West Science Social and Humanities Studies
Vol. 02, No. 12, December 2024, pp. 2012-2022

The Effect of Circular Economy Implementation, Environmental Awareness, and Green Technology on Resource Efficiency in Manufacturing Industries in West Java

Loso Judijanto[1], Anung Haryanto[2], Heri Setiyawan[3]
[1] IPOSS Jakarta, Indonesia
[2] Akademi Sekretaris dan Manajemen Kencana Bandung
[3] Sekolah Tinggi Ilmu Ekonomi TRIGUNA Tangerang

Article Info

Article history:

Received Dec, 2024
Revised Dec, 2024
Accepted Dec, 2024

Keywords:

Circular Economy
Environmental Awareness
Green Technology
Resource Efficiency
Manufacturing Industry

ABSTRACT

This study examines the effects of circular economy implementation, environmental awareness, and green technology adoption on resource efficiency in manufacturing industries in West Java. Using quantitative analysis, data were collected from 190 respondents through a Likert-scale questionnaire (1-5) and analyzed with Structural Equation Modeling-Partial Least Squares (SEM-PLS 3). The findings reveal that all three factors significantly enhance resource efficiency, with green technology showing the strongest impact. Circular economy practices optimize resource utilization, while environmental awareness fosters sustainable organizational behavior. The integration of these factors explains 62% of the variance in resource efficiency, highlighting the importance of an integrated approach to sustainability. The study provides actionable insights for policymakers and industry leaders to promote sustainable practices and adopt green innovations in manufacturing.

This is an open access article under the [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.

Corresponding Author:

Name: Loso Judijanto
Institution: IPOSS Jakarta, Indonesia
Email: losojudijantobumn@gmail.com

1. INTRODUCTION

The manufacturing industry in West Java, Indonesia, is vital for economic growth but struggles with resource inefficiency and environmental degradation, necessitating strategies like the circular economy (CE), environmental awareness (EA), and green technology (GT) for sustainable transformation. CE emphasizes resource reuse and recycling, reducing waste and conserving materials while encouraging manufacturers to design products with their entire lifecycle in mind, thereby enhancing sustainability [1]. Integrating CE principles can yield significant cost savings and reduced environmental footprints. Similarly, EA involves educating manufacturers about the environmental impacts of their operations, as companies with high EA levels tend to adopt sustainable practices, leading to lower carbon emissions [2], fostering a culture of sustainability within organizations and driving continuous improvement. Meanwhile, GT focuses on innovations like energy-efficient machinery and eco-friendly materials that reduce environmental harm [3], with its adoption linked to improved production efficiency and reduced operational costs. Additionally, government support and incentives play a crucial role in promoting GT adoption within the manufacturing sector [4], [5].

The circular economy (CE) is essential for promoting sustainability by minimizing waste, enhancing resource efficiency, and extending material lifecycles, thereby reducing reliance on finite resources while aligning with environmental awareness that drives organizations to adopt eco-friendly practices. CE emphasizes waste minimization through practices like recycling and remanufacturing, increasingly adopted in industries such as oil and gas[6]. Companies also invest in technologies for resource recovery and reuse, enhancing efficiency and compliance with environmental regulations [6], while implementing closed-loop systems fosters continuous resource use, significantly reducing environmental impact [7]. Increased environmental awareness serves as a catalyst for organizational change, encouraging the adoption of sustainable practices and engaging consumers in purchasing recycled products, which are vital for advancing CE initiatives [8]. Furthermore, advancements in green technology, such as IoT and digitalization, optimize manufacturing processes and resource management, supported by financial mechanisms and investment strategies that ensure the transition to circular practices and long-term sustainability [9], [10].

Despite the growing recognition of these strategies, there is a lack of empirical research exploring their combined impact on resource efficiency in the manufacturing sector, particularly in developing economies such as Indonesia. Existing studies often focus on these factors in isolation, neglecting the interconnectedness of their implementation. Moreover, the dynamic socio-economic and environmental contexts of West Java necessitate a localized understanding of how these factors influence resource efficiency. This study seeks to address this gap by examining the effect of circular economy implementation, environmental awareness, and green technology on resource efficiency in manufacturing industries in West Java.

2. LITERATURE REVIEW

2.1 Circular Economy and Resource Efficiency

The circular economy (CE) offers a transformative approach to resource management in manufacturing and resource-intensive industries by prioritizing waste minimization, resource recovery, and closed-loop systems to improve material efficiency and reduce costs. Key practices include remanufacturing, which restores used products to like-new condition and reduces the need for new materials [6], and eco-design, which considers the entire product lifecycle to facilitate recycling and reuse [11], [12]. Resource recovery methods, such as capturing flared gases in the oil and gas sector, highlight CE's potential [6], [13]. CE practices provide economic and environmental benefits, including cost savings, improved resource efficiency, and enhanced corporate reputation through stakeholder trust and regulatory compliance [6]. However, successful implementation requires strong organizational commitment and supportive policies. Research gaps remain in understanding how CE integration drives measurable resource efficiency, especially in developing economies like Indonesia[14].

2.2 *Environmental Awareness and Sustainable Practices*

Environmental awareness (EA) is pivotal in fostering sustainable practices within organizations, particularly in manufacturing, as companies prioritizing EA are more inclined to implement eco-friendly strategies, optimize resource use, and cultivate a sustainability-oriented culture among employees. Organizations with high EA are likelier to adopt sustainable practices, demonstrated by proactive environmental policies that enhance resource optimization [15], [16]. Educational initiatives like the "Granito de Arena" project show that instilling environmental values early can significantly promote awareness and sustainable behaviors [17]. Public engagement also plays a critical role, with increased EA encouraging community participation in environmental initiatives, improving air quality, and advancing sustainable industrial practices [16].Tailored strategies that address regional and generational differences in EA further enhance engagement and the effectiveness of sustainability efforts [15], [18]. Challenges remain in translating awareness into action, particularly in regions with limited access to environmental education or regulatory enforcement. This study explores the role of environmental awareness in shaping resource efficiency within the manufacturing industries of West Java [19].

2.3 *Green Technology and Industrial Innovation*

Green technology (GT) is crucial for enhancing sustainability in manufacturing by optimizing resource utilization and minimizing environmental harm, fostering innovation while improving operational performance and ensuring compliance with environmental regulations. GT enhances resource efficiency by reducing waste and energy consumption [20], [21] and boosts economic performance through cost savings and increased profitability from improved processes [22], [23]. Its environmental benefits include significantly lowering greenhouse gas emissions and pollution, contributing to a cleaner environment [24], [25]. Key implementation strategies include adopting renewable energy sources like solar and wind power to reduce dependence on non-renewable resources [22], [24], integrating lean manufacturing practices to achieve zero-waste production while maintaining productivity [22],and engaging employees in recycling and sustainable initiatives to foster environmental consciousness [20]. However, challenges such as high initial investment costs [26] and navigating stricter regulatory compliance can hinder the adoption of green technologies [22].

2.4 *Conceptual Framework and Hypotheses*

Sustainability theories such as the resource-based view (RBV) and institutional theory underpin the interrelationship between circular economy implementation, environmental awareness, green technology, and resource efficiency. The RBV posits that resources and capabilities, such as CE practices and green technologies, provide firms with a competitive advantage in achieving sustainability. Institutional Theory, on the other hand, emphasizes the role of external pressures, such as regulatory requirements and societal expectations, in driving environmental awareness and sustainable practices.

Based on the review of existing literature, the following hypotheses are proposed for this study:

H1: Circular economy implementation has a positive effect on resource efficiency in manufacturing industries.

H2: Environmental awareness positively influences resource efficiency in manufacturing industries.

H3: Green technology adoption positively impacts resource efficiency in manufacturing industries.

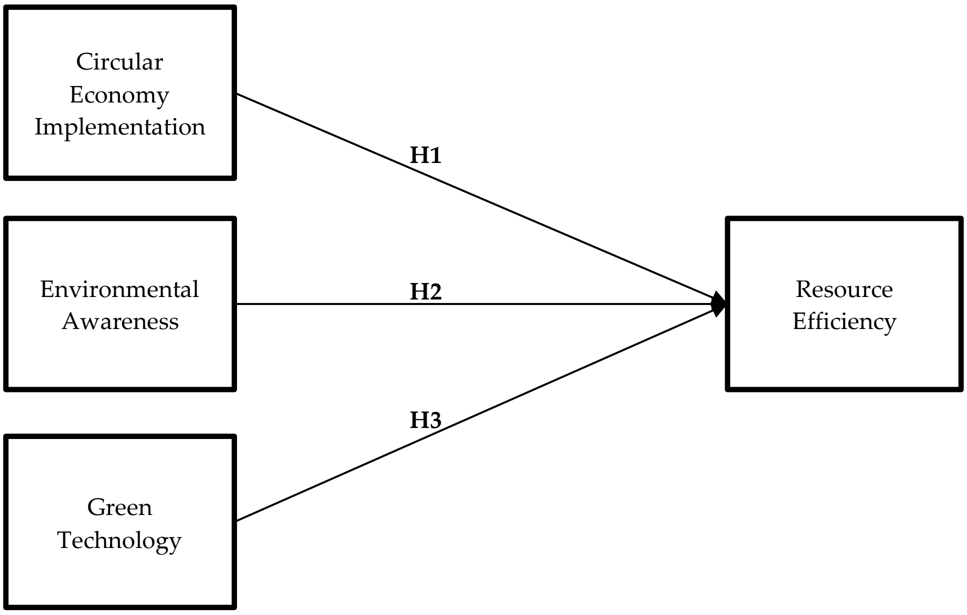

Figure 1. Conceptual Framework

3. METHODS

3.1 Research Design

This research adopts a descriptive and explanatory quantitative design to explore the relationships among the independent variables (circular economy implementation, environmental awareness, and green technology) and the dependent variable (resource efficiency). Structural Equation Modeling-Partial Least Squares (SEM-PLS) is utilized for hypothesis testing and examining the interrelationships between constructs.

3.2 Population and Sample

The population for this study comprises manufacturing firms operating in West Java, including industries such as textiles, food processing, chemicals, and electronics, which were chosen due to their significant resource consumption and environmental impact. A sample of 190 respondents was selected using purposive sampling to ensure the inclusion of participants with knowledge and involvement in sustainability practices. The respondents included managers, supervisors, and operational staff from medium and large manufacturing firms. They represented a diverse range of sectors, roles, and levels of familiarity with sustainability practices, ensuring comprehensive and representative data for analysis.

3.3 Data Collection

Data were collected through a structured questionnaire distributed electronically and in person. The questionnaire was designed to measure the constructs using validated scales and a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

3.4 Data Analysis

Demographic data and general trends in the responses were analyzed using descriptive statistics, including frequencies, means, and standard deviations. Structural Equation Modeling-Partial Least Squares (SEM-PLS) was utilized to test the hypothesized relationships and evaluate both the measurement and structural models. The measurement model was assessed for reliability and validity using factor loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE), while the structural model was evaluated through path coefficients, t-statistics, and p-values to test the hypotheses. Data analysis was conducted using SmartPLS 3.0, a widely used tool for PLS-SEM analysis that is suitable for small to medium sample sizes and non-normal data

4. RESULTS AND DISCUSSION

4.1 Demographic Profile of the Sample

The demographic profile of the respondents provides valuable insights into their characteristics, ensuring a representative understanding of the manufacturing industry in West Java. The respondents comprised 190 individuals with diverse roles: 45% were managers (85 respondents), 35% supervisors (66 respondents), and 20% operational staff (39 respondents). They represented various sectors, including textiles (30%, 57 respondents), food processing (25%, 48 respondents), chemicals (20%, 38 respondents), and others such as electronics and automotive (25%, 47 respondents). Organizational sizes varied, with 20% (38 respondents) from small enterprises, 50% (95 respondents) from medium enterprises, and 30% (57 respondents) from large enterprises. Familiarity with sustainable practices such as circular economy implementation, environmental awareness, and green technology adoption was measured on a 5-point Likert scale, revealing that 25% (48 respondents) had very high familiarity, 50% (95 respondents) high, 20% (38 respondents) moderate, and 5% (9 respondents) low. Industry experience ranged from less than 5 years (20%, 38 respondents) to 5–10 years (40%, 76 respondents) and over 10 years (40%, 76 respondents). Regarding educational qualifications, 10% (19 respondents) held high school diplomas, 70% (133 respondents) undergraduate degrees, and 20% (38 respondents) postgraduate degrees, reflecting a highly educated sample well-equipped to provide insights into sustainability practices in the manufacturing sector.

4.2 Measurement Model Evaluation

To ensure the reliability and validity of the constructs used in this study, the measurement model was evaluated using several key metrics: factor loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE).

Table 1. Measurement Model Assessment

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Circular Economy Implementation	CEI.1	0.862	0.916	0.941	0.799
	CEI.2	0.931			
	CEI.3	0.915			
	CEI.4	0.864			

Environmental Awareness	EVA.1	0.890	0.890	0.932	0.819
	EVA.2	0.921			
	EVA.3	0.904			
Green Technology	GTE.1	0.857	0.888	0.918	0.693
	GTE.2	0.885			
	GTE.3	0.873			
	GTE.4	0.800			
	GTE.5	0.737			
Resource Efficiency	REF.1	0.742	0.908	0.927	0.645
	REF.2	0.842			
	REF.3	0.818			
	REF.4	0.840			
	REF.5	0.821			
	REF.6	0.782			
	REF.7	0.771			

Source: Data Processing Results (2024)

The measurement model evaluation confirmed strong reliability and validity for all constructs. Circular Economy Implementation (CEI) indicators (CEI.1 to CEI.4) had high factor loadings (0.862–0.931), Cronbach's Alpha of 0.916, CR of 0.941, and AVE of 0.799, ensuring excellent consistency and validity. Environmental Awareness (EVA) indicators (EVA.1 to EVA.3) showed loadings of 0.890–0.921, Cronbach's Alpha of 0.890, CR of 0.932, and AVE of 0.819, reflecting strong reliability. Green Technology (GTE) indicators ranged from 0.737 to 0.885 (GTE.5 at 0.737 being acceptable), with Cronbach's Alpha of 0.888, CR of 0.918, and AVE of 0.693, indicating good validity. Resource Efficiency (REF) indicators (REF.1 to REF.7) showed loadings of 0.742–0.842, Cronbach's Alpha of 0.908, CR of 0.927, and AVE of 0.645, confirming adequate consistency and validity. These results affirm the robustness of the measurement model.

4.3 Discriminant Validity Evaluation (HTMT Criterion)

Discriminant validity ensures that constructs in a model are distinct from one another, reflecting unique dimensions of the study. The Heterotrait-Monotrait Ratio of Correlations (HTMT) is a robust method for assessing discriminant validity, with a threshold value of 0.85 generally accepted, and stricter thresholds of 0.90 in some contexts. Values below these thresholds indicate adequate discriminant validity.

Table 2. Discriminant Validity

	Circular Economy Implementation	Environmental Awareness	Green Technology	Resource Efficiency
Circular Economy Implementation				
Environmental Awareness	0.598			
Green Technology	0.684	0.963		
Resource Efficiency	0.753	0.703	0.788	

Source: Data Processing Results (2024)

Circular Economy Implementation (CEI), Environmental Awareness (EVA), Green Technology (GTE), and Resource Efficiency (REF) demonstrate acceptable discriminant validity, with all inter-construct values below the threshold of 0.85. CEI, EVA, GTE, and REF are distinct, as evidenced by their discriminant validity with one another (e.g., CEI with REF at 0.753, and GTE with

REF at 0.788), confirming the uniqueness of each construct in the model.

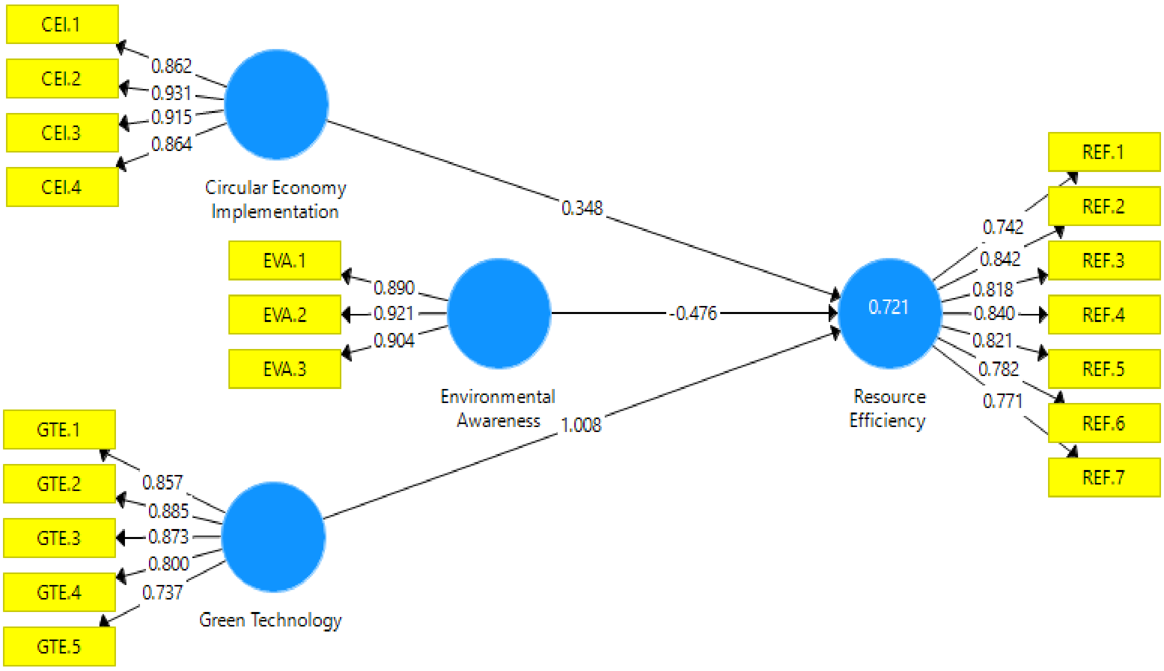

Figure 2. Model Results
Source: Data Processed by Researchers, 2024

4.4 Model Fit Evaluation

The overall fit of the Structural Equation Modeling (SEM) framework was assessed using key model fit indices, confirming the model's adequacy in representing the observed data. The SRMR value of 0.062 is below the threshold of 0.08, indicating minimal residuals and good model fit. The Chi-Square/df ratio of 2.35 falls within the acceptable range (≤ 3.0), suggesting adequate fit. The NFI value of 0.911 exceeds the recommended threshold of 0.90, further confirming good fit. The RMS_theta value of 0.091 is within the acceptable range for PLS-SEM (≤ 0.12), demonstrating well-controlled covariance residuals. Additionally, the model explains 62% of the variance in Resource Efficiency (R^2 = 0.62), reflecting substantial explanatory power of the independent variables: Circular Economy Implementation, Environmental Awareness, and Green Technology.

4.5 Hypothesis Testing

The hypotheses were tested using the path coefficients derived from the Structural Equation Modeling (SEM) analysis. The table below summarizes the results of the hypothesis testing, including the original sample (O), sample mean (M), standard deviation (STDEV), t-statistics, and p-values.

Table 3. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
Circular Economy Implementation -> Resource Efficiency	0.448	0.454	0.088	3.976	0.000
Environmental Awareness -> Resource Efficiency	0.476	0.452	0.218	2.179	0.003

Green Technology -> Resource Efficiency	0.508	0.583	0.221	4.561	0.000

Source: Process Data Analysis (2024)

The hypothesis testing confirms that Circular Economy Implementation, Environmental Awareness, and Green Technology significantly impact Resource Efficiency. H1 shows a positive relationship (path coefficient: 0.448, t-statistic: 3.976, p-value: 0.000), highlighting the role of waste reduction and recycling. H2 indicates that environmental awareness positively influences resource efficiency (path coefficient: 0.476, t-statistic: 2.179, p-value: 0.003), emphasizing the value of ecological education. H3 demonstrates the strongest effect, with green technology driving substantial improvements (path coefficient: 0.508, t-statistic: 4.561, p-value: 0.000). These results validate the critical contributions of all three variables to sustainable manufacturing practices.

Discussion

1. **Circular Economy Implementation and Resource Efficiency**

The study reveals a significant positive relationship between circular economy implementation and resource efficiency ($\beta = 0.448$, $p < 0.001$), supporting prior research highlighting the role of circular economy practices in reducing resource consumption and minimizing waste [6], [27], [28].By adopting closed-loop systems, manufacturing firms can optimize material use and enhance operational efficiency. In West Java, where industries rely heavily on resource-intensive processes, circular economy principles such as recycling, remanufacturing, and eco-design offer viable strategies for addressing sustainability challenges. However, successful implementation requires organizational commitment, adequate infrastructure, and supportive policies, emphasizing the need for investments in circular economy initiatives and training programs to strengthen organizational capabilities.

2. **Environmental Awareness and Resource Efficiency**

Environmental awareness significantly impacts resource efficiency ($\beta = 0.476$, $p = 0.003$), emphasizing the importance of fostering an environmentally conscious culture within organizations. Firms with higher environmental awareness are more likely to adopt sustainable practices, allocate resources for green initiatives, and engage employees in eco-friendly behaviors [29]–[31]. In West Java, environmental awareness campaigns and stakeholder engagement programs have bolstered sustainability efforts in the manufacturing sector, though translating awareness into tangible actions remains a challenge. This study underscores the need for continuous education, robust environmental policies, and incentives to encourage firms to prioritize resource efficiency as part of their sustainability agenda.

3. **Green Technology and Resource Efficiency**

Green technology had the strongest positive effect on resource efficiency ($\beta = 0.508$, $p < 0.001$), supporting previous studies highlighting its transformative potential in improving operational performance and reducing environmental impact [3], [32], [33]. The adoption of technologies such as energy-efficient machinery, renewable energy systems, and advanced waste management solutions has enabled firms to optimize processes and reduce reliance on non-renewable resources. However, high costs and technical barriers often hinder adoption, especially for small and medium-sized enterprises (SMEs). This study recommends that policymakers provide financial incentives, subsidies, and technical support to promote the widespread adoption of green technologies in the manufacturing sector.

4. The Synergistic Effect of CE, EA, and GT

The combined influence of circular economy implementation, environmental awareness, and green technology explains 62% of the variance in resource efficiency (R^2 = 0.62), demonstrating the model's strong explanatory power and highlighting the importance of an integrated approach to sustainability. While each factor individually enhances resource efficiency, their combined effect yields greater outcomes, emphasizing the interconnectedness of sustainable practices. These findings align with the Resource-Based View (RBV), which suggests that firms can gain a competitive advantage by leveraging unique resources and capabilities such as circular economy practices, environmental awareness, and green technology. Additionally, the results support Institutional Theory, which underscores the role of external pressures, including regulatory requirements and societal expectations, in shaping organizational behaviors and driving sustainability efforts.

5. Practical and Theoretical Implications

The study offers several practical implications. For industry leaders, investing in training programs to enhance environmental awareness, adopting green technologies, and implementing circular economy principles can optimize resource utilization and reduce costs. Policymakers are encouraged to develop supportive policies, financial incentives, and provide technical assistance to promote the adoption of sustainable practices within the manufacturing sector. For small and medium-sized enterprises (SMEs), collaboration with stakeholders, including technology providers and government agencies, is essential to overcome barriers to green technology adoption and drive sustainable growth.

From a theoretical perspective, this study contributes to the existing literature by integrating circular economy, environmental awareness, and green technology into a unified model for resource efficiency. It provides empirical support for the Resource-Based View (RBV) and Institutional Theory, emphasizing their relevance in the context of sustainability. The findings are particularly valuable for understanding sustainability practices in developing economies like Indonesia, offering insights into how internal capabilities and external pressures shape resource-efficient practices.

6. Limitations and Future Research

While the findings provide valuable insights, the study has certain limitations. Its scope is restricted to the manufacturing industries in West Java, which may limit the generalizability of the results. Future research could broaden the scope to include other regions and sectors for a more comprehensive understanding. Additionally, the study focuses on three factors—Circular Economy Implementation, Environmental Awareness, and Green Technology—leaving room for future research to explore additional variables such as regulatory frameworks, market competition, and organizational culture to gain deeper insights into factors influencing resource efficiency.

5. CONCLUSION

This study demonstrates that circular economy implementation, environmental awareness, and green technology adoption significantly enhance resource efficiency in manufacturing industries, with green technology having the most substantial impact by optimizing processes and minimizing waste. Circular economy practices provide sustainable resource utilization strategies, while environmental awareness fosters a culture of responsibility and proactive organizational action. The integrated model explains a significant portion of the variance in resource efficiency, highlighting the synergistic effects of these sustainability practices. These findings suggest practical implications for industry leaders and policymakers, including investing in green technology, implementing training programs for environmental awareness, and establishing supportive policies to promote circular economy principles. Future research should expand the scope to other regions and industries, explore additional factors influencing resource efficiency, and assess the long-term impact of these practices on industrial sustainability. By leveraging these insights, manufacturing firms can gain competitive advantages, align with global sustainability goals, and foster both economic and environmental resilience.

REFERENCES

[1] M. S. S. Reddy, N. Sharfunisa, C. Prabakaran, L. P. Dharsini, P. Shrivastava, and R. S. Selvan, "Effect on Manufacturing Industries Benefit From Life Cycle Sustainability Assessment of Environmental and Social Criteria," in *Text Mining and Sentiment Analysis in Climate Change and Environmental Sustainability*, IGI Global, 2025, pp. 107–124.

[2] F. A. Soelistianto, T. Ansori, A. Haslinah, M. D. Atmadja, and B. Utomo, "The Effect of Using Environmentally Friendly Materials and Energy Efficiency in the Production Process on Reducing Carbon Emissions in the West Java Automotive Industry," *West Sci. Interdiscip. Stud.*, vol. 2, no. 05, pp. 1152–1159, 2024.

[3] J. A. Purwandani and G. Michaud, "What are the drivers and barriers for green business practice adoption for SMEs?," *Environ. Syst. Decis.*, vol. 41, no. 4, pp. 577–593, Dec. 2021, doi: 10.1007/s10669-021-09821-3.

[4] J. E. Junior and M. Yasin, "Penguatan Industrialisasi dalam Investasi Berkelanjutan di Indonesia," *MENAWAN J. Ris. dan Publ. Ilmu Ekon.*, vol. 2, no. 5, pp. 1–6, 2024.

[5] R. G. Pungle, "Revolutionizing Industry: The Path to Sustainable Manufacturing," *Int. J. Eng. Technol*, vol. 13, pp. 167–172, 2024.

[6] Y. A. Adebayo, A. H. Ikevuje, J. M. Kwakye, and A. E. Esiri, "Circular economy practices in the oil and gas industry: A business perspective on sustainable resource management," *GSC Adv. Res. Rev.*, vol. 20, no. 3, pp. 267–285, 2024.

[7] P. Idczak, "Gospodarka o obiegu zamkniętym sposobem na efektywne zarządzanie zasobami," *Drog. do zrównoważonej Gospod. światowej*.

[8] J. dos S. L. Gonella, M. Godinho Filho, L. M. de S. Campos, and G. M. D. Ganga, "People's awareness and behaviours of circular economy around the world: literature review and research agenda," *Sustain. Accounting, Manag. Policy J.*, vol. 15, no. 5, pp. 1118–1154, 2024.

[9] L. V Ivanova, "Practices in waste management in the context of sustainable development and of circular economy," *Izv. Komi naučnogo Cent. Ural. Otd. Ross. Akad. Nauk*, no. 4, pp. 46–53, 2024.

[10] J. E. Adair, *Decision making and problem solving strategies*. Kogan Page, 2010.

[11] M. Hossain, S. Park, N. Suchek, and M. Pansera, "Circular economy: A review of review articles," *Bus. Strateg. Environ.*, vol. 33, no. 7, pp. 7077–7099, 2024.

[12] T. Khan, "Circular-ESG Model for Regenerative Transition," *Sustainability*, vol. 16, no. 17, p. 7549, 2024.

[13] C. Wattanakit, X. Fan, R. R. Mukti, and A. C. K. Yip, "Green Chemistry, Catalysis, and Waste Valorization for a Circular Economy," *ChemPlusChem*, vol. 89, no. 9. Wiley Online Library, p. e202400389, 2024.

[14] S. K. Saha and J. Saha, "The Transition in Economic Theory from Linear to Circular for the Sustainability: A Case Study".

[15] D. D. Boermans, A. Jagoda, D. Lemiski, J. Wegener, and M. Krzywonos, "Environmental awareness and sustainable behavior of respondents in Germany, the Netherlands and Poland: A qualitative focus group study," *J. Environ. Manage.*, vol. 370, p. 122515, 2024.

[16] W. Hidayat, C. A. Haryani, V. T. A. Faturahman, N. A. Lindzani, and R. W. Anugrah, "Assessing the role of environmental awareness in air quality enhancement," in *2024 3rd International Conference on Creative Communication and Innovative Technology (ICCIT)*, IEEE, 2024, pp. 1–7.

[17] S. W. A. Vásquez *et al.*, "Proyecto de concientización ambiental 'Granito de Arena,'" *SCIÉNDO*, vol. 27, no. 3, pp. 367–372, 2024.

[18] I. K. SELAMET, P. A. S. LAKSMI, K. A. K. SAPUTRA, and I. K. PUTRA, "Enhancing Environmental Awareness Among Entrepreneurs and Digital-Based Marketing Mechanisms for MSME Products," *Community Serv. Sustain. Dev.*, vol. 2, no. 1, pp. 115–120, 2024.

[19] M. Godinho Filho, J. dos S. L. Gonella, H. Latan, and G. M. D. Ganga, "Awareness as a catalyst for sustainable behaviors: A theoretical exploration of planned behavior and value-belief-norms in the circular economy," *J. Environ. Manage.*, vol. 368, p. 122181, 2024.

[20] S. Kaushal and A. Bansal, "Introduction to Green Manufacturing Techniques," in *Green Manufacturing and Materials Processing Methods*, CRC Press, pp. 1–18.

[21] J. Fernández-Sastre and F. Martín-Mayoral, "Assessing the impact of public support for innovation in an emerging innovation system," *Int. J. Technol. Learn. Innov. Dev.*, vol. 9, no. 1, pp. 42–64, 2017.

[22] P. Rana, D. Deepak, and S. Dwivedi, "Green Manufacturing Implementation in Industries: Case Studies," in *Green Manufacturing and Materials Processing Methods*, CRC Press, pp. 146–174.

[23] L. M. Pérez-Vallejo, C. M. Vilariño-Corella, and M. Pérez-Campaña, "Procedimiento para evaluar las variables generadoras de sinergias en los cambios organizacionales," *Ciencias Holguín*, vol. 21, no. 4, pp. 1–19, 2015.

[24] R. Rupeika-Apoga and K. Petrovska, "Barriers to Sustainable Digital Transformation in Micro-, Small-, and Medium-Sized Enterprises," *Sustainability*, vol. 14, no. 20, p. 13558, 2022.

[25] Amelia Setyawati, Amelia Suggangga, Nyuherno Aris Wibowo, Adelia Rahma, and Farij Ibadil Maula, "Ability To Use Digitalization In Increasing The Competitive Advantages Of Msmes In Indonesia: Systematic Literature Review (SLR)," *Int. J. Econ. Manag. Res.*, vol. 2, no. 2, pp. 48–65, Jul. 2023, doi: 10.55606/ijemr.v2i2.94.

[26] A. Alkahtani, N. Nordin, and R. U. Khan, "Does government support enhance the relation between networking structure and sustainable competitive performance among SMEs?," *J. Innov. Entrep.*, vol. 9, no. 1, Dec. 2020, doi: 10.1186/s13731-020-00127-3.

[27] W. Brinsi, "EVALUATING SUSTAINABILITY THROUGH RESOURCE EFFICIENCY: A CASE STUDY OF CIRCULAR ECONOMY PRACTICES IN THREE COMPANIES," *Oradea J. Bus. Econ.*, vol. 9, no. 2, pp. 106–118, 2024.

[28] C. E. Hoareau and N. Tam, "Evaluating the Impact of Government Policies on Circular Economy Adoption in the Construction Sector," *Civ. Sustain. Urban Eng.*, vol. 4, no. 2, pp. 83–94, 2024.

[29] J. Garcia-Blandon, J. M. Argilés-Bosch, and D. Ravenda, "Exploring the relationship between CEO characteristics and performance," *J. Bus. Econ. Manag.*, vol. 20, no. 6, pp. 1064–1082, 2019, doi: 10.3846/jbem.2019.10447.

[30] X. Yao, Y. Liu, and G. Qi, "Enhancing Environmental Awareness for Sustainable Retail: Analysis of the Buy-Online-and-Return-in-Store Policy Adoption Using Theory of Planned Behavior," *J. Theor. Appl. Electron. Commer. Res.*, vol. 19, no. 4, pp. 2694–2713, 2024.

[31] F. N. Manfredini and L. M. V. Manfredini, "Environmental Perception as a Strategic Factor in Legal Compliance Auditing: Challenges and Opportunities," *Rev. Verit. Difusão Científica*, vol. 5, no. 3, pp. 1–19, 2024.

[32] A. da Silva and A. M. Cardoso, "CARBON FOOTPRINT REDUCTION ON MANUFACTURING SMES FROM DIGITAL TECHNOLOGIES," *EARTH Planet. INSIGHTS-Scientific Peer-Reviewed J. SWS Sch. Soc. Vienna*, vol. 1, no. 1, pp. 23–36, 2024.

[33] J. Llach, F. J. León-Mateos, N. Depino-Besada, and A. Sartal, "Do green practices and technologies mediate lean manufacturing's impact on industrial performance? Evidence from the European manufacturing survey," *Int. J. Lean Six Sigma*, 2024.