Jurnal Ilmiah
Bisnis dan Ekonomi Asia
e-ISSN: 2620-875X
Institut Teknologi dan Bisnis Asia Malang

The implementation of green behavior and green innovation in the sustainable development goals of culinary SMEs in Surakarta

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ARTICLE INFO

Volume 20 No 3

Article History
Received 19 January 2026
Revised 22 October 2026
Accepted 27 October 2026

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ABSTRACT

Culinary small and medium enterprises (SMEs) in Surakarta, Indonesia, generate substantial waste, yet the roles of green behavior and green innovation in their sustainable development remain underexplored. Prior studies have focused mainly on large manufacturers and hospitality chains, leaving resource-constrained micro enterprises largely unexamined. This study integrates the Theory of Planned Behavior and the Natural Resource-Based View to examine how these two green practices relate to sustainable development. A survey of 171 culinary SME owner-managers and supervisors was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). Green behavior and green innovation together explain 53.3% of the variance in sustainable development, with green behavior showing the stronger, followed by green innovation. These findings suggest that everyday environmental practices are a strong driver of sustainable development, alongside green innovation. For SME owners and policymakers, routine waste management and conservation practices offer a practical path toward economic, social, and environmental balance.

Keywords green behavior; green innovation; sustainable development; SMEs; theory of planned behavior

https://doi.org/10.32815/jibeka.v20i3.2471

1. Introduction

The challenges of global climate change and the high volume of waste contributors in Indonesia have driven a transition toward the concept of a green economy. This concept is often interpreted as an economic approach that enhances social welfare through income growth and job availability, supported by both government and private sector roles in economic activities that enable carbon emission and pollution reduction, biodiversity and ecosystem protection, as well as improvements in energy and resource efficiency (Widodo et al., 2023). The green economy has emerged as a response to several issues currently faced worldwide. It plays a crucial role in achieving the Sustainable Development Goals (SDGs) established by the United Nations in 2015. The SDGs aim to address various global challenges such as poverty, hunger, climate change, inequality, and environmental degradation. The green economy offers sustainable solutions to overcome these challenges.

Sustainable development is defined as human efforts in carrying out economic activities based on the principle of meeting present needs without compromising the needs of future generations. Sustainable development encompasses three main pillars: economic, social, and environmental aspects. These three components are interrelated and create conditions for sustainability (Hapsoro & Bangun, 2020). From an economic perspective, there are three reasons why Indonesia's economic development must be sustainable. The first reason relates to morality, as current generations enjoy goods and services provided by the environment and therefore have a moral obligation to ensure the availability of natural resources for future generations. The second reason is ecological, such as biodiversity, where economic

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development should not threaten ecosystems. The third reason is economic rationality, referring to how organizations utilize resources efficiently and effectively to achieve optimal outcomes.

The contribution of SMEs as engines of macroeconomic expansion that focus on environmental issues as a fundamental concept of their business model also plays a strategic role in economic sustainability. As business actors, SMEs are responsible for maintaining their business cycle to ensure a sustainable business climate. SMEs sustainability refers to the ability of Small, and Medium Enterprises to survive, grow, and adapt in the long term by considering economic, social, and environmental aspects. This sustainability includes business strategies that are not only profit-oriented but also consider social impacts as well as environmental conservation in order to remain relevant and competitive in the modern era. Yanti & Nawangsari (2019) explain that SMEs sustainability is crucial for maintaining economic stability in a region.

SMEs sustainability must prioritize behavioral principles that reflect concern for environmental conditions. This attitude supports efforts to maintain climate stability. According to Norton et al. (2015), green behavior refers to individual or group behaviors that contribute to environmental conservation in a work context. Green behavior is defined as any measurable individual action aimed at achieving environmental sustainability in the workplace (Ones & Dilchert, 2012). In other words, green behavior encourages individuals to act based on environmental conservation principles. Aboramadan (2020) states that green behavior consistently prioritizes environmental preservation in operational activities. In the context of MSMEs, green behavior involves the effective and efficient use of available resources (Wiernik et al., 2016). One implementation of green behavior within SMEs is ensuring that business actors manage waste properly to avoid environmental damage and create green workspaces.

Kurniawan et al. (2014) add that SMEs actors must consider the long-term effects of waste generated by their businesses. MSME waste management must be carried out systematically to achieve effectiveness (Yanti & Nawangsari, 2019). Poorly managed SMEs waste can lead to negative impacts on the environment and business sustainability. According to Law No. 32 of 2009 on Environmental Protection and Management, waste is defined as the residue of a business or production activity, while pollution refers to the entry of substances, energy, living organisms, or other components into the environment. Himawan et al. (2022) state that pollution is caused by human activities such as littering, natural processes, and economic and technological developments including uncontrolled industrialization and exploitation of nature (Akhmad & Purnomo, 2021). Since human activities are a major cause of pollution, green behavior is necessary to reduce its impact. Green behavior must be implemented by SMEs actors to enhance environmental balance, improve safety, health, and the continuity of life, and reduce long-term environmental risks.

Furthermore, business sustainability in SMEs can be assessed based on the success of business actors in carrying out innovation and managing employees and consumers. This indicates that MSMEs have an orientation toward growth and continuous innovation (Galuh et al., 2024). In relation to environmental issues, innovation must focus on efforts that promote sustainable development while maintaining harmony and fairness across economic, social, environmental, and governance pillars (Pratama, 2023). This concept serves as the foundation for the development of green innovation in the context of SMEs empowerment in Indonesia. Hilamawati (2021) adds that MSMEs have recently begun taking initiatives related to green innovation but still face challenges in adopting new innovations. These challenges arise due to limited time and resources. Additionally, SMEs tend to show low engagement in environmental protection activities, particularly in developing countries, and often continue to use conventional methods. Gadenne et al. (2009) further state that while SMEs are considered engines of macroeconomic growth, they are also major contributors to environmental exploitation.

Surakarta is a city with 10,907 SMEs (BPS, 2023). Based on data from the Cooperative, Small, and Medium Enterprises Office of Central Java Province, Surakarta became the city with the highest number of MSMEs in 2024. The culinary sector accounts for the largest portion, absorbing 42% of all MSMEs. The high number of culinary MSMEs also requires attention to the amount of waste generated from their operations. Much of the waste comes from household food plastic use (Environmental Department, 2023). This includes plastic food packaging used for selling meals or beverages. Other waste comes from

leftover food and kitchen materials from culinary businesses, with each MSME producing an average of 7.3 kg of waste per day. The high volume of waste generated by culinary MSMEs in Surakarta raises concerns regarding their sustainability in the future. According to Islam et al. (2020), SMEs sustainability is influenced by the green behavior of business actors to maintain operational stability in an environmentally conscious manner. In addition, SMEs sustainability requires green innovation to create environmentally friendly products and workspaces.

To strengthen the theoretical foundation of this study, the relationship between green behavior, green innovation, and sustainable development is anchored in the Theory of Planned Behavior (TPB) proposed by Ajzen (1991) and complemented by the Natural Resource-Based View (NRBV) of the firm (Hart, 1995). Within the TPB framework, an individual's pro-environmental action (green behavior) is driven by behavioral intentions shaped by positive attitudes toward environmental preservation, subjective norms within the local business community, and perceived behavioral control in daily operations. In micro and small culinary enterprises—where ownership and daily operational execution are tightly coupled—the owner-manager's and employees' green behavior directly translates intention into resource conservation and waste reduction routines (Ones & Dilchert, 2012; Norton et al., 2015). Complementarily, the NRBV posits that long-term competitive advantage and organizational sustainability depend on a firm's capability to deploy eco-friendly technological and process innovations—such as pollution prevention, product stewardship, and clean production—that minimize environmental burdens while enhancing economic efficiency (Islam & Wahab, 2020; Pratama, 2023).

Despite growing scholarly attention to corporate sustainability, prior empirical studies have predominantly examined green behavior and green innovation in large manufacturing corporations or hospitality chains, leaving a theoretical and empirical gap regarding how behavioral routines versus capital-dependent green innovations operate simultaneously in resource-constrained culinary MSMEs (Gadenne et al., 2009; Kusuma et al., 2021). Drawing upon the integration of TPB and NRBV, this study formulates two primary hypotheses: (H1) Green Behavior has a positive and significant effect on the Sustainable Development of culinary SMEs in Surakarta; and (H2) Green Innovation has a positive and significant effect on the Sustainable Development of culinary SMEs in Surakarta.

2. Research Method

This research employs an explanatory quantitative approach with a cross-sectional survey design conducted on the culinary SMEs sector in Surakarta City. The selection of respondents is based on the importance of sustainable SMEs development through the implementation of green behavior and green innovation. The population in this study were comprised 1729 culinary MSMEs in Surakarta (Dinkopukmprin Surakarta, 2024). The sample size was determined using the Slovin formula, yielding a number of 171 respondents, consist consisting of 93 food sector and 78 beverage sector enterprises. The sampling technique in this study used Accidental Sampling targeting owner-managers or operational supervisors who directly oversee daily kitchen production and waste management.

Primary data were collected using a structured self-report questionnaire measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4.0 software (Hair et al., 2019; Ghozali & Latan, 2015). Following standard PLS-SEM rules—and strictly distinguishing them from covariance-based or SPSS regression rules—model evaluation was executed in two sequential stages: (1) Evaluation of the Reflective Measurement Model (Outer Model), examining outer loadings (> 0.70), internal consistency reliability via Cronbach's Alpha (> 0.70) and Composite Reliability (CR > 0.70), convergent validity via Average Variance Extracted (AVE > 0.50), and discriminant validity via the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio of correlations (HTMT < 0.85); and (2) Evaluation of the Structural Model (Inner Model), assessing lateral collinearity via Variance Inflation Factor (VIF < 5.0), coefficient of determination (R^2), Stone-Geisser predictive relevance ($Q^2 > 0$), effect size (f^2, where 0.02, 0.15, and 0.35 indicate small, medium, and large effects), and path coefficient hypothesis testing using bootstrapping (5,000 subsamples, two-tailed test at $\alpha = 0.05$, critical z-value = 1.96).

3. Result

Outer Model Evaluation (Convergent Validity & Reliability): In accordance with PLS-SEM evaluation rules, the measurement model was first assessed for convergent validity and internal consistency reliability. In this study, the loading factor value was > 0.70, which means that the indicators used in this study have good ability to explain the construct (Ghozali & Latan, 2015). Internal consistency reliability was evaluated using both Cronbach's Alpha (CA) and Composite Reliability (CR). The conclusion from the data processing above shows satisfactory figures, with all variables above the 0.70 threshold (Cronbach's Alpha ranging from 0.841 to 0.884, and Composite Reliability ranging from 0.892 to 0.919), indicating high consistency and stability of the instruments used. It is concluded that all constructs in this study are suitable measuring instruments and have good reliability (Ghozali & Latan, 2015; Hair et al., 2019).

Figure 1 SmartPLS Measurement (Outer) and Structural (Inner) Model Diagram

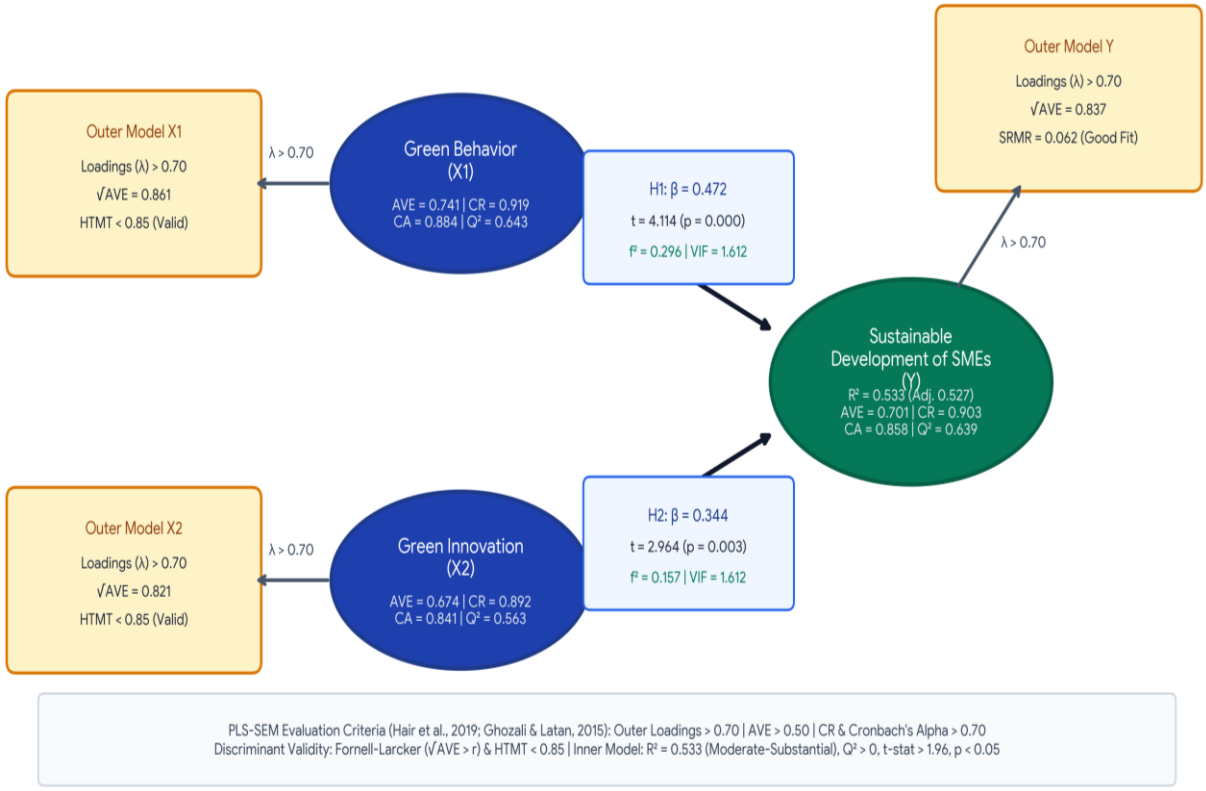


Table 1 Outer Model Evaluation

Construct	Outer Loadings	Cronbach's Alpha	Composite Reliability	AVE
Green Behavior (X1)	> 0.70 (0.812 – 0.895)	0.884	0.919	0.741
Green Innovation (X2)	> 0.70 (0.785 – 0.856)	0.841	0.892	0.674
Sustainable Development of SMEs (Y)	> 0.70 (0.804 – 0.872)	0.858	0.903	0.701

The Average Variance Extracted (AVE) value for the Green Behavior (0.741), Green Innovation (0.674), and Sustainable Development of SMEs (0.701) variables is > 0.5. In PLS-SEM rules (Hair et al., 2019), an AVE value > 0.50 confirms strong Convergent Validity, meaning each construct explains more than 50% of its indicators' variance. Discriminant Validity was subsequently evaluated using the Fornell-Larcker criterion (square root of AVE) and the Heterotrait-Monotrait Ratio (HTMT). The square root of AVE (√AVE) of the Green Behavior construct (X1) is greater than the correlation of the Green Behavior variable (X1) to other variables, which is 0.861. The square root of AVE (√AVE) of Green Innovation (X2) is greater than the correlation of the Green Innovation variable (X2) to the Sustainable Development of SMEs (Y) variable, which is 0.821 and the Sustainable Development of MSMEs (Y) variable has a

~~correlation~~ square root of AVE (√AVE) of 0.837 which exceeds its inter-construct correlations with X1 (0.684) and X2 (0.636). Furthermore, all HTMT values between constructs range from 0.714 to 0.781 (< 0.85), confirming robust discriminant validity (Henseler et al., 2015).

Table 2 Discriminant Validity Test

Construct	X1	X2	Y	HTMT (X1)	HTMT (X2)
Green Behavior (X1)	0.861 (√AVE)	-	-	-	-
Green Innovation (X2)	0.616	0.821 (√AVE)	-	0.714	-
Sustainable Development (Y)	0.684	0.636	0.837 (√AVE)	0.781	0.735

This shows that the variables used in this study have met the category for the discriminant validity test (Ghozali & Latan, 2015). Inner Model Evaluation: Inner VIF values for X1 and X2 are both 1.612 (< 5.0), confirming no collinearity issues. The R-square value of the MSME Sustainable Development variable is 0.533, meaning that the variability of the MSME Sustainable Development construct that can be explained by the variability of Green Behavior and Green Innovation is 53.3%, while the rest (46.7%) is explained by other variables outside those studied. According to Ghozali & Latan (2015)~~.~~ R^2 values of 0.67, 0.33, and 0.19 represent strong, moderate, and weak models, respectively; thus, an R^2 of 0.533 indicates a moderate-to-substantial model. In addition, the effect size (f^2) evaluation shows that Green Behavior has a medium-to-large effect ($f^2 = 0.296$) and Green Innovation has a medium effect ($f^2 = 0.157$) on Sustainable Development. The Q-Square value for the Green Behavior variable is 0.643, the Green Innovation variable is 0.563, and the Sustainable Development of MSMEs is 0.639, all of which are greater than 0 (zero). This means that this model has predictive relevance (Ghozali & Latan, 2015). In this hypothesis test, the ~~standard error~~ significance level (α) is 5%. The research hypothesis can be declared accepted if the t-statistics value is > 1.96 and the P-value is < 0.05 (Ghozali & Latan, 2015). Table 3 shows the results of the hypothesis test.

Table 3 Hypothesis test

Hypothesis	Sample (O)	Mean (M)	Std dev	t-stat	P values	Effect Size
H1	0.472	0.479	0.115	4.114	0.000	0.296
H2	0.344	0.344	0.116	2.964	0.003	0.157

Based on the description above, the hypothesis testing for the assessment based on the table above can be conducted as follows:

1) H1 (Accepted): Green Behavior has a positive and significant effect on the Sustainable Development of MSMEs. The results of the study indicate a positive and significant relationship between the Green Behavior variable (X1) and the Sustainable Development of MSMEs (Y). The direction of the relationship can be seen from the Original Sample (O) path coefficient (β) value of 0.472. Significance is indicated by the t-statistic value of 4.114, which is greater than the critical z-value (1.96). The p-value of 0.000 also meets the predetermined standard (<0.05), with an effect size (f^2) of 0.296 (medium-to-large).
2) H2 (Accepted): Green Innovation has a positive and significant impact on the Sustainable Development of MSMEs. The results of the study indicate a positive and significant relationship between the Green Innovation variable (X2) and the Sustainable Development of MSMEs (Y). The direction of the relationship can be seen from the Original Sample (O) path coefficient (β) value of 0.344. Significance is indicated by the t-statistic value of 2.964 which is greater than the critical z-value (1.96). The p-value of 0.003 also meets the predetermined standard of (<0.05), with an effect size (f^2) of 0.157 (medium).

4. Discussion

Culinary MSMEs in Surakarta have implemented green behavior in sustainable development to maintain a balance between economic growth, social welfare, and environmental sustainability. Culinary MSMEs in Surakarta have adopted environmentally and socially friendly business practices. In their business practices, culinary MSMEs in Surakarta demonstrate voluntary environmentally friendly behavior,

namely behavior that arises from MSME initiatives to maintain environmental sustainability. Culinary MSMEs in Surakarta also require it in the form of core tasks, such as organizational policies, changes in work methods, including choosing responsible and sustainable alternatives in creating products and their production processes. MSMEs demonstrate a supportive attitude towards selecting environmentally friendly products and production processes (working sustainably).

MSMEs avoid harm (loss) by engaging in avoidance and inhibition of negative environmental behavior. This helps maintain a healthy MSME environment. MSMEs have also implemented savings against wasteful use of resources, including water, energy, gas, and other resources. MSMEs have also influenced each other by focusing on employee behavior, aiming to spread sustainable behavior to others. The focus is on providing influence, which involves disseminating knowledge, encouraging, and supporting behavioral change in others. MSMEs also demonstrate initiative in the form of individual-initiated work programs and policies that can address all aspects of environmental sustainability or environmentally friendly employee behavior.

MSMEs are a pillar of national economic growth, contributing 61.1%. This indicates that innovation within MSMEs is necessary to accelerate sustainable economic development. Food MSMEs in Surakarta are implementing green innovation in their business processes, such as energy efficiency by implementing energy-saving technologies in production and business operations. At an operational level, culinary MSMEs contribute to localized emission reductions by sourcing fresh ingredients from nearby traditional markets in Surakarta and optimizing cooking fuel usage. MSMEs have implemented sustainable waste management with a recycling system and reuse of production waste.

MSME waste can also be used for product innovation, thereby reducing environmental impact. The use of environmentally friendly raw materials is carried out with more environmentally friendly raw material substitutions. MSMEs also innovate through sustainable product design through innovations in more recyclable packaging. MSMEs have implemented green technology in their business innovation processes by using accessible digital technology to reduce waste through paperless programs by sending invoices via email or WhatsApp to consumers. MSMEs have policies in implementing sustainability by providing training and continuously educating employees about the importance of green innovation for the sustainable development of MSMEs.

Furthermore, comparing the empirical magnitude of the two predictors reveals an important finding: Green Behavior exerts a stronger effect on Sustainable Development ($\beta = 0.472$; $t = 4.114$; $f^2 = 0.296$) than Green Innovation ($\beta = 0.344$; $t = 2.964$; $f^2 = 0.157$). While studies in large manufacturing enterprises often report technological green innovation as the primary driver of sustainability (Islam & Wahab, 2020), our findings in culinary MSMEs align with behavioral perspectives (Ajzen, 1991; Ones & Dilchert, 2012; Aboramadan, 2020; Yanti & Nawangsari, 2019). Two alternative explanations clarify why green behavior outperforms green innovation in Surakarta's culinary sector. First, due to limited working capital and thin profit margins (Gadenne et al., 2009; Kusuma et al., 2021), habitual green behaviors—such as turning off idle LPG stoves, conserving dishwashing water, accurate food portioning, and sorting kitchen waste—require zero capital investment and immediately reduce daily operating costs. Second, green product and packaging innovations (e.g., biodegradable food containers or energy-efficient kitchen appliances) entail higher unit costs that price-sensitive culinary consumers in Surakarta are reluctant to absorb, thus limiting the immediate impact of green innovation (Pratama, 2023; Himawan et al., 2022).

Theoretically, these findings extend the Theory of Planned Behavior (Ajzen, 1991) and the Natural Resource-Based View (Hart, 1995) by demonstrating that in resource-constrained culinary SMEs, TPB-driven pro-environmental behavioral routines serve as the foundational prerequisite that enables NRBV-driven green process innovations to succeed. Practically, rather than generic environmental advice, culinary SMEs in Surakarta should implement specific kitchen-level recommendations: (1) partnering with biodiesel collectors or local waste banks (Bank Sampah) to valorize used cooking oil (minyak jelantah) rather than pouring it into drains; (2) collaborating with local Black Soldier Fly (BSF) maggot cultivators and urban farmers in Surakarta to process daily organic kitchen scraps (7.3 kg/day); (3) utilizing traditional Solo eco-friendly food wrappers (banana leaves, besek bambu) and offering

discounts to customers bringing reusable containers; and (4) conducting simple kitchen energy audits alongside local government (Dinkopukmprin) bulk-purchasing subsidies for eco-packaging.

Finally, several methodological limitations of this study must be acknowledged. First, the cross-sectional survey design captures data at a single point in time, preventing strict longitudinal causal inferences. Second, reliance on self-report questionnaires from SME owners/managers may introduce social desirability bias regarding environmental practices. Third, the use of non-probability accidental sampling (n = 171) in a single city (Surakarta) limits the generalizability of the results. Future research should employ longitudinal designs, objective waste/energy audits, and probability sampling across broader geographic regions.

5. Conclusion

Green behavior and green innovation are both positively associated with the sustainable development of culinary SMEs in Surakarta, and together they account for a substantial share of the variation in that development. Green behavior appears to be the stronger of the two, which suggests that routine environmental practices carry particular weight for resource-constrained enterprises. This difference, however, was observed through comparison rather than formal testing, and it should be read as a tendency rather than a settled result.

Theoretically, the findings are consistent with the view that intention-driven, everyday environmental actions matter for organizational sustainability in small firms, and they may extend the Theory of Planned Behavior to micro and small food businesses. The results also suggest that green innovation contributes to sustainable development in this setting, which offers some support for the Natural Resource-Based View. The design, however, does not test whether behavioral routines and innovation operate in sequence, so the study cannot confirm that one enables the other. Future theory building in this area would benefit from models that specify and test such pathways directly.

Practically, SME owners can gain from low-threshold practices such as resource conservation and waste sorting, which fit into daily operations and do not require major capital. Green innovation remains valuable, and it may be most effective when it builds on established routines. Local government and cooperative agencies may therefore consider programs that first strengthen everyday environmental habits among SME operators and then support selected innovations, such as energy-efficient equipment and eco-friendly packaging.

Future research should use longitudinal designs to test causal direction, measure waste and energy use objectively rather than relying solely on self-report, and sample more widely across regions and business types. Researchers should also examine whether green behavior mediates or moderates the effect of green innovation. Such work would clarify whether the pattern observed in this study holds beyond a single city and a single survey.

Author contributions

First Author: Conceptualization, formal analysis, investigation, methodology, project administration, resources, software, and writing - review & editing. S. Author: Data curation, investigation and validation.

Conflict of interest

The authors declare no competing financial interests that could have appeared to influence the work.

Publication ethics

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee.

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