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GREEN PROCUREMENT AND ECO-FRIENDLY TECHNOLOGY AS DRIVERS OF SME SUSTAINABILITY: THE MEDIATING ROLE OF CIRCULAR ECONOMY

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ABSTRACT: Small and Medium Enterprises (SMEs) support regional economic development, yet their sustainability remains constrained by resource inefficiency, limited technological capability, and rising environmental pressure. This study offers novelty by explaining how Green Procurement and Environmentally Friendly Technology strengthen SME Sustainability through Circular Economy practices, integrating the Resource-Based View and Natural Resource-Based View. Using a quantitative design with Partial Least Squares Structural Equation Modeling, data were collected from 179 SME owners and managers across various sectors in Banten Province, Indonesia. The findings show that Green Procurement has no significant direct effect on SME Sustainability but significantly promotes Circular Economy practices, which then enhance sustainability. Environmentally Friendly Technology positively affects both Circular Economy and SME Sustainability, while Circular Economy mediates both proposed relationships. The study implies that SMEs should integrate green procurement, environmentally friendly technology, and circular economy practices to strengthen long-term sustainability in developing regions.

Keywords: Green Procurement; Evironmental Friendly Technology; Circular Economy; SME Sustainability; Natural Resource-based View

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INTRODUCTION

Micro, Small, and Medium Enterprises (SMEs) constitute a major pillar of Indonesia's economy, contributing approximately 60.5% of national Gross Domestic Product (GDP) and absorbing nearly 97% of the workforce. Their dominant economic role makes the transition toward sustainable and environmentally responsible business practices essential for long-term economic resilience and sustainable development (OECD, 2022). In Banten Province, SMEs are also recognized as important drivers of regional economic development. Nevertheless, many SMEs still face serious constraints in maintaining competitiveness while responding to environmental demands, including inefficient resource use, limited technological capability, and weak readiness to adopt green business models. These challenges reflect a broader problem in developing economies, where SMEs are expected to support green transition agendas but often lack sufficient financial, technological, and managerial resources to do so effectively (Ivanova, 2020; OECD, 2021).

The growing global commitment to sustainable development, carbon reduction, and circular resource use has increased pressure on firms of all sizes to adopt environmentally responsible practices. In Indonesia, sustainable development policies, circular economy initiatives, and green industry programs require SMEs to improve environmental performance without sacrificing economic viability. This balance is difficult because sustainability practices often demand new capabilities, supplier coordination, investment in cleaner technologies, and changes in operational routines. Prior studies show that green supply chain redesign and implementation remain constrained by cost, institutional weakness, limited technical capacity, and resistance to operational change, particularly in emerging and developing-market settings (Agyemang et al., 2019; Testa & Iraldo, 2010). SMEs therefore need strategic environmental practices that are not only normatively desirable but also operationally feasible.

To address these challenges, green procurement and environmentally friendly technology have emerged as important strategic approaches. Green procurement encourages firms to include environmental criteria in supplier selection, materials purchasing, logistics decisions, and procurement processes. These practices can reduce waste, improve input efficiency, and strengthen sustainable supply chain management (Rejeb et al., 2024; Walker & Jones, 2012; Zhu et al., 2013). Evidence also suggests that green purchasing can improve firm outcomes when it is supported by environmental performance and internal capability development (Balin & Sari, 2023). Environmentally friendly technology, meanwhile, enables firms to reduce energy consumption, optimize production processes, improve material efficiency, and reduce environmental impacts. Prior research links green technology innovation with financial and sustainability outcomes among SMEs, especially when firms are able to align cleaner technology with operational efficiency and market positioning (Maghfuriyah et al., 2024; Oduro, 2024; Wu et al., 2023).

The Resource-Based View (RBV) provides a useful theoretical foundation for understanding these relationships. RBV argues that valuable, rare, inimitable, and non-substitutable resources can generate sustained competitive advantage (Barney, 1991). The Natural Resource-Based View (NRBV) extends this argument by positioning environmental capabilities as strategic resources that allow firms to build competitive advantage through pollution prevention, product stewardship, and sustainable development (Hart, 1995). From this perspective, green procurement, environmentally friendly technology, and circular economy practices are not merely compliance activities. They are strategic environmental capabilities that may improve sustainability when they are embedded in firm routines, resource allocation, and operational systems. This theoretical logic is also consistent with the Triple Bottom Line view, which frames sustainability through the integration of economic, environmental, and social value creation (Elkington, 1997; Goh et al., 2020).

Previous studies provide strong evidence that environmental capabilities can improve sustainability performance, although their effects remain context dependent. Green procurement contributes to organizational and environmental performance by improving resource efficiency and strengthening sustainable supply chain practices (Rejeb et al., 2024). Sustainable procurement has also been linked with organizational performance, though its effectiveness depends on institutional support, supplier readiness, and managerial commitment (Islam, 2017; Kaur & Singh, 2019). Eco-innovation improves SME sustainable performance by enhancing

operational efficiency, environmental outcomes, and long-term competitiveness (Oduro, 2024). Circular economy practices create economic and environmental value through resource optimization, waste reduction, reuse, recycling, and value retention mechanisms (Ghisellini et al., 2016; Kirchherr et al., 2017). Circular business models further show how firms can redesign value creation and value capture around resource circularity rather than linear production and disposal systems (Centobelli et al., 2020; Geissdoerfer et al., 2020).

Despite these contributions, the empirical evidence remains inconclusive, especially for SMEs in developing-country contexts. Several studies suggest that green procurement improves sustainability performance, while others imply that its direct contribution may weaken when firms face resource constraints, weak supplier coordination, financial limitations, or insufficient managerial capability (Agyemang et al., 2019; Ivanova, 2020; Nande & Vhankate, 2022). Similarly, environmentally friendly technology may not automatically improve sustainability unless firms can integrate technology into broader resource management and operational systems. Studies on Industry 4.0 and circular economy show that technology can support circular practices, but the value of technology depends on business model alignment, organizational readiness, and process integration (Nascimento et al., 2019). Thus, the sustainability effects of green procurement and environmentally friendly technology may operate not only through direct relationships but also through internal mechanisms that convert environmental initiatives into practical sustainability outcomes.

One important mechanism that may explain these relationships is the circular economy. Circular economy practices emphasize reducing, reusing, recycling, recovering, and retaining resources to maximize economic value while minimizing environmental harm (Ghisellini et al., 2016; Kirchherr et al., 2017). From the NRBV perspective, circular economy capability functions as a strategic environmental capability because it allows firms to transform green procurement and cleaner technology into more efficient resource use, lower waste, and stronger sustainability performance. Recent studies also show that circular economy practices can improve financial and organizational outcomes through operational efficiency, agility, and better resource coordination (Gonçalves et al., 2022; Oktrivina et al., 2025; Ramos et al., 2022). However, limited studies have simultaneously examined green procurement, environmentally friendly technology, circular economy, and SME sustainability in one integrated model. Existing research still tends to focus on large firms, manufacturing sectors, or developed-economy contexts, leaving uncertainty about how NRBV mechanisms work among resource-constrained SMEs in developing regions.

Therefore, this study investigates the direct effects of green procurement and environmentally friendly technology on SME sustainability and examines the mediating role of circular economy among SMEs in Banten Province. By integrating RBV and NRBV, this study extends the sustainability literature by explaining how circular economy capability operates as a strategic mediating mechanism through which environmental capabilities enhance SME sustainability. This study also contributes to the SME sustainability debate by shifting the focus from whether green practices matter to how such practices become effective under resource-constrained conditions in developing-country settings.

THEORETICAL REVIEW

The literature review provides the conceptual foundation for explaining the relationships among green procurement, environmentally friendly technology, circular economy, and SME sustainability. This study is grounded in the Resource-Based View (RBV) and the Natural Resource-Based View (NRBV), which explain how strategic organizational resources and environmental capabilities can support sustainable competitive advantage and long-term sustainability performance.

The Resource-Based View argues that firms achieve sustained competitive advantage through resources and capabilities that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). In the context of SMEs, green procurement and environmentally friendly technology can be understood as strategic organizational capabilities because they enable firms to improve resource efficiency, reduce operational costs, and enhance sustainability performance. When these capabilities are embedded within organizational routines, supplier relationships, and managerial competencies, they become more difficult for competitors to imitate and may contribute to long-term organizational sustainability.

The Natural Resource-Based View extends RBV by emphasizing the strategic role of environmental capabilities in achieving competitiveness and sustainability (Hart, 1995). NRBV argues that capabilities related to pollution prevention, product stewardship, and sustainable development can generate both environmental and economic value. In this study, green procurement, environmentally friendly technology, and circular economy practices are conceptualized as environmental capabilities that support SME sustainability through improved resource utilization, reduced environmental impact, and stronger organizational performance. This view is also consistent with the Triple Bottom Line perspective, which positions sustainability as the integration of economic, environmental, and social value creation (Elkington, 1997; Goh et al., 2020).

Circular economy refers to a regenerative system that seeks to minimize waste and maximize resource use through reducing, reusing, recycling, recovering, and retaining materials and resources (Ghisellini et al., 2016; Kirchherr et al., 2017). From the NRBV perspective, circular economy capability enables firms to convert environmental initiatives into sustainability and competitive outcomes. Circular business models also show how firms can redesign value creation, delivery, and capture around resource circularity rather than linear production and disposal systems (Centobelli et al., 2020; Geissdoerfer et al., 2020). Therefore, the integration of green procurement, environmentally friendly technology, and circular economy practices is expected to strengthen SME sustainability by improving resource efficiency, reducing waste, lowering operational costs, and enhancing long-term organizational performance. Drawing on RBV, NRBV, and previous empirical evidence, this section develops hypotheses regarding the direct effects of green procurement and environmentally friendly technology on SME sustainability, as well as the mediating role of circular economy in these relationships.

Green procurement refers to the integration of environmental criteria into purchasing decisions, supplier selection, material sourcing, and procurement processes. It encourages firms to select environmentally responsible suppliers, use eco-friendly materials, reduce waste, and improve resource efficiency. Green procurement is a key element of green supply chain management because it helps firms reduce environmental damage while improving operational efficiency (Testa & Iraldo, 2010; Walker & Jones, 2012). Rejeb et al. (2024) further emphasized that green procurement contributes to environmental and organizational performance by strengthening resource efficiency and sustainable supply chain management.

From the RBV perspective, green procurement capability can be considered a strategic organizational resource because it supports efficient resource allocation, waste reduction, and environmentally responsible supplier relationships. Prior studies suggest that sustainable procurement can improve organizational performance when it is supported by managerial commitment, supplier readiness, and institutional support (Islam, 2017; Kaur & Singh, 2019). Green purchasing has also been found to improve financial performance through the mediating role of environmental performance (Balin & Sari, 2023). However, the effect of green procurement may be weaker among SMEs when firms face financial constraints, limited technical capability, and insufficient supplier coordination (Agyemang et al., 2019; Ivanova, 2020; Nande & Vhankate, 2022). Despite these constraints, SMEs that implement green procurement practices are expected to achieve better sustainability outcomes because these practices improve efficiency and reduce environmental pressure.

H1: Green procurement has a positive effect on SME sustainability.

Environmentally friendly technology refers to the adoption of technologies that reduce environmental impact, improve resource efficiency, and support cleaner production processes. These technologies may help firms optimize energy consumption, reduce waste generation, improve material efficiency, and strengthen operational productivity. From the RBV and NRBV perspectives, environmentally friendly technology represents a strategic capability because it enables firms to improve productivity while reducing environmental harm. Such technology can generate both economic and environmental value when it is integrated into production processes and organizational routines.

Empirical evidence supports the role of green technology in improving SME outcomes. Maghfuriyah et al. (2024) found that green technology innovation improves SME financial performance, suggesting that cleaner technologies may enhance cost efficiency, revenue potential, and market competitiveness. Oduro (2024) also showed that eco-innovation improves

SME sustainable performance by strengthening operational efficiency, environmental performance, and long-term competitiveness. Similarly, Wu et al. (2023) argued that technological innovation contributes to enterprise resilience under green recovery conditions. Therefore, SMEs that adopt environmentally friendly technology are expected to achieve higher sustainability performance.
H2: Environmentally friendly technology has a positive effect on SME sustainability.

Circular economy emphasizes a closed-loop approach based on reducing, reusing, recycling, recovering, and retaining resources. Green procurement contributes to circular economy by encouraging firms to select suppliers, materials, and products that are environmentally friendly, durable, recyclable, and resource-efficient. Through environmentally responsible purchasing, SMEs can reduce material waste, improve resource productivity, and support circular production and consumption systems. Ghisellini et al. (2016) explained that circular economy supports the transition toward sustainable production and consumption by maximizing material and energy use. Kirchherr et al. (2017) also emphasized that circular economy reduces waste and improves resource productivity through systemic changes in production and consumption. Therefore, green procurement is expected to support the implementation of circular economy practices among SMEs.
H3: Green procurement has a positive effect on circular economy practices.

Environmentally friendly technology also plays an important role in enabling circular economy practices. Green technologies support cleaner production, energy efficiency, waste reduction, material recovery, and the conversion of waste into economic value. These technological capabilities allow SMEs to implement circular economy principles more effectively. Geissdoerfer et al. (2020) emphasized the importance of technological innovation in circular business models because technology can improve resource efficiency and extend product life cycles. Nascimento et al. (2019) also showed that Industry 4.0 technologies can enable circular economy practices in manufacturing by supporting cleaner, more efficient, and more circular production processes. Therefore, greater adoption of environmentally friendly technology is expected to strengthen circular economy implementation among SMEs.
H4: Environmentally friendly technology has a positive effect on circular economy practices.

Circular economy practices contribute to SME sustainability by improving resource efficiency, reducing waste, lowering operational costs, and creating value from materials that would otherwise be discarded. Circular economy is not merely an environmental practice; it is also a strategic resource management system that can improve economic, environmental, and organizational outcomes. Kirchherr et al. (2017) define circular economy as a systemic framework that supports sustainable production and consumption by reducing waste and improving resource productivity. Gonçalves et al. (2022) showed that circular economy is closely linked with financial aspects because circular practices may generate cost savings, efficiency gains, and new value creation opportunities. Ramos et al. (2022) further demonstrated that circular economy implementation can provide economic benefits through improved cost-benefit structures. Recent evidence also suggests that circular economy practices can improve firm performance through operational efficiency and organizational agility (Oktrivina et al., 2025).

From the NRBV perspective, circular economy capability represents an environmental capability that allows firms to create value from resource efficiency, waste reduction, and material recovery. These practices reduce environmental impact while improving organizational resilience and sustainability performance. Consequently, SMEs that implement circular economy practices effectively are expected to achieve higher sustainability performanc
H5: Circular economy practices have a positive effect on SME sustainability.

Circular economy may also serve as a mediating mechanism that explains how green procurement and environmentally friendly technology enhance SME sustainability. According to NRBV, environmental capabilities generate long-term organizational benefits when they are embedded into operational systems and converted into efficiency, innovation, and sustainability outcomes (Hart, 1995). In this study, circular economy capability is viewed as a strategic

environmental capability that transforms green procurement and environmentally friendly technology into sustainability performance. Green procurement provides environmentally responsible inputs and supplier relationships, while environmentally friendly technology provides cleaner and more efficient operational processes. Circular economy then connects these capabilities by improving resource utilization, reducing waste, enhancing process efficiency, and creating greater value from existing resources.

Empirical studies support this logic. Circular economy practices have been linked to organizational and financial gains through efficiency, agility, and better resource coordination (Gonçalves et al., 2022; Oktrivina et al., 2025; Ramos et al., 2022). Circular business models also show that sustainability outcomes depend not only on environmental initiatives but on how firms redesign resource flows, operational processes, and value creation mechanisms (Centobelli et al., 2020; Geissdoerfer et al., 2020). Therefore, circular economy capability is expected to mediate the relationship between green procurement and SME sustainability, as well as the relationship between environmentally friendly technology and SME sustainability.

H6: Circular economy mediates the relationship between green procurement and SME sustainability.

H7: Circular economy mediates the relationship between environmentally friendly technology and SME sustainability.

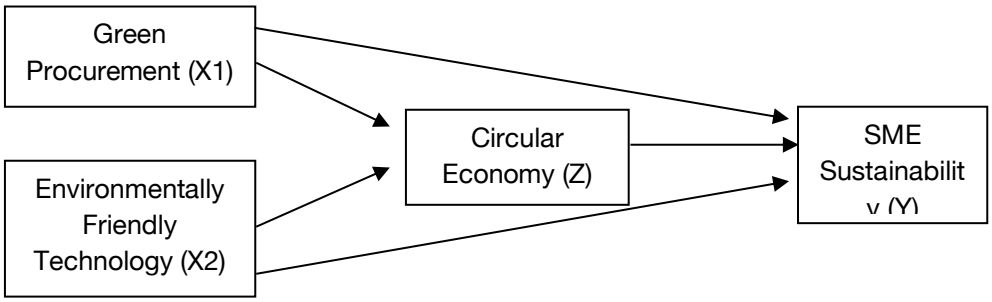

Figure 1. Conceptual Model of the Study

RESEARCH METHOD

This study employed a quantitative explanatory design to examine the relationships among green procurement, environmentally friendly technology, circular economy practices, and SME sustainability. The explanatory design was selected because the study tests theoretically derived hypotheses based on the Resource-Based View (RBV) and Natural Resource-Based View (NRBV). The study used Partial Least Squares Structural Equation Modeling (PLS-SEM) because the model includes multiple latent constructs, direct relationships, and mediation mechanisms. The research design was cross-sectional, meaning that all primary data were collected at one point in time from SME owners and managers.

Banten Province was selected as the research setting for three reasons. First, Banten has a large SME population, with approximately 720,000 SMEs recorded by the Banten Province Office of Cooperatives and SMEs in 2024. Second, only a small proportion of SMEs, around 2,000 units, have received formal government guidance, which indicates a gap between the size of the SME sector and the institutional support available for upgrading business capabilities. Third, Banten provides a relevant empirical context for examining SME sustainability because its SMEs operate in a region exposed to industrial development, market competition, and increasing pressure to adopt digital, green, and circular business practices. Therefore, Banten is not used merely as a geographical label, but as a context where resource constraints, sustainability pressure, and capability development intersect.

The population of this study consisted of SMEs operating in Banten Province. The study did not restrict the population only to SMEs that had fully implemented sustainability practices because the research aimed to capture different stages of sustainability adoption. This approach allows the study to include SMEs that have adopted, partially adopted, or begun considering green procurement, environmentally friendly technology, and circular economy practices. The sampling frame was developed from SMEs recorded by the Banten Province Office of

Cooperatives and SMEs and from SMEs assisted by Rumah BUMN Serang and Rumah BUMN Cilegon. These two Rumah BUMN units were relevant because they provide access to SMEs that are more likely to be involved in business development, capacity building, and early-stage sustainability-oriented practices.

This study used purposive sampling. Respondents were selected based on three inclusion criteria. First, the SME had operated for at least two years to ensure that the business had sufficient operational experience. Second, the SME had adopted, partially adopted, or shown initial awareness of green practices, such as environmentally oriented purchasing, energy efficiency, waste reduction, cleaner production, or circular resource use. Third, the respondent had direct involvement in business decision-making, particularly in purchasing, production, finance, operations, or overall business management. These criteria were applied to ensure that respondents had adequate knowledge of the constructs measured in this study.

The initial data collection target was 150 SMEs to improve statistical power and regional coverage across Banten Province. After screening the returned questionnaires, 179 complete and usable responses were included in the final analysis. Responses were excluded when the questionnaire contained substantial missing values, straight-line answers, inconsistent responses, or when the respondent did not meet the inclusion criteria. The final sample size was evaluated using the minimum sample size guidance for PLS-SEM. Following Hair et al. (2022), the ten-times rule requires the sample to exceed ten times the maximum number of structural paths directed at a single endogenous construct. In this model, the highest number of paths directed at one endogenous construct is three, namely green procurement, environmentally friendly technology, and circular economy toward SME sustainability. Therefore, the minimum threshold is 30 respondents. The final sample of 179 respondents exceeds this requirement and is considered acceptable for PLS-SEM with the specified model complexity. However, the sample size is acknowledged as a limitation because a larger sample would provide stronger statistical power and broader generalizability.

Primary data were collected using a structured questionnaire. The questionnaire consisted of two sections. The first section captured respondent and firm characteristics, including business age, business sector, respondent position, and operational background. The second section measured the four latent constructs: green procurement, environmentally friendly technology, circular economy, and SME sustainability. All measurement items were adapted from prior studies on green procurement, green technology, circular economy, and SME sustainability. The items were adjusted to the SME context without changing their conceptual meaning. Each item was measured using a five-point Likert scale ranging from 1, meaning strongly disagree, to 5, meaning strongly agree. Short follow-up interviews were also conducted with selected respondents to clarify the practical meaning of green procurement, technology use, and circular economy practices in SME operations. These interviews were used only as contextual support and were not included in the statistical model.

To improve replicability, the data collection procedure followed a standardized protocol. Eligible SMEs were first identified based on the sampling frame and inclusion criteria. The researcher then contacted SME owners or managers and explained the research purpose, confidentiality assurance, voluntary participation, and approximate questionnaire completion time. Respondents completed the same questionnaire format and received the same item order and response scale. The questionnaire was administered consistently across respondents to reduce procedural variation. The final dataset was screened before analysis by checking eligibility, missing responses, duplicate entries, response consistency, and extreme response patterns.

Secondary data were used to support the research context and sampling justification. These data were obtained from the Banten Province Office of Cooperatives and SMEs, Statistics Indonesia, Rumah BUMN Serang, Rumah BUMN Cilegon, and relevant policy and academic sources. Secondary data were not used to estimate the structural model. They were used only to describe the SME population, justify the selection of Banten Province, and strengthen the contextual interpretation of the findings.

Several procedures were applied to reduce common method bias. Respondents were assured that their answers would remain anonymous and confidential. The questionnaire avoided leading statements and used clear wording to reduce socially desirable responses. The items were arranged systematically to reduce respondent fatigue and response pattern bias. Since the

data were collected from a single respondent at one point in time, Harman's single-factor test was conducted as an initial diagnostic test for common method variance. In addition, collinearity diagnostics were examined using variance inflation factor values to assess whether common method bias was likely to distort the structural estimates.

Data were analyzed using SmartPLS 4. The analysis followed two main stages. First, the measurement model was evaluated to assess indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Indicator reliability was assessed using outer loadings. Internal consistency reliability was evaluated using Cronbach's Alpha and Composite Reliability. Convergent validity was assessed using Average Variance Extracted. Discriminant validity was examined using the Fornell-Larcker criterion and the Heterotrait-Monotrait ratio. Items with weak loadings were considered for removal only when their removal improved construct reliability and validity without damaging theoretical meaning.

Second, the structural model was evaluated to test the hypothesized relationships. The assessment included collinearity among predictor constructs, path coefficients, coefficient of determination, effect size, predictive relevance, and the significance of direct and indirect effects. Bootstrapping was conducted with 5,000 subsamples to test the statistical significance of path coefficients and mediation effects. The mediation analysis examined whether circular economy transmitted the effects of green procurement and environmentally friendly technology on SME sustainability. The interpretation of mediation was based on the significance and direction of the indirect effects, direct effects, and total effects.

The operational definitions of the constructs were grounded in prior literature. Green procurement refers to the extent to which SMEs integrate environmental considerations into supplier selection, material purchasing, and procurement decisions. Environmentally friendly technology refers to the adoption of technologies or technical practices that reduce energy use, waste, emissions, or environmental impact. Circular economy refers to the extent to which SMEs apply reduce, reuse, recycle, recover, and resource-efficiency practices in their operations. SME sustainability refers to the ability of SMEs to maintain economic viability, environmental responsibility, and long-term operational continuity. These definitions were used to guide item adaptation, questionnaire development, and interpretation of the empirical results.

Green procurement refers to purchasing activities that integrate environmental considerations into supplier selection, material sourcing, and procurement decisions, in addition to conventional criteria such as cost, quality, and delivery performance. In this study, green procurement is treated as an organizational capability that enables SMEs to reduce environmental impacts, improve resource efficiency, and support sustainability-oriented business practices. The measurement of green procurement was adapted from prior studies on green procurement and sustainable supply chain management, particularly those emphasizing environmentally responsible supplier selection, eco-friendly material sourcing, waste reduction, and procurement efficiency (Walker & Jones, 2012; Zhu et al., 2013; Kaur & Singh, 2019; Rejeb et al., 2024).

Environmentally friendly technology refers to the adoption of cleaner technologies, eco-innovation, and technical practices that reduce environmental impacts while improving operational efficiency. These technologies include energy-efficient equipment, cleaner production processes, waste treatment systems, emission-reduction technologies, and environmentally responsible production facilities. In the SME context, environmentally friendly technology is important because it allows firms to produce more efficiently with fewer resources while reducing pollution and operational waste. Prior studies suggest that eco-innovation and green technology can create both environmental and economic value by lowering operational costs, improving resource productivity, and strengthening long-term competitiveness (Lavado & Herranz, 2020; Maghfuriyah et al., 2024; Oduro, 2024; Wu et al., 2023). The indicators measure the adoption of energy-efficient technology, the use of environmentally friendly waste treatment, the implementation of technologies that reduce emissions and environmental impacts, investment in cleaner equipment and production technology, and continuous improvement of sustainable production technologies.

Circular economy is positioned as the mediating variable in this study. It refers to business practices that maximize resource value and minimize waste through reducing, reusing, recycling, recovering, and reprocessing materials within the business system. Circular economy practices enable SMEs to close production loops, reduce material waste, reuse operational inputs, and

transform waste into new economic value. This concept follows prior circular economy literature that views circularity as a transition from linear production and disposal toward regenerative resource systems (Ghisellini et al., 2016; Kirchherr et al., 2017; Centobelli et al., 2020; Geissdoerfer et al., 2020; Nascimento et al., 2019). In this study, circular economy is measured through indicators related to recycling production waste for further business use, reusing materials and resources to minimize waste, designing products and processes that improve resource efficiency, reducing material and energy consumption in production activities, and utilizing secondary or recycled materials as production inputs. For SMEs in Banten Province, these indicators are relevant because circular practices may improve both environmental efficiency and financial efficiency by reducing raw material costs, production waste, and working capital pressure.

SME sustainability refers to the ability of SMEs to maintain long-term business viability while addressing environmental and social responsibilities. This construct is grounded in the Triple Bottom Line perspective, which views sustainability as the integration of economic, environmental, and social performance (Elkington, 1997; Goh et al., 2020). In this study, SME sustainability reflects the firm's capacity to remain economically resilient, reduce environmental impacts, use resources efficiently, comply with relevant environmental expectations, and maintain stakeholder trust over time. The indicators measure long-term business continuity and organizational resilience, improvement of environmental performance through sustainable business practices, efficient use of resources and reduction of operational waste, compliance with environmental regulations and sustainability standards, and enhancement of stakeholder trust, customer satisfaction, and business reputation.

RESULTS

The final dataset consisted of 179 usable responses collected from SME owners and managers operating in Banten Province. The respondents represented various business sectors, including trade, food and beverage, manufacturing, and services. The majority of respondents were business owners (65%), while the remaining respondents were managers or operational administrators (35%). The duration of business operations ranged from 3 to 15 years, with an average business age of 6.2 years.

Descriptive statistics were employed to provide an overview of respondents' perceptions regarding the study variables. Green Procurement achieved a mean score of 4.38, indicating that SMEs generally incorporate environmental considerations into procurement activities. Environmentally Friendly Technology recorded a mean score of 4.20, suggesting a relatively high level of adoption of environmentally friendly technologies. Circular Economy practices obtained a mean score of 3.98, reflecting the implementation of reduce, reuse, and recycle activities among SMEs. SME Sustainability achieved a mean score of 4.22, indicating that respondents perceive their businesses as relatively sustainable in terms of long-term continuity, environmental responsibility, resource efficiency, and stakeholder trust

Average Variance Extracted (AVE). As presented in Table 2, all constructs demonstrated satisfactory reliability and convergent validity. Cronbach's Alpha values ranged from 0.725 to 0.876, exceeding the recommended threshold of 0.70. Composite Reliability values ranged from 0.833 to 0.916, indicating strong internal consistency among the measurement items. Furthermore, AVE values ranged from 0.517 to 0.688, exceeding the minimum threshold of 0.50. Therefore, all constructs were considered reliable and valid for subsequent structural model analysis.

Table 2. Reliability and Convergent Validity Assessment

Construct	Cronbach's Alpha	Composite Reliability	AVE
Green Procurement	0.841	0.916	0.688
Environmentally Friendly Technology	0.876	0.910	0.673
Circular Economy	0.813	0.854	0.540
SME Sustainability	0.725	0.833	0.517

Source: Processed data with Smartpls 4 (2025)

Hypothesis testing was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. The bootstrapping results generated the following path coefficients and p-values

Table 3. Hypothesis Testing Results

Hypothesized Paths		Effect	*p*	Decision
H1	Green Procurement → SME Sustainability	0.090	0.317	Rejected
H2	Environmentally Friendly Technology → SME Sustainability	0.534	0.000	Accepted
H3	Green Procurement → Circular Economy	0.249	0.043	Accepted
H4	Environmentally Friendly Technology → Circular Economy	0.253	0.040	Accepted
H5	Circular Economy → SME Sustainability	0.308	0.000	Accepted
H6	Green Procurement → SME Sustainability mediated by Circular Economy	0.149	0.002	Accepted
H7	Environmental Technology Friendly → SME Sustainability mediated by Circular Economy	0.098	0.004	*-value*

Source: Processed data with Smartpls 4 (2025)

The structural model results indicate that Environmentally Friendly Technology significantly affects SME Sustainability ($\beta = 0.534$, $p < 0.001$), while Green Procurement does not have a significant direct effect on SME Sustainability ($\beta = 0.090$, $p = 0.317$). Green Procurement and Environmentally Friendly Technology both significantly influence Circular Economy, which in turn positively affects SME Sustainability. Furthermore, the indirect effects indicate that Circular Economy significantly mediates the relationships between Green Procurement and SME Sustainability, as well as between Environmentally Friendly Technology and SME Sustainability.

DISCUSSION

The findings show that green procurement does not have a significant direct effect on SME sustainability. This result suggests that environmentally oriented purchasing among SMEs remains insufficient to generate measurable sustainability outcomes when it is implemented only as a partial operational practice. Some SMEs may have begun selecting eco-friendly materials, reducing hazardous inputs, or considering supplier responsibility, yet these actions may not be fully integrated into cost control, production systems, supplier governance, or long-term business strategy. As a result, green procurement alone may not immediately improve resource efficiency, financial stability, environmental performance, or market reputation. This finding is consistent with studies showing that SMEs in developing economies often face financial, technological, managerial, and supply chain constraints that limit the direct performance effects of green procurement (Agyemang et al., 2019; Ivanova, 2020; Nande & Vhankate, 2022). Green procurement therefore appears to function more as an initial environmental capability than as a stand-alone driver of sustainability. It needs complementary mechanisms, particularly circular economy practices, to convert purchasing decisions into operational and sustainability gains.

The study also finds that environmentally friendly technology has a positive and significant effect on SME sustainability. This result indicates that cleaner production tools, energy-efficient equipment, waste-treatment systems, and low-impact technologies can directly improve SME sustainability by reducing operational waste, lowering resource consumption, improving process efficiency, and strengthening environmental performance. Within the RBV and NRBV perspectives, environmentally friendly technology can be viewed as a strategic capability because it creates value through efficiency, environmental risk reduction, and stronger long-term competitiveness (Barney, 1991; Hart, 1995). The finding supports previous studies showing that green technology innovation and eco-innovation improve SME performance by increasing operational efficiency, financial resilience, and sustainability outcomes (Maghfuriyah et al., 2024; Oduro, 2024; Wu et al., 2023). This result also shows that cleaner technology is no longer relevant only for large firms. SMEs can use environmentally friendly technology as a practical route toward sustainability when the technology is affordable, usable, and connected to daily operations.

The findings further show that green procurement has a positive effect on circular economy practices. This result suggests that environmentally responsible purchasing decisions help SMEs adopt circular practices by encouraging the use of recyclable materials, lower-impact inputs, reusable resources, and suppliers that support waste reduction. Green procurement therefore contributes to circularity by shaping what enters the production system. When SMEs purchase better inputs, select more responsible suppliers, and reduce environmentally harmful materials, they create stronger conditions for reducing, reusing, recycling, and recovering resources. This finding aligns with the view that green procurement strengthens sustainable supply chain management and improves resource efficiency (Testa & Iraldo, 2010; Walker & Jones, 2012; Zhu et al., 2013; Rejeb et al., 2024). It also supports circular economy theory, which emphasizes that circularity begins not only at the waste-management stage but also at the input and sourcing stage (Ghisellini et al., 2016; Kirchherr et al., 2017).

Environmentally friendly technology also has a positive and significant effect on circular economy practices. This finding indicates that cleaner technologies help SMEs implement circular economy principles through more efficient resource use, cleaner production, waste reduction, material recovery, and energy efficiency. Technology enables circularity because it gives firms the operational tools needed to process materials more efficiently, recover value from waste, and reduce dependence on linear production systems. This result supports the NRBV argument that environmental technologies can become strategic resources when they are embedded into production systems and used to generate environmental and economic value (Hart, 1995). It is also consistent with studies showing that technological innovation plays an important role in circular business models by improving resource efficiency, extending product life cycles, and supporting cleaner production systems (Nascimento et al., 2019; Centobelli et al., 2020; Geissdoerfer et al., 2020). For SMEs, this means that circular economy adoption is unlikely to progress through environmental intention alone. It requires practical technological capability.

The positive effect of circular economy on SME sustainability confirms that resource efficiency, waste reduction, reuse, recycling, and material recovery contribute to stronger long-term sustainability. SMEs that apply circular economy practices can reduce input costs, limit operational waste, improve environmental performance, and create additional value from resources that would otherwise be discarded. This finding supports prior studies that view circular economy as a strategic resource-management system rather than a narrow environmental practice (Ghisellini et al., 2016; Kirchherr et al., 2017; Geissdoerfer et al., 2020). It also aligns with evidence showing that circular economy practices can improve financial and organizational outcomes through operational efficiency, cost-benefit improvement, and organizational agility (Gonçalves et al., 2022; Ramos et al., 2022; Oktrivina et al., 2025). In this study, circular economy functions as a practical bridge between environmental responsibility and business sustainability.

The mediation results show that circular economy mediates the relationships between green procurement, environmentally friendly technology, and SME sustainability. This finding is important because it explains why green procurement does not directly improve sustainability but still matters through circular economy practices. Green procurement provides environmentally responsible inputs and supplier choices, while environmentally friendly technology provides cleaner and more efficient production capabilities. Circular economy converts these capabilities into sustainability outcomes by reorganizing resource flows, reducing waste, improving efficiency, and creating value from reused or recovered materials. This result supports the NRBV argument that environmental capabilities generate sustainability advantages when they are transformed into organizational routines and resource-management practices (Hart, 1995). It also extends circular economy literature by showing that circularity is not only suitable for large firms or advanced manufacturing systems, but can also operate as a strategic mechanism for SMEs in developing regions.

Theoretically, this study contributes to the SME sustainability literature by showing that environmental capabilities do not always create direct sustainability gains. Green procurement may remain too limited when it is not supported by circular operational systems, while environmentally friendly technology can produce stronger direct and indirect sustainability effects because it changes how firms use resources. The study also strengthens RBV and NRBV by positioning circular economy as a mediating capability that transforms environmental practices

into sustainability performance. Practically, the findings suggest that SME sustainability programs should not stop at encouraging green purchasing or technology adoption. Local governments, SME associations, and support institutions should develop integrated programs that combine supplier guidance, cleaner technology access, circular economy training, waste-reduction systems, and technical assistance. For SMEs in Banten, this integrated support is essential to move sustainability from scattered green gestures into a more efficient, competitive, and circular business model.

CONCLUSION AND FURTHER STUDY

This study concludes that SME sustainability is strengthened not only by adopting green initiatives, but by converting them into circular and operationally embedded capabilities. Green procurement does not directly improve SME sustainability, which suggests that environmentally oriented purchasing remains insufficient when it is not supported by wider resource-management systems. Environmentally friendly technology has a stronger role because it directly improves efficiency, reduces environmental pressure, and supports circular economy practices. Circular economy also functions as a key mediating mechanism that transforms green procurement and environmentally friendly technology into sustainability outcomes. The study is limited by its cross-sectional design, purposive sampling, and relatively small sample size, which restrict causal interpretation and broader generalization. Future studies should use larger samples, longitudinal designs, multi-region comparisons, and sector-specific analysis to test whether these relationships remain stable across different SME contexts. Practically, local governments, SME associations, and support institutions should design integrated programs that combine green procurement guidance, access to cleaner technology, circular economy training, and technical assistance.

ETHICAL DISCLOSURE

This study was conducted in accordance with accepted ethical standards for research involving human participants. Prior to data collection, respondents were informed about the purpose of the study, the voluntary nature of their participation, the confidentiality of their responses, and their right to withdraw from the study at any stage without consequence. The study collected data only from SME owners and managers for academic purposes, and no personal identifying information was disclosed in the analysis or reporting.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest. The study receives funding from Universitas Sultan Ageng Tirtayasa, Indonesia, but did not influence the research process, analysis, interpretation, or conclusions of this study.

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