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Green innovation for sustainable performance: Insights from the TOE framework

Frank Aligarh[1,2*], Agung Nur Probohudono[2], Eko Arief Sudaryono[2], Wahyu Widarjo[2], M. Rahmawan Arifin[1], Bayu Sindhu Raharja[1], Anissa Hakim Purwantini[3]

[1] Universitas Islam Negeri Raden Mas Said, Sukoharjo, Indonesia
[2] Universitas Sebelas Maret, Surakarta, Indonesia
[3] Universitas Muhammadiyah Magelang, Magelang, Indonesia
[*]Corresponding author's email: frank.aligarh@staff.uinsaid.ac.id

Abstract

The issue of environmental degradation has intensified significantly over the past decade. Governments, society, and businesses have increasingly engaged in discussions on how to ensure the achievement of sustainable development. Following the Paris Agreement, the adoption of green innovation practices has garnered substantial attention worldwide. In Indonesia, Micro, Small, and Medium Enterprises (MSMEs), as the backbone of the nation, play a crucial role in implementing green innovation to ensure sustainable performance. Using the Technology-Organization-Environment (TOE) framework, this study examines the determinants of green innovation and its impact on sustainable performance. A survey was conducted with 180 manufacturing MSMEs, and the data were analyzed using the partial least squares method. The results indicate that technology factors, organizational factors, and environmental factors positively influence green innovation. Furthermore, green innovation is identified as a critical factor for achieving sustainable performance. This study contributes theoretically by expanding the development of models that investigate green innovation and sustainable performance. Practically, it offers insights into sustaining sustainable development by positioning MSMEs as key stakeholders.

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Keywords

Sustainable performance, Green innovation, TOE framework, MSMEs

Introduction

As an archipelagic nation, Indonesia plays a significant role in addressing global environmental issues. Researchers, business practitioners, and policymakers have actively contributed to promoting environmental awareness and campaigns [1]. However, due to Indonesia's diverse demographic and geographic conditions, environmental issues are often primarily discussed within large-scale organizations.

MSMEs represent a critical element in efforts to mitigate environmental degradation. With a substantial contribution of 61% to the Gross Domestic Product (GDP), amounting to IDR 9,580 trillion, and accounting for 97% of total employment, MSMEs are pivotal in supporting environmental sustainability. Moreover, international agreements have urged MSMEs to reduce pollution to minimize the challenges posed by climate change[2].

Issues related to climate change, environmental quality, and human quality of life have been escalating exponentially across various levels [3]. This aligns with the growing public awareness of environmental impacts, which significantly influences the success of efforts to reduce environmental pollution. Green innovation is regarded as a critical mechanism, particularly for MSMEs, in their efforts to promote environmental sustainability [4]. Although green innovation is crucial, various findings indicate that its implementation continues to yield mixed results [5]. Several previous studies have revealed that the challenges faced by MSMEs in implementing green innovation include difficulties in bringing green products to market, weak regulations related to green innovation, low incentives for the success of green innovation, and limited consumer awareness regarding the importance of environmental sustainability [6]. Furthermore, the slow adoption of green innovation can also be attributed to financial and regulatory constraints, technological and market barriers, cultural and educational gaps, as well as limitations in infrastructure and logistics [7].

Business practices aligned with environmental concerns require the capability of individual MSMEs to innovate. Green innovation is essential for MSMEs to achieve circular business sustainability [3]. The implementation of green innovation, however, relies on certain driving factors. This study aims to identify the determinants of successful green innovation adoption by MSMEs. It employs the TOE framework to examine these determinants [8]. Originally developed to study technology adoption, the TOE framework has evolved to identify the adoption of green innovation [9]. The technological factor evaluates the ability of MSMEs to optimize technological potential in supporting green innovation. The organizational factor examines the internal capacity of firms to implement green innovation practices. Meanwhile, the environmental factor assesses external support, including that from the government, society, and regulations, in adopting green innovation. Furthermore, after identifying the determinants of green innovation practices, this study seeks to explore their impact on sustainable performance [10]. This study is expected to provide a theoretical contribution to the development of innovation models by integrating the TOE framework with green innovation. Additionally, it contributes to the development of survey instruments in the context of MSMEs, encouraging future researchers to focus not only on large corporations but also on MSMEs.

Method

Sample and Population

This study focuses on the population of all manufacturing MSMEs in the Central Java region. In this study, a convenience sampling method was utilized as the technique for selecting participants. This method was chosen due to the widespread use of social media by manufacturing MSMEs for communication purposes. The use of convenience sampling facilitates data collection for the surveyors. The study successfully obtained 180 questionnaires, both online and in-person.

Measurement

The study utilized a questionnaire divided into two sections. The first section collected demographic data, including gender, type of business, age, and other relevant information. The second section required respondents to rate statements related to the variables using a 5-point Likert scale. The variables for technology factors, organizational factors, and environmental factors were adopted from [4], green innovation was adopted from[4], [6], [11], and sustainable performance was adopted from [3], [10].

Data analysis

The study aims to predict and develop a new research model, making SEM-PLS the recommended analytical tool [12]. SEM-PLS is advantageous due to its ability to test complex relationships involving multiple interrelated variables. The SEM analysis begins with the outer model, assessing discriminant validity, convergent validity, and reliability. This is followed by the inner model analysis, which tests the hypotheses between variables. Mediation testing is also conducted to determine whether green innovation mediates the relationship between technology factors, organizational factors, and environmental factors on sustainable performance [12].

Result and Discussion

Respondent Profile

Table 1 presents information about the research respondents. The demographic profile of the respondents reveals a diverse representation. In terms of gender, the majority are male (56%), while females constitute 44%. Most respondents fall within the age range of 18-28 years (50%), followed by 29-39 years (32%), 40-49 years (10%), and 50-60 years (3%). Regarding business age, 59% of the businesses have been operating for 3-5 years, 29% for 6-10 years, 21% for more than 10 years, and 6% for 1-2 years. In terms of business size, small businesses dominate at 54%, followed by medium-sized businesses at 23%. The types of businesses represented include furniture and wood products (21%), textiles, apparel, and leather (21%), food and beverages (19%), paper and printing (11%), and trailers, machinery, and repairs (6%). This demographic distribution highlights the diverse characteristics of the respondents and their businesses.

Table 1. Respondent Data

Demography	Category	Frequency	Percentage
Gender	Male	100	56%
	Female	80	44%
Age	18-28 Years	90	50%
	29-39 Years	57	32%
	40-49 Years	18	10%
	50-60 Years	5	3%
Age of Business	1-2 Years	10	6%
	3-5 Years	107	59%
	6-10 Years	52	29%
	>10 Years	37	21%
Size	Small	98	54%
	Medium	42	23%
Business type	Food Beverages	35	19%
	Furniture and wood products	37	21%
	Paper & Printing	19	11%
	Textiles, apparel and leather	37	21%
	Trailers, machinery and repairs	10	6%

Source: Table created by author

Result

Table 2 depicts that the results of the convergent validity and reliability tests indicate that all items tested are valid. The analysis of Table 2 highlights the results for convergent validity, reliability, and multicollinearity diagnostics for the constructs evaluated using Smart PLS. All factor loadings surpass the recommended threshold of 0.7, confirming that the indicators appropriately measure their respective constructs. Additionally, the Cronbach's Alpha values are above 0.7, while the Composite Reliability (CR) values exceed 0.8, demonstrating internal consistency and reliability across all constructs. The Average Variance Extracted (AVE) values also meet the minimum acceptable standard of 0.5, confirming that each construct adequately captures the variance of its indicators, thus establishing convergent validity.

In terms of multicollinearity, the Variance Inflation Factor (VIF) values for all indicators are below the commonly accepted cutoff of 3, suggesting that multicollinearity is not a concern. This indicates that each variable is distinct and does not overlap significantly with others in the model. Together, these findings verify the robustness of the measurement properties for the constructs: Environmental Factors (EF), Green Innovation (GINV), Organizational Factors (OF), Sustainable Performance (SP), and Technology Factors (TF), providing a reliable foundation for further statistical analysis and hypothesis testing.

Table 2. Convergent Validity and Reliability

Variable	Indicator	Factor Loading	Cronbach's Alpha	Composite Reliability	AVE	VIF
Environmental Factors	EF1	0.873	0.806	0.886	0.72	1.945
	EF2	0.863				1.855
	EF3	0.810				1.576
Green Innovation	GINV1	0.735	0.841	0.888	0.61	1.525
	GINV2	0.756				1.584
	GINV3	0.823				2.463
	GINV4	0.826				2.397
	GINV5	0.771				1.709
Organizational Factors	OF1	0.844	0.792	0.878	0.71	1.698
	OF2	0.848				1.697
	OF3	0.828				1.617
Sustainable Performance	SP1	0.762	0.861	0.895	0.59	2.020
	SP2	0.805				2.295
	SP3	0.778	0.826	0.896	0.74	1.865
	SP4	0.768				2.615
	SP5	0.733				2.436
	SP6	0.754				1.931
Technology Factors	TF1	0.884	0.888	0.914	0.64	2.121
	TF2	0.869				2.068
	TF3	0.832				1.647

Source: Table created by author

Table 3 shows the results of discriminant validity testing. The discriminant validity table below indicates that all variables in this study meet the Fornell-Larcker Criterion, where the square root of AVE (diagonal, in bold) for each variable is greater than its correlations with other variables (off-diagonal). EF have a square root of AVE of 0.849, GINV is 0.783, OF is 0.840, SP is 0.767, and TF is 0.862. This demonstrates that each variable is distinctly different from the others, confirming that the discriminant validity of the research model is satisfactory.

Table 3. Fornell Larcker Criterion

Variable	EF	GINV	OF	SP	TF
EF	0.849				
GINV	0.577	0.783			
OF	0.534	0.550	0.840		
SP	0.545	0.519	0.635	0.767	
TF	0.585	0.557	0.701	0.611	0.862

Notes: TF= Technology Factors; OF= Organizational Factors; EF= Environmental Factors; GINV= Green Innovation SP= Sustainable Performance;

(Source: Table created by author, 2024)

Table 4 presents the overall hypothesis testing results, demonstrating that TF has a positive effect on GINV with (β = 0.917, t = 2.906). OF also show a positive impact on GINV with (β = 0.231, t = 3.049). EF exhibit consistent positive effects on GINV with (β = 0.338, t = 5.603). Furthermore, the analysis of impact reveals that GINV positively influences SP with (β = 0.338, t = 5.603). Mediation testing was also conducted to evaluate the indirect effects of TF, OF, and EF on SP through GINV. The results indicate that GINV partially mediates the effects of TF, OF, and EF on SP.

Table 4. Hypothesis Testing

No.	Hypothesis	*β*	T Statistics	p-values	Conclusion
1.	H1: TF → GINV	0.197	2.906	0.004	Supported
2.	H2: OF → GINV	0.231	3.049	0.002	Supported
3.	H3: EF → GINV	0.338	5.603	0.000	Supported
4.	H4: GINV → SP	0.519	10.332	0.000	Supported
		Mediating Variables			
6.	H5: TF → GINV → SP	0.102	2.633	0.009	Supported
7.	H6: OF → GINV → SP	0.120	2.928	0.004	Supported
8.	H7: EF → GINV → SP	0.176	4.624	0.000	Supported

Notes: TF= Technology Factors; OF= Organizational Factors; EF= Environmental Factors; GINV: Green Innovation SP= Sustainable Performance;

(Source: Table created by author. 2024)

Discussion

Based on the results of the hypothesis testing, it can be concluded that all the hypotheses in this study are supported with statistical significance. The positive effect of TF, OF, and EF on GINV is consistent with previous research [4]. Technology helps accelerate the process of implementing green innovation while the organization's ability to maximize its resources also motivates MSMEs to carry out green innovation. In addition, support from consumers and the government also acts as a driving force as an environmental factor to determine the success of green innovation.

The testing of impact further indicates that GINV positively affects SP. This finding aligns with other studies, which have demonstrated that organizations adopting green innovations are typically more efficient and effective in meeting long-term sustainability objectives [13][14]. Green innovation is not only an effort to improve the environment, but also an effort to ensure that sustainability in the future can be maintained properly. Additionally, the mediation analysis shows that GINV acts as a significant mediator in the relationship between TF, OF, EF, and SP. In essence, the successful integration of environmentally sustainable technologies and strategies, supported by a culture that prioritizes sustainability, will have a more substantial impact if green innovation is actively incorporated, thereby boosting the organization’s sustainable performance.

Conclusion

This study reveals that the application of the TOE framework can also influence green innovation. Although the TOE framework is typically used for technology adoption, recent studies have increasingly utilized it to predict green innovation. The findings demonstrate that technological factors. organizational factors. and environmental factors positively impact green innovation. Furthermore. green innovation can significantly contribute to sustainable performance. This research provides theoretical contributions by reinforcing the applicability of the TOE framework beyond technology adoption. extending its relevance to innovation. particularly for SMEs. It also broadens the scope of TOE by not only examining its antecedents but also its consequences on sustainable performance. Practically. this study offers insights for environmentally friendly practices. urging all stakeholders. particularly SMEs. to adopt eco-friendly initiatives. Such practices hold long-term benefits. ensuring sustainability in economic. social. and environmental dimensions. However. this study has limitations. The sample size is restricted to the Central Java region. and future research could expand the sample to include regions across Indonesia. Additionally. this study focuses solely on manufacturing SMEs and has not comprehensively examined other types of SMEs. Future research should consider incorporating variables related to both innovation and technological capabilities as drivers of sustainable green innovation. Further investigations could also explore green innovation across products. processes. and management dimensions of green innovation.

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References

1. R. Ramadhan, M. T. Mon, S. Tangparitkul, R. Tansuchat, and D. A. Agustin, "Carbon capture, utilization, and storage in Indonesia: An update on storage capacity, current status, economic viability, and policy," *Energy Geoscience*, p. 100335, 2024.
2. M. A. Baloch, I. Ozturk, F. V. Bekun, and D. Khan, "Modeling the dynamic linkage between financial development, energy innovation, and environmental quality: does globalization matter?," Bus Strategy Environ, vol. 30, no. 1, pp. 176–184, 2021.
3. M. N. Alraja, R. Imran, B. M. Khashab, and M. Shah, "Technological Innovation, Sustainable Green Practices and SMEs Sustainable Performance in Times of Crisis (COVID-19 pandemic)," Information Systems Frontiers, vol. 24, no. 4, pp. 1081–1105, Aug. 2022, doi: 10.1007/s10796-022-10250-z.
4. Y. Zhang, J. Sun, Z. Yang, and Y. Wang, "Critical success factors of green innovation: Technology, organization and environment readiness," J Clean Prod, vol. 264, p. 121701, 2020.
5. N. R. Khan, F. Ameer, R. B. Bouncken, and J. G. Covin, "Corporate sustainability entrepreneurship: The role of green entrepreneurial orientation and organizational resilience capacity for green innovation," J Bus Res, vol. 169, p. 114296, 2023.

6. F. Chien, H. W. Kamran, M. A. Nawaz, N. N. Thach, P. D. Long, and Z. A. Baloch, "Assessing the prioritization of barriers toward green innovation: small and medium enterprises Nexus," Environ Dev Sustain, pp. 1–31, 2021.
7. H. Salmenperä, "Different pathways to a recycling society–Comparison of the transitions in Austria, Sweden and Finland," J Clean Prod, vol. 292, p. 125986, 2021.
8. F. Aligarh, B. Sutopo, and W. Widarjo, "The antecedents of cloud computing adoption and its consequences for MSMEs' performance: A model based on the Technology-Organization-Environment (TOE) framework," Cogent Business & Management, vol. 10, no. 2, p. 2220190, 2023.
9. M. Dadhich and K. K. Hiran, "Empirical investigation of extended TOE model on Corporate Environment Sustainability and dimensions of operating performance of SMEs: A high order PLS-ANN approach," J Clean Prod, vol. 363, Aug. 2022, doi: 10.1016/j.jclepro.2022.132309.
10. E. Yadegaridehkordi, B. Foroughi, M. Iranmanesh, M. Nilashi, and M. Ghobakhloo, "Determinants of environmental, financial, and social sustainable performance of manufacturing SMEs in Malaysia," Sustain Prod Consum, vol. 35, pp. 129–140, 2023.
11. N. T. K. Chi, "Driving factors for green innovation in agricultural production: An empirical study in an emerging economy," J Clean Prod, vol. 368, p. 132965, 2022.
12. J. F. Hair, J. J. Risher, M. Sarstedt, and C. M. Ringle, "When to use and how to report the results of PLS-SEM," European business review, vol. 31, no. 1, pp. 2–24, 2019.
13. S. Ullah, T. Ahmad, B. Lyu, A. Sami, M. Kukreti, and A. Yvaz, "Integrating external stakeholders for improvement in green innovation performance: role of green knowledge integration capability and regulatory pressure," International Journal of Innovation Science, vol. 16, no. 4, pp. 640–657, 2024.
14. F. Zhang and L. Zhu, "Enhancing corporate sustainable development: Stakeholder pressures, organizational learning, and green innovation," Bus Strategy Environ, vol. 28, no. 6, pp. 1012–1026, 2019.