficiencies. This finding aligns with prior case-based evidence reported by Gale (2006), who showed that EMA implementation led to measurable reductions in waste disposal costs and enhanced production efficiency. Similarly, Christ and Burritt (2013) emphasized that firms using environmental performance indicators experienced lower defect rates and improved energy intensity. These results also support the efficiency-oriented perspective of cost management proposed by Hansen et al. (1997), highlighting that environmental cost control is not merely a compliance mechanism but a driver of operational excellence.

From a financial perspective, the study confirms that environmental cost control positively influences financial performance, particularly through cost savings, improved profitability, and enhanced competitiveness. This finding is consistent with Bellamy et al. (2023) and Santika et al. (2023), who reported that green accounting practices and environmental performance contribute to improved corporate financial outcomes. Moreover, the results align with Deb et al. (2023) and Maryati and Soediro (2024), who found that EMA enhances financial performance both directly and indirectly through innovation and efficiency gains. The experiences of firms such as Toyota and Unilever further illustrate how integrating environmental metrics into managerial accounting systems can reduce emissions and energy costs while strengthening brand value and investor confidence (Toyota, 2021; Unilever, 2021).

Importantly, this study confirms the mediating role of environmental cost control in linking managerial accounting strategies with operational and financial performance. Environmental cost control translates sustainability-oriented accounting practices into tangible performance outcomes by making inefficiencies visible and economically quantifiable (Schaltegger et al., 2008; Qian et al., 2011). This mediating effect supports the argument that sustainability initiatives yield optimal results only when supported by robust accounting and control mechanisms, as emphasized by Huynh and Nguyen (2024) and Komarudin et al. (2024).

Furthermore, the moderating effects of organizational culture, environmental leadership, and technological capacity underscore the contextual nature of EMA effectiveness. A sustainability-oriented culture enhances accountability and continuous improvement, while transformational leadership strengthens cross-functional alignment and strategic commitment (Egri & Herman, 2000; Sun et al., 2022; Rely, 2025). Technological capacity, particularly digital and analytics-based systems, improves the accuracy and timeliness of environmental cost information, amplifying performance

outcomes (Schaltegger et al., 2008; Ajibade, 2025). These findings are consistent with Latan et al. (2019), who highlighted the importance of organizational and governance factors in determining the success of sustainability initiatives.

This study contributes to the literature by demonstrating that performance optimization in green manufacturing firms is achieved through the strategic integration of managerial accounting, environmental cost control, and contextual enablers. The findings imply that managers should embed environmental cost information into core accounting systems, supported by leadership commitment, organizational culture, and technology, to transform sustainability from a regulatory obligation into a source of long-term competitive advantage.

## **CONCLUSION**

This study emphasizes the growing importance of environmental cost control within the framework of managerial accounting in green manufacturing. By adopting strategies like environmental management accounting, firms can optimize environmental costs and improve both operational efficiency and financial performance. The integration of environmental considerations into accounting practices not only enhances sustainability but also strengthens corporate competitiveness, reducing waste and energy use while maintaining profitability. The study also highlights the crucial role of leadership commitment, technological capacity, and organizational culture in ensuring the successful implementation of these strategies.

Manufacturing companies should integrate EMA tools, such as activity-based costing and life cycle costing, to track and allocate environmental costs accurately. A sustainability-oriented culture, along with strong leadership, is essential to fostering a commitment to environmental management. Companies should invest in technological advancements, such as digital accounting tools, to enhance the precision of environmental cost tracking. By aligning sustainability goals with financial performance, firms can drive long-term success and improve stakeholder trust.

This study is limited by its focus on green manufacturing, which may constrain the generalizability of the findings to other sectors. Additionally, the use of cross-sectional data limits causal interpretation and prevents observation of long-term performance effects. Future research should explore the practical challenges faced by companies in implementing environmental cost control strategies. Empirical studies involving primary data collection from green manufacturing firms could provide deeper insights into the barriers and opportunities for integrating environmental accounting into operational strategies. Additionally, research could examine the role of emerging technologies, such as artificial intelligence and blockchain, in enhancing environmental cost control and sustainability in manufacturing sectors.

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