BUILDING GREEN SMEs THROUGH ENVIRONMENTAL ACCOUNTING: ANALYSIS OF ENVIRONMENTAL-COST MODELS AND ITS IMPACT ON LONG-TERM PROFITABILITY

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ABSTRACT

This article aims to explore the role of environmental accounting, particularly the environmental-cost model, in shaping sustainable green SME business models. The main objective is to examine the extent to which the implementation of environmental accounting practices can improve long-term cost efficiency and profitability, while reducing the ecological footprint of small businesses. The main problem faced by MSMEs is the lack of integration of environmental costs in the financial accounting system, so that external costs such as waste management, energy use, and air pollution are not accurately calculated in the decision-making process. This causes inefficiency and the risk of long-term losses and low competitiveness in a market that is increasingly concerned with sustainability. This study offers a new approach by systematically integrating the environmental cost model into MSME accounting practices. Unlike conventional approaches, this model presents a cost structure based on the product life cycle and its ecological impact. This allows small entrepreneurs to understand the sources of inefficiency and design data-based mitigation strategies, which are still rarely applied in the Indonesian MSME sector. This study uses a descriptive qualitative approach with a case study method on five environmentally friendly manufacturing MSMEs in Surabaya. Data collection techniques include in-depth interviews, participant observation, and analysis of financial statements and operational documents. Data are analyzed using the Environmental Cost Accounting (ECA) approach to evaluate the impact of environmental cost integration on financial performance. The findings show that the implementation of environmental accounting based on the environmental cost model can reduce operational costs by up to 15%, improve compliance with environmental regulations, and strengthen business reputation in the eyes of consumers and investors. In addition, there is an increase in profit margins of up to 10% due to increased production efficiency and consumer loyalty, accompanied by increased access to green financing. The integration of environmental accounting into the financial system of MSMEs not only improves economic efficiency but also accelerates the transition to a competitive green business model. This study recommends the implementation of the environmental cost model as a new accounting standard for sustainability-oriented MSMEs and suggests policy support to expand its adoption.

Keywords: SMEs, environmental accounting, environmental costs, sustainability, profitability

INTRODUCTION

Climate change, biodiversity crisis, and pollution have driven global agendas such as the Paris Agreement (2015) and the Sustainable Development Goals (SDGs) to reduce carbon emissions and promote a circular economy. Indonesia, as one of the world's largest emitters (ranked 9th according to Climate Watch, 2023), faces international pressure to strengthen its environmental commitments. The MSME sector, which includes 99% of the 64.2 million business units (KemenkopUKM, 2023), is in the spotlight because of its contribution to 28% of national solid waste and 15% of industrial greenhouse gas emissions (KLHK, 2022). MSME activities in the textile, food, and craft sectors often rely on linear production practices (take-make-dispose) that ignore sustainability principles, such as the disposal of textile dye liquid waste directly into rivers in the Pekalongan batik center. This phenomenon triggers socio-ecological conflicts, such as declining water quality and public health problems, which have the potential to hinder the competitiveness of MSMEs in the global market that increasingly demands environmentally friendly products.

Despite being the backbone of the economy (contributing 61.97% of non-oil and gas GDP), 72% of MSMEs in Indonesia do not yet have an integrated waste management system (BPS, 2023). The culinary sector, for example, produces 9.8 million tons of plastic waste per year, but only 23% of MSMEs separate organic and inorganic waste (Indonesian Retail Entrepreneurs Association, 2023). This lack of environmental awareness is exacerbated by limited access to green technology and funding. An OJK survey (2023) showed that 68% of MSMEs considered the cost of wastewater treatment installations (IPAL) too expensive, while 54% did not understand environmental regulations such as Government Regulation No. 22/2021 concerning the Implementation of Environmental Protection. As a result, MSMEs are vulnerable to legal risks and loss of market opportunities, especially from millennial consumers, 63% of whom prefer green-labeled products (Nielsen, 2022).

Conventional accounting fails to capture the costs of environmental externalities, such as ecosystem restoration costs or public health impacts, creating distortions in business decision-making. A real-world example occurred in a tofu processing MSME in Kediri: the cost of cleaning liquid waste containing sulfide of IDR 12 million/month was not recorded in the financial report, even though this activity caused groundwater pollution in 3 villages (Field Study, 2023). The hidden cost analysis revealed that 41% of MSMEs in East Java face potential environmental fines averaging IDR 50 million/year, but only 9% allocate emergency funds to mitigate these risks. This failure reflects the need for an accounting approach that is able to quantify environmental costs as an integral part of operational costs.

Environmental management accounting (EMA) integrates the triple bottom line principle (profit, people, planet) through models such as full-cost accounting (FCA) and material flow cost accounting (MFCA). FCA, for example, calculates the total cost of production by including environmental costs (e.g., waste recycling costs) and external benefits (e.g., green tax incentives). In the Philippines, the application of MFCA to furniture MSMEs successfully identified 22% of wood wastage, reducing raw material costs by 18% in 2 years (ADB, 2021). In Indonesia, a pilot study on batik MSMEs in Solo showed that recording environmental costs increased business awareness to switch to natural dyes, reducing production costs by 15% while increasing export demand by 30% (UGM, 2022). This approach not only improves financial transparency but also creates added value through resource efficiency.

This article explores the integration of environmental accounting based on full-cost accounting (FCA) and material flow cost accounting (MFCA) models into the financial system of MSMEs to measure environmental impact holistically. The focus of the study is to analyze how internalization of environmental costs, such as waste management and energy efficiency, can improve long-term profitability through operational cost savings and increased market competitiveness, as seen in batik MSMEs in Solo that managed to reduce production costs by 15% while increasing export demand by 30% after adopting EMA. In addition, this study examines the mechanism of transforming conventional accounting practices into environmentally responsive systems, including the potential for implementing fiscal incentives and collaboration with digital platforms to expand access to green markets. These findings are expected to produce evidence-based policy recommendations, such as the integration of EMA training modules into the KemenkopUKM program and grant funding schemes for environmentally friendly technologies. Thus, this study aims to encourage the transition of MSMEs towards sustainable business models that are in line with Indonesia's low-carbon development targets.

Problem Formulation and Significance

The main problems that this research wants to answer are as follows.

1. How can environmental accounting models based on environmental costs (full-cost accounting and material flow cost accounting) be integrated into the financial systems of MSMEs in Indonesia to internalize environmental externality costs?
2. To what extent does the implementation of environmental accounting affect the long-term profitability and operational efficiency of MSMEs, especially in the context of sector heterogeneity and business scale?
3. What are the structural barriers (technical, financial, regulatory) that hinder the adoption of environmental accounting practices by MSMEs, and how can public policy address these challenges?
4. How can the environmental-cost model be a strategic tool to drive the transition of MSMEs towards a green economy that is aligned with Indonesia's sustainable development targets?
5. The significance of this research is as follows.
6. Theoretical: Developing a contextual environmental accounting framework for MSMEs, enriching the literature with the integration of the triple bottom line and life cycle costing concepts in the context of micro-enterprises that have not been widely explored.
7. Practical: Providing operational guidance for MSMEs in measuring and managing environmental costs, such as cost savings simulations through biogas technology or waste recycling, as well as increasing competitiveness through green certification.
8. Policy: Recommend fiscal incentive schemes (e.g. progressive tax reductions) and local wisdom-based technical assistance programs (e.g. tempeh waste processing training modules) to accelerate the adoption of green MSMEs.

9. Socio-Ecological: Reducing the negative impact of MSMEs on the environment (such as 28% of national solid waste from MSMEs) while improving community welfare through the creation of green jobs and prevention of environmental conflicts.
10. Global: Support Indonesia's commitment to the Paris Agreement and SDGs by strengthening the role of MSMEs as key actors in the transition to a low-carbon economy.

Research Purposes

The objectives of this research are:

1. Analyzing the integration mechanism of environmental accounting models based on full-cost accounting (FCA) and material flow cost accounting (MFCA) into the financial system of MSMEs in Indonesia to internalize environmental externality costs.
2. Measuring the impact of environmental accounting implementation on long-term profitability and operational efficiency of MSMEs, taking into account variations in sectors (textiles, culinary, crafts) and business scale.
3. Identifying structural barriers (technical, financial, regulatory) in the adoption of environmental accounting practices by MSMEs and formulating policy strategies to overcome them, such as fiscal incentives or technical assistance programs.
4. Evaluating the role of environmental-cost models as a strategic tool in driving the transition of MSMEs towards a green economy that is aligned with Indonesia's sustainable development targets, including its contribution to reducing national carbon emissions and solid waste.

Research Novelty

This study develops an adaptation of the full-cost accounting (FCA) and material flow cost accounting (MFCA) models modified to accommodate the unique characteristics of Indonesian MSMEs (small scale, limited resources, and sector heterogeneity). Unlike previous studies that focused on large companies, this model includes local variables such as local wisdom in waste management (e.g., utilization of tempeh waste as animal feed) and innovative community-based funding mechanisms.

LITERATURE REVIEW

Conventional accounting has been criticized for its narrow focus on short-term financial performance, while ignoring environmental externalities such as ecosystem damage, public health costs, or reputational risks (Gray, 1992). A study by Bebbington et al. (2001) showed that 89% of financial statements of small companies in Southeast Asia did not include environmental costs, including legal fines and restoration costs, which have the potential to reduce profitability by up to 30% in 5 years. In Indonesia, research by Hariyani & Safitri (2022) found that batik MSMEs in Pekalongan spent an average of IDR 15 million/month to illegally dispose of liquid waste, but these costs were not recorded in the books, creating an illusion of unsustainable profitability. This strengthens the argument that traditional accounting systems are inadequate to support the transition to a green economy, especially in the dominant MSME sector in developing countries. The Environmental Costing model classifies costs based on their direct or indirect

relationship to environmental impacts, including prevention costs, detection costs, internal and external failure costs. Jasch's (2003) research shows that this classification helps companies understand cost causes and optimize managerial decisions.

Environmental Management Accounting (EMA) emerged as a response to the failure of conventional accounting by integrating the triple bottom line principle (people, planet, profit). Models such as full-cost accounting (FCA) and material flow cost accounting (MFCA) allow the identification of hidden environmental costs through mapping material and energy flows (Schaltegger & Burritt, 2000). A study in Thailand by ADB (2021) showed that the application of MFCA in ceramic MSMEs reduced raw material waste by 22% and increased profit margins by 12% in 2 years. However, these studies still focus on medium-sized companies with organized financial structures, while applications in MSMEs with limited technical and financial capacity are still rarely explored (Jalaludin et al., 2019). This is where this study contributes by adapting the EMA model to the unique context of Indonesian MSMEs.

The literature identifies three main barriers to EMA adoption in MSMEs: (1) low environmental literacy of business actors, (2) limited access to supporting technology, and (3) lack of regulatory incentives (Lukviarman, 2020). A survey by OJK (2023) in Central Java revealed that 72% of MSMEs do not understand the concept of carbon footprint, and 85% do not use accounting software that can track environmental costs. A case study in the culinary sector by Sari (2021) shows that MSMEs only allocate 2-5% of their income for waste management, far below the FAO recommendation (10-15%). In addition, the absence of strict sanctions against environmental violations (for example PP No. 22/2021 which is rarely implemented at the regional level) exacerbates MSME apathy. These findings highlight the need for a holistic policy approach, not only education but also the creation of a supporting ecosystem.

Several empirical studies have shown a positive correlation between EMA adoption and increased profitability. For example, batik MSMEs in Solo that implemented FCA managed to reduce production costs by 15% through optimizing the use of natural dyes and waste recycling (UGM, 2022). In the Philippines, investment in biogas technology in fish processing MSMEs increased side income by 18% from organic fertilizer sales (ADB, 2021). However, contradictory research by Wahyudi et al. (2023) found that 65% of MSMEs in East Java experienced a decrease in net profit in the first year due to transition costs to EMA, although profitability increased significantly in the third year. This phenomenon indicates the importance of time horizon analysis in evaluating the impact of EMA, as well as the need for a transition funding scheme to reduce the short-term cost burden.

Fiscal incentive policies and technical assistance have proven effective in encouraging the adoption of green practices. In Thailand, a 2% tax reduction for MSMEs implementing EMA increased participation by 40% in 3 years (World Bank, 2020). In Indonesia, the Eco-SMES program of the Ministry of Cooperatives and SMEs (2021) failed to achieve its target because it was not accompanied by financial incentives and contextual training modules (Miswanto, 2022). This study proposes lessons learned from Germany's success in integrating EMA into MSME training curricula based on local wisdom, such as training on processing tofu waste into bioethanol in Kediri. In addition, the role of digital platforms (Gojek, Tokopedia) in providing green accounting tools needs to be explored as part of an inclusive policy.

EMA is aligned with SDGs Goal 12 (Responsible Consumption and Production) and the Paris Agreement through reducing carbon emissions and industrial waste. A study by Utomo (2023) estimates that the adoption of EMA in 30% of Indonesian MSMEs can reduce MSME sector CO2 emissions by 9.8

million tons/year, which is equivalent to 12% of Indonesia's NDC target. However, the literature is still minimal in discussing integrated reporting mechanisms that link MSME environmental performance with SDGs indicators. This study fills this gap by proposing a blockchain-based reporting model for MSMEs, facilitating verification of sustainability impacts by external parties (investors, government).

METHOD, DATA, AND ANALYSIS

Research Approach and Design

This study uses a quantitative explanatory method with a cross-sectional survey design to test the causal relationship between the implementation of environmental management accounting (EMA) and the long-term profitability of MSMEs. This approach was chosen because it allows empirical measurement of the main variables (environmental cost model, operational efficiency, profitability) and identification of moderating factors (such as business sector and MSME scale). The research design includes two stages:

1. Descriptive Stage: Mapping the level of EMA adoption and characteristics of green MSMEs in Indonesia.
2. Explanatory Stage: Hypothesis testing using Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the direct and indirect effects of EMA on profitability.

Data Collection Technique

Population and Sample

Population

MSMEs in the textile, culinary and craft sectors in Java, Sumatra and Bali recorded in the Ministry of Cooperatives and SMEs (2023) with the following criteri like a Operating for at least 3 years and have basic financial bookkeeping.

Sample

350 MSMEs were selected using stratified random sampling based on sector (textile: 120, culinary: 150, crafts: 80) and business scale (micro, small, medium). The sample calculation used the Slovin formula (margin of error 5%, confidence level 95%).

Research Instruments

Data is collected through:

Structured Questionnaire (Likert scale 1-5) to measure:

1. Independent Variable: Implementation of EMA (indicators: use of full-cost accounting, waste flow mapping, environmental cost reporting)
2. Dependent Variable: Long-term profitability (indicators: 3-year ROI, net profit margin, sustainable sales growth)
3. Control Variables: Business sector, business scale, geographical location

Secondary Data:

MSME financial reports (last 3 years), waste data from KLHK, and regional policies related to green MSMEs.

Validity and Reliability

- Content Validity: Validated by 3 environmental accounting experts and 2 MSME actors
- Reliability Test: Using Cronbach's Alpha ($\alpha > 0.7$) in the preliminary test (pilot study) on 30 MSMEs

Data Analysis Techniques

Descriptive Analysis

- Descriptive statistics to profile MSME characteristics (sector distribution, scale, EMA adoption rate)
- Environmental Cost Ratio (ECR) Calculation:

$$\text{ECR} = \frac{Total\ Biaya\ Lingkungan}{Total\ Pendapatan}\ x\ 100\% \frac{Total\ Biaya\ Lingkungan}{Total\ Pendapatan}\ x\ 100\%$$

PLS-SEM analysis

- Measurement Model: Convergent validity test (outer loading > 0.7, AVE > 0.5) and discriminant (Fornell-Larcker criterion)
- Structural Model:

1. Testing the main hypothesis (example: H1: EMA implementation has a significant positive effect on long-term profitability)
2. Path analysis to measure the moderating effects of sector and business scale
3. Calculation of R^2 (model predictive power) and Q^2 (predictive relevance)

Additional Analysis

- **Break Even Analysis**: Calculate the payback period for green technology investments (e.g. biogas) using the formula:

$$Payback\ Period = \frac{Biaya\ Investasi\ Awal}{Arus\ Kas\ Bersih\ Tahunan}$$

- **NPV Simulation**: Long-term profitability evaluation (10 years) with a discount rate of 12% (BI Rate 2023)

Analysis Software

- SmartPLS 4.0 for PLS-SEM
- SPSS 27 for descriptive statistics and classical assumption tests (normality, multicollinearity)
- Excel for financial simulation (NPV, ROI)

RESULT AND DISCUSSION

Implementation of the Environmental-Cost Model and Impact on Profitability

PLS-SEM analysis revealed that the implementation of environmental accounting (*$\beta = 0.48$, $p < 0.01$*) has a significant effect on increasing the long-term profitability of MSMEs. The textile sector showed the highest coefficient (*$\beta = 0.56$*), especially in batik MSMEs in Solo which succeeded in reducing the Environmental Cost Ratio (ECR) from 18% to 12% in 2 years through the adoption of material flow cost accounting (MFCA). NPV simulation confirmed that an investment in biogas technology of IDR 100 million in culinary MSMEs generated a cumulative net cash flow of IDR 280 million in 10 years (discount rate 12%), with a payback period of 3.5 years. However, 65% of micro-scale MSMEs experienced

a decrease in net profit in the first year (*average 8%*) due to transition costs, although profitability increased by 15-20% in the third year.

Structural Barriers and Sectoral Variations

There are significant disparities in EMA adoption across sectors Textiles: 32% of MSMEs have used full-cost accounting (FCA), driven by export demands and green certification incentives and Culinary: Only 12% allocate an environmental budget (>5% of income), with the main obstacle being the cost of waste treatment technology (65% of respondents). Craft: 41% of MSMEs utilize local wisdom (for example, recycling wood waste) without a structured accounting approach. Linear regression shows that MSMEs with access to technical assistance have an EMA adoption rate 2.3 times higher than those without ($p < 0.05$)

Policy Effectiveness and Digital Collaboration

MSMEs that received progressive tax incentives (1% reduction in final income tax) showed an increase in environmental budget allocation of 18% (*$R^2 = 0.67$*). Collaboration with digital platforms such as Tokopedia (green product tagging feature) increased sales of green products by 27% in 6 months. However, only 15% of MSMEs utilize carbon footprint calculator-based accounting applications, indicating the need for technological education interventions

EMA as a Sustainable Profitability Lever

This finding is in line with the ADB study (2021) in Thailand that internalizing environmental costs through EMA improves resource efficiency, but enriches the evidence with the heterogeneous context of Indonesian MSMEs. The decline in first-year profits is consistent with Wahyudi et al.'s (2023) research, but the NPV simulation strengthens the argument that green investment is self-liquidating in the medium term. The success of batik MSMEs in Solo confirms the resource-based view theory (Barney, 1991) that environmental capabilities can be a competitive advantage.

Adaptation of EMA Model Based on Local Wisdom

The low adoption of EMA in the craft sector despite the existence of traditional recycling practices indicates a gap between informal practices and structured accounting systems. This study proposes a modification of MFCA by including local indicators such as the economic value of recycled waste (e.g., tempeh waste into animal feed worth IDR 2 million/month), which has not been accommodated in the conventional EMA model (Schaltegger & Burritt, 2000). This approach answers Jalaludin et al.'s (2019) criticism of the incompatibility of the global EMA model with MSMEs in developing countries.

Policy Implications: From Incentives to Digital Ecosystems

The high impact of technical assistance (*$\beta = 0.39$*) supports Lukviarman's (2020) argument that MSMEs need capacity building interventions, not just regulations. The success of progressive tax incentives in Java is in line with the recommendations of the World Bank (2020), but the inequality of access to technology (for example, 85% of MSMEs outside Java do not use green applications) requires affirmative policies, such as digital vouchers for accounting software. Collaboration with e-commerce platforms can

be a game-changer, as shown by the increase in green sales on Tokopedia, filling the gap in the failure of the KemenkopUKM Eco-SMES program (Miswanto, 2022).

Contribution to the Sustainable Development Agenda

If 30% of MSMEs adopt this model, the simulation shows the potential for carbon emission reduction of 2.4 million tons/year—equivalent to 3% of Indonesia's NDC target. This finding strengthens the position of MSMEs as key actors in SDGs Goal 12, while also suggesting the need for an integrated blockchain-based reporting mechanism to improve accountability, as proposed by Utomo (2023).

CONCLUSION

This study confirms that the integration of environmental accounting models based on full-cost accounting (FCA) and material flow cost accounting (MFCA) into the financial system of MSMEs can improve long-term profitability through resource efficiency and environmental cost reduction. The results of the quantitative analysis show that MSMEs that adopt environmental accounting practices experience an average increase in net profit margin of 15-20% in three years, with a payback period for green technology investments (such as biogas) reaching 3.5 years. Although there is a decrease in net profit in the first year due to transition costs, discounted cash flow (DCF) simulations prove that internalization of environmental costs is a sustainable strategic investment.

These findings reinforce the importance of adapting contextual environmental-cost models, such as integrating local wisdom in waste management (e.g. tempeh waste into animal feed) and collaborating with digital platforms to expand green markets. The textile sector is a pioneer with the highest EMA adoption rate (32%), driven by export demands and certification incentives, while the culinary sector still faces challenges in waste processing technology costs. Progressive fiscal incentive policies (e.g. tax reductions based on environmental performance) and community-based technical assistance have proven effective in increasing MSME participation by 2.3 times.

This research contributes to the development of green MSMEs by offering an integrated policy framework that combines accounting, technology, and regulatory aspects. If implemented massively, this model has the potential to reduce carbon emissions in the MSME sector by up to 2.4 million tons/year, supporting the achievement of Indonesia's NDC and SDGs targets. However, it is necessary to expand the study to Eastern Indonesia and a longitudinal approach to test the consistency of long-term impacts. Thus, environmental accounting is not only a risk management tool, but also a catalyst for transformation towards an inclusive and globally competitive green economy.

IMPLICATION/LIMITATION AND SUGGESTIONS

Theoretical Implications for this study enrich the environmental accounting literature by introducing a hybrid model of full-cost accounting (FCA) and material flow cost accounting (MFCA) tailored for MSMEs in developing countries. The findings fill a theoretical gap on how the triple bottom line principle can be operationalized in the context of resource-constrained microenterprises. This study strengthens the resource-based view theory by showing that environmental capabilities (such as structured waste management) can be a source of competitive advantage for MSMEs. Practical Implications for MSMEs: The study provide concrete guidance to internalize environmental costs through simple training

modules and affordable technology (e.g., carbon footprint calculator-based accounting applications). The case study of MSME batik in Solo can be adopted as a best practice. For the Government: Recommendations for progressive fiscal incentives (e.g., 1% tax reduction for green SMEs) and the establishment of green SME hubs at the regional level can be used as a reference in designing mentoring programs based on local wisdom.

ACKNOWLEDGMENT

The author would like to thank the Ministry of Cooperatives and SMEs (KemenkopUKM) and the Ministry of Environment and Forestry (KLHK) of the Republic of Indonesia for supporting data and research facilities related to green MSMEs. Not to forget, the research team who have contributed to data analysis and discounted cash flow simulation. Collaboration with the digital platforms Tokopedia and Gojek in providing carbon footprint calculation features for MSMEs deserves to be appreciated as a form of academic-industry synergy. Finally, thank you to the family and colleagues who provided moral support during the research process, as well as to the reviewers who have provided valuable suggestions for improving this article.

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