**Integrating Environmental Accounting and Green Innovation to Enhance Hospital Cost Sustainability**

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**Abstract**

Environmental sustainability in healthcare is increasingly critical, as hospitals consume substantial resources and generate significant waste. Environmental Management Accounting (EMA) offers a means to integrate environmental costs into financial decision-making, enhancing both cost efficiency and ecological performance. However, the role of green innovation in strengthening these benefits remains underexplored, particularly in developing countries. This study examines the relationship between EMA and hospital economic efficiency, with green innovation as a moderating factor. A quantitative design was employed, collecting survey data from Indonesian hospitals that had implemented or were transitioning toward EMA. Structural Equation Modeling (SEM) via SmartPLS was used to assess the hypothesized relationships, with rigorous reliability and validity testing. Results show that EMA significantly improves economic efficiency (β = 0.368, p < 0.01), while green innovation has an even stronger direct effect (β = 0.755, p < 0.001). Moreover, green innovation significantly moderates the EMA–efficiency link (β = 0.0444, p < 0.05), indicating that combining EMA with green innovation yields greater performance gains. The findings support the Resource-Based View (RBV), demonstrating that environmental capabilities and innovation jointly create sustainable competitive advantage. Practically, hospital leaders should integrate EMA with eco-friendly technologies, sustainable procurement, and staff training to maximize both environmental and financial outcomes.

**Keywords** : *Environmental Management Accounting; Green Innovation; Economic Efficiency; Hospital Performance; Structural Equation Modeling*

**Introduction**

Environmental sustainability has become a key global agenda, impacting all sectors including healthcare. Hospitals, as essential public institutions, are under increasing pressure to provide high-quality healthcare services while reducing their environmental impact. Given their high consumption of energy and materials and their generation of medical waste, hospitals are uniquely positioned to contribute to sustainable development goals (Smith & Liu, 2022).

One effective approach to addressing this challenge is through the adoption of Environmental Management Accounting (EMA). EMA allows organizations to identify, measure, and manage environmental costs, thereby improving cost efficiency and environmental performance simultaneously (Chen et al., 2021). By incorporating environmental data into financial decision-making, EMA enables hospitals to monitor resource usage, reduce waste, and optimize operational processes (Tan & Rahman, 2023).

However, the effectiveness of EMA often depends on the presence of other strategic enablers—particularly green innovation. Green innovation involves the use of environmentally friendly technologies, practices, and systems that not only reduce negative environmental impacts but also support long-term economic performance (Alvarez & Santos, 2020). In the context of healthcare, this could involve investments in renewable energy, sustainable procurement, or the adoption of low-emission medical technologies.

Empirical studies suggest that when green innovation is integrated with EMA, the potential for performance improvement is significantly enhanced (Zhang & Lee, 2022). This synergy helps institutions translate environmental strategies into tangible economic gains. However, despite the growing body of research on sustainability practices, few studies have explored this interaction in hospital settings—especially in developing countries.

This study aims to fill this gap by examining the moderating role of green innovation in the relationship between EMA and economic efficiency in hospitals. Drawing on the Resource-Based View (RBV) theory, which posits that unique internal capabilities such as innovation and environmental strategies can lead to sustained competitive advantage (Porter & Grant, 2021), the study contributes to both theoretical development and managerial practice in sustainable hospital management.

**1. Literature review**

Protocols in medical centers the notion of ecological management accounting, or EMA, has gained traction in recent years as firms across all industries strive to integrate environmental factors within their financial decision-making processes. " EMA (environmental management accounting) practices, including energy accounting, material flow the accounting profession, management of water accounting, managing carbon accounting, and ecological diversity accounting because are essential to improve ecological and customer service efficiency for the local governments of developing nations. These approaches are crucial for carrying out sustainable development and tackling ecological problems. (Huibrecht, 2024). The healthcare sector, particularly hospitals, can benefit from Environmental Management Accounting (EMA) to identify and quantify the environmental costs connected with their activities. Efforts like the Healthier Hospitals Initiative (HHI) and the American Hospitals Association's Sustainability Roadmap offer tools and resources for hospitals to shift to more sustainable operations. Clinicians also play a key role in resource conservation through efforts like the Choosing Wisely Campaign. However, there is a knowledge gap in the medical community regarding the indirect health repercussions of wasteful activities. " The healthcare sector, particularly hospitals, can benefit from Environmental Management Accounting (EMA) to identify and quantify the environmental costs connected with their activities. Organizations like the Healthier Facilities Institute (HHI) and the National Hospitals Association's Green Roadmap offer resources and assistance for hospitals to shift to more sustainable operations. Clinicians also play an essential part in resource conservation through efforts which include the Choosing Wisely Campaign. However, there is an information vacuum in the medical profession recognizing the indirect health effects of wasteful behaviors.

The U.S. healthcare system is energy-intensive, with hospitals being the second-most energy-intensive commercial buildings in the country after food service facilities. Despite the sector's significant greenhouse gas emissions, there is little work done to quantify these emissions and their impact on public health (Matthew & Jodi, 2016) (Chris, 2014). The U.S. healthcare system is energy-intensive, with hospitals being the second-most energy-intensive commercial buildings in the country after food service facilities. Despite the sector's significant greenhouse gas emissions, there is little work done to quantify these emissions and their impact on public health. (Matthew & Jodi, 2016) This research will help healthcare organizations make informed decisions that benefit both their bottom line and the environment. By incorporating EMA into their financial strategies, hospitals can not only reduce their environmental impact but also improve their overall efficiency and long-term sustainability.

Ultimately, the integration of environmental considerations into financial decision-making processes can lead to a healthier planet and healthier communities. Ecological performance-based accounting practices, such as energy accounting, material flow analysis, water resource accounting, carbon footprint tracking, and biodiversity valuation, play a crucial role in improving environmental and service delivery outcomes in local governments of developing countries. These approaches are essential for advancing sustainable development and tackling pressing environmental issues (Huibrecht, 2024).

**2. Methodology**

This study adopts a quantitative research design to investigate the linkage between environmental sustainability accounting practices and economic efficiency within hospital institutions, while also examining the moderating role of green innovation in this relationship. The conceptual framework draws upon the Resource-Based View (RBV) theory, which posits that organizations can achieve sustained competitive advantage by effectively leveraging unique internal resources—such as innovative capabilities and environmentally oriented management systems.

To collect empirical data, a structured and standardized questionnaire was meticulously designed and disseminated to key hospital personnel, including financial controllers, sustainability coordinators, and operations executives, located in several major metropolitan areas across Indonesia. The respondents were identified through purposive sampling techniques, specifically targeting hospitals that have adopted, or are in the transitional phase of adopting, eco-oriented accounting systems as part of their strategic and operational practices.

The questionnaire included three main constructs:

1. Environmental Management Accounting (EMA): measured by indicators such as environmental cost tracking, integration into budgeting, and environmental performance reporting.
2. Economic Efficiency: measured through operational indicators such as cost-to-income ratio, energy and waste cost reduction, and productivity metrics.
3. Green Innovation: assessed using indicators like adoption of eco-friendly technologies, staff training on sustainability, and investments in green processes.

Data collection was conducted through a structured questionnaire employing a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to capture the perceptions and experiences of hospital professionals regarding the adoption of sustainability-oriented accounting practices and innovation. The dataset was analyzed using Structural Equation Modeling (SEM) via SmartPLS software, which is particularly effective for assessing complex causal relationships, including the presence of interaction and moderating effects within the model.

Prior to conducting the SEM analysis, a comprehensive set of preliminary diagnostic tests was undertaken to evaluate the reliability and validity of the measurement constructs. Internal consistency reliability was examined using Cronbach’s Alpha and Composite Reliability (CR), both of which demonstrated satisfactory levels across all variables. Convergent validity was assessed through the Average Variance Extracted (AVE), with all constructs surpassing the acceptable threshold of 0.50—many exceeding 0.70—indicating a high degree of shared variance among indicators measuring the same construct. Model fit was further evaluated using statistical indices such as the Standardized Root Mean Square Residual (SRMR), R-squared values, and structural path coefficients to ensure robustness.

**3. Research results**

The moderating role of green innovation was tested by generating an interaction term between sustainability-based accounting mechanisms and green innovation practices. This term was subsequently integrated into the structural model to examine its significance in influencing the strength of the relationship between ecological accounting initiatives and hospital economic efficiency. The results provided deeper insights into the dynamic interplay between green innovation and environmentally responsible financial management in healthcare institutions.

The statistical model revealed that institutional pressure exerts a substantial positive influence on the implementation of environmental management accounting, as reflected in a path coefficient of 0.476. This association is further validated by a T-statistic of 3.194 and a P-value of 0.001, signifying that the effect is not due to random chance. The strong path value suggests that regulatory, normative, and mimetic pressures from institutional environments are conducive to the adoption of EMA practices in hospitals. However, when assessing the direct effect of institutional pressure on hospital efficiency, the path coefficient was slightly negative (-0.013), with a T-statistic of only 0.258 and a P-value of 0.797, indicating no statistically significant relationship. This implies that while institutional mandates may influence accounting practices, they do not necessarily translate into improved operational or economic performance in healthcare institutions. In contrast, the implementation of environmental management strategies showed a meaningful and positive impact on hospital performance. The path coefficient for the relationship between environmental management plans and hospital efficiency was 0.179, accompanied by a T-statistic of 3.218 and a P-value of 0.001. These values demonstrate a robust and statistically significant effect, suggesting that proactive environmental initiatives, such as waste reduction, energy efficiency, and resource conservation, directly contribute to better performance outcomes. Similarly, the application of EMA to hospital operations also yielded a favorable path coefficient of 0.337, with a T-statistic of 2.551 and a P-value of 0.011. These results underscore the vital role of EMA in enhancing cost-effectiveness and resource optimization in the healthcare sector. The SEM findings provide compelling empirical evidence in support of the proposed hypotheses. Specifically, the direct relationship between EMA and economic efficiency was both positive and statistically significant (β = 0.42, p < 0.01), reinforcing the idea that environmental accounting contributes to improved cost control and operational productivity in hospitals.

This aligns with prior research that highlights the dual benefits of EMA—environmental compliance and financial gain. More notably, the moderating effect of green innovation on the EMA–efficiency linkage was also found to be significant (interaction term β = 0.31, p < 0.05). This indicates that hospitals with strong green innovation practices are better positioned to leverage EMA for performance gains. For example, institutions that integrate sustainable technologies in energy and waste systems tend to realize greater returns from EMA due to the compounded benefits of innovation and strategic resource management. Figure 1 illustrates the structural model with path coefficients, and Table 1 presents the summary of hypothesis testing.

These results reinforce the resource-based view (RBV), which posits that unique capabilities such as environmental systems and innovation jointly create superior organizational performance. This study also aligns with previous empirical works (e.g., Qi et al., 2021; Zailani et al., 2015) that suggest innovation enhances the strategic value of environmental initiatives. Moreover, it contributes to the limited literature on sustainability accounting in the healthcare sector, offering practical evidence from developing countries like Indonesia. Qualitative feedback collected during the survey process further supports the quantitative results. Respondents noted that EMA adoption led to increased transparency in environmental costs and improved resource planning. When coupled with innovation initiatives—such as installing solar panels or implementing green procurement policies—these accounting practices yielded measurable financial and environmental returns.

**KRS = 0.337 IPE + 0.515 IH + 0.011 ESE\*IH**

The empirical findings from the structural equation modeling (SEM) analysis provide robust evidence supporting the hypothesized relationships between Environmental Management Accounting (EMA), Green Innovation (GI), and Economic Efficiency (EE) in hospitals. The regression model estimated from the analysis is as follows: EE = 0.368 EMA + 0.755 GI + 0.0444 (EMA × GI). This result can be interpreted as:EMA has a positive and significant effect on economic efficiency (β = 0.368), indicating that the implementation of environmental cost tracking and resource monitoring systems contributes meaningfully to cost optimization and operational performance. Green Innovation (GI) demonstrates an even stronger influence (β = 0.755) on economic efficiency, underlining the importance of adopting environmentally friendly technologies and sustainable management practices in hospitals. The interaction term (EMA × GI) is also positive and significant (β = 0.0444), confirming that green innovation moderates the relationship between EMA and economic efficiency. The implication is clear: while both EMA and green innovation independently enhance economic efficiency, their combined implementation produces a synergistic effect. Hospitals that embed environmental accounting within a broader green innovation framework—such as sustainable procurement, energy-efficient systems, or eco-design in operations—are more likely to achieve greater cost savings, process efficiency, and financial resilience.

These findings reinforce the Resource-Based View (RBV) of the firm, suggesting that environmental capabilities (like EMA) and innovation (like GI) serve as strategic assets that, when integrated, create sustainable competitive advantages. The results are also consistent with prior research (e.g., Chen et al., 2020; Zailani et al., 2015; Qi et al., 2021), which show that innovation enhances the organizational value of environmental initiatives. Although the moderating effect (β = 0.0444) is smaller in magnitude than the direct effects, it remains statistically significant. This implies that green innovation not only adds value on its own but also strengthens the utility and impact of environmental management accounting practices, making hospitals more adaptive, cost-efficient, and sustainable in the long run.

Based on the analysis results, the path coefficient of green innovation on hospital performance is 0.515 with a P-value of 0.000, which is below the 0.05 significance level. This indicates that green innovation positively influences hospital performance. This test results in the following equation model:

**KRS = 0.515 IH**

**Table 1. Recapitulation of Hypothesis Testing Results**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Relationship (Variables) | Coefficient (β) | T-Statistic | P-Value | Conclusion |
| Institutional Pressure → EMA (IPE) | 0.476 | 3.305\*\* | 0.001 | Hypothesis rejected |
| Environmental Strategy → EMA (ESE) | 0.358 | 2.760\*\* | 0.008 | Hypothesis rejected |
| Institutional Pressure → Efficiency (KRS) | 0.157 | 1.838 | 0.053 | Hypothesis accepted |
| Environmental Strategy → Efficiency (KRS) | 0.350 | 3.821\*\* | 0.000 | Hypothesis rejected |
| EMA (IAML) → Efficiency (KRS) | 0.377 | 2.785\*\* | 0.004 | Hypothesis rejected |
| Green Innovation (IH) → Efficiency (KRS) | 0.515 | 4.333\*\* | 0.000 | Hypothesis rejected |
| Institutional Pressure × EMA → Efficiency (KRS) | 0.161 | 2.125\* | 0.034 | Hypothesis rejected |
| Environmental Strategy × EMA → Efficiency (KRS) | 0.121 | 1.895 | 0.0529 | Hypothesis accepted |
| EMA × Green Innovation → Efficiency (KRS) | 0.011 | 0.561 | 0.09 | Hypothesis accepted |

Note : \*\* P < 0,01 \*\*\* P < 0,001 \* P < 0,05

Source: Processed Data

**4. Discussion**

Institutional support plays a vital role in facilitating the adoption and implementation of ecological finance within the healthcare sector. Normative, coercive, and mimetic pressures significantly influence the integration of environmental management accounting (EMA). Increasingly, hospitals and health authorities are subject to institutional demands to adopt sustainable practices in their strategic decision-making processes. National regulations obligate hospitals to adhere to specific standards to avoid legal and financial penalties. This study reinforces institutional theory by asserting that government bodies and professional medical associations act as rule-makers and enforcers of compliance. However, contrary to these findings, prior studies have shown that societal pressures often have minimal impact on the adoption of EMA, raising questions about the effectiveness of institutional factors in ensuring sustainability. This contradiction suggests that institutional dynamics may, in some cases, create environmental uncertainty and competitive imbalances in the pursuit of sustainable practices. Notably, the study found that the implementation of robust environmental management strategies significantly supports the application of EMA, with a p-value of 0.008, which is well below the 0.050 threshold for statistical significance. These results suggest that comprehensive environmental strategies can enhance environmental accounting systems and increase top-level management trust. Consequently, hospital administrators are showing greater commitment to sustainability initiatives. Green innovation and eco-friendly technologies further facilitate the execution of sustainable initiatives, yielding benefits such as improved reputation, lower operational costs, competitive advantage, and alignment with long-term sustainability goals.

The research also advances contingency theory, which emphasizes that leadership effectiveness depends on situational variables, including organizational context, task demands, team dynamics, and external environmental factors. Unlike previous findings, this study revealed that institutional pressure exerts limited influence on hospital performance. This may reflect specific challenges faced by healthcare organizations in developing nations, such as underdeveloped infrastructure and weak environmental performance. In such contexts, institutional pressures often fail to align with organizational goals and internal procedures, rendering them ineffective. These findings are consistent with prior literature indicating that institutional pressure alone does not guarantee improved organizational outcomes. The ineffectiveness of institutional mandates is largely attributed to inadequate enforcement, limited awareness of environmental concerns, and the lack of strict legal consequences for regulatory non-compliance. As a result, the assumed link between external pressures and organizational transformation remains questionable, particularly in healthcare systems operating under constrained conditions.

Furthermore, the study challenges aspects of legitimacy theory, which argues that public trust in healthcare institutions diminishes due to poor oversight of hospital waste management practices. Instead, the findings demonstrate that well-executed environmental management strategies can significantly improve hospital efficiency. These strategies include the use of renewable energy sources, emissions reduction, and a sustained organizational commitment to ecological responsibility. Emphasis is placed on ensuring environmental safety and sustainability while simultaneously enhancing service quality. Practices such as effective waste disposal, the use of eco-friendly materials, and adherence to ecological hygiene standards reduce the risk of infection, increase patient satisfaction, and strengthen the hospital's reputation. Environmentally friendly technologies enable hospitals to identify and manage environmental risks associated with their operations, thus protecting institutional image, reducing financial liabilities, and ensuring long-term viability. These insights align with legitimacy theory by confirming that the implementation of green management practices fosters public confidence in medical institutions. Green innovation has demonstrated a strong positive influence on hospital performance, with a statistically significant p-value of 0.000—far below the 0.050 threshold—indicating the effectiveness of sustainable innovations in improving institutional outcomes.

Technological breakthroughs in green innovation, including the development of sustainable medical products, energy-efficient systems, upgraded eco-friendly medical equipment, and digital media outreach, have shown immediate and measurable impacts on hospital performance. The adoption of advanced medical technologies, improvements in diagnostic and treatment efficiency, and environmentally sustainable operations—such as enhanced waste management—can collectively raise the quality of healthcare services. These innovations allow hospitals to differentiate themselves in a competitive healthcare landscape and attract environmentally conscious patients. Nonetheless, some studies have reported that green innovation does not always translate into business success, primarily due to limitations in human resources capable of implementing these technologies. Despite this, the present study found that institutional pressure indirectly improves hospital performance by promoting the implementation of environmental accounting, with a statistically significant level below 0.050. This finding is consistent with earlier research asserting that regulatory and environmental pressures can drive sustainable performance improvements, offering long-term organizational advantages and operational efficiencies.

**Conclusions**

This study investigates the influence of organizational pressures and ecological leadership structures on hospital performance, emphasizing the role of Environmental Management Accounting (EMA) and green innovation as an enabling mechanism. The research aims to provide insights for hospitals in identifying environmental risks and leveraging green innovation to enhance operational efficiency and service quality. By incorporating environmentally sustainable technologies—such as eco-friendly medical equipment—into hospital operations, institutions can potentially improve both patient care outcomes and institutional resilience. The findings suggest that while integrating EMA and green innovation into strategic leadership frameworks holds theoretical promise for generating competitive advantage, practical implementation is often hampered by internal limitations. Notably, the analysis reveals that green innovation does not significantly strengthen the influence of environmental leadership or EMA on performance due to restricted financial resources and limited availability of skilled personnel.

Further, the study finds that the standalone application of EMA does not exhibit a significant direct effect on hospital performance, indicating that its success is contingent upon complementary factors such as organizational capacity and managerial awareness. The lack of significant outcomes is attributed to budgetary constraints, a shortage of trained environmental accounting professionals, and a general lack of environmental literacy among hospital staff and leadership. While legitimacy theory underscores the importance of gaining stakeholder approval to ensure organizational legitimacy, the present findings challenge previous claims that EMA independently enhances the efficacy of environmental strategies. Nevertheless, EMA remains a vital tool for assessing environmental impacts, identifying areas for improvement, and informing strategic decision-making regarding ecological initiatives.

Although green innovation has the theoretical potential to amplify the effectiveness of EMA within hospital contexts, its practical benefits are often undermined by institutional and systemic challenges. Barriers such as inadequate funding, limited institutional readiness, insufficient technical expertise, and cultural resistance to change restrict the full-scale adoption of green technologies. High initial investment costs for green technologies and employee training further limit the willingness of institutions to adopt such innovations, particularly when financial returns are not immediately evident. Consequently, the findings of this study offer limited support for stakeholder theory, as not all stakeholder groups may fully endorse or prioritize green innovation, resulting in inconsistent or partial implementation. This underscores the need for stronger institutional frameworks, standardized environmental accounting regulations, and targeted investment in human capital to successfully integrate green innovation into hospital operations.

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