International Journal of Accounting and Economics Studies, 12 (4) (2025) 113-119

International Journal of Accounting and Economics Studies

Website: www.sciencepubco.com/index.php/IJAES
https://doi.org/10.14419/3k4e3441
Research paper



Adoption of Circular Economy Principles: An Empirical Study of Green Strategies in Manufacturing Organizations

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Received: June 27, 2025, Accepted: August 1, 2025, Published: August 4, 2025

Abstract

This study investigates the adoption of circular economy (CE) principles within the manufacturing sector, emphasizing the interconnected roles of green operational practices, stakeholder communication, corporate green image, and customer-driven sustainability demands. Circular economy frameworks advocate for closed-loop systems where materials are reused, waste is minimized, and product life cycles are extended to achieve environmental and economic sustainability. As global awareness of ecological challenges intensifies, consumers and regulatory bodies are increasingly expecting companies to demonstrate genuine commitments to sustainable operations. The research collected primary data from employees across three manufacturing firms actively engaging in environmental initiatives. Analytical tools such as SPSS and Smart PLS-SEM were employed to examine the relationships among the key variables. The results show a significant positive relationship between the adoption of CE principles more broadly and the successful communication of green practice implementation. CE adoption was further strengthened by upholding a visible green image. It's interesting to note that although they were significant, customer preferences had little influence on these strategic decisions. The significance of manufacturers institutionalizing sustainability through internal procedures and open stakeholder engagement is highlighted by these insights. To improve long-term environmental performance and shift towards a circular economy model, the study offers useful implications for industries.

Keywords: *sustainability, stakeholder, circular economy, customer priority, water reduction*

1. Introduction

Manufacturing businesses have been urged to embrace the Circular Economy (CE) principles in recent years to reduce waste production and preserve available resources. Resource reduction, recycling, and reuse are all growing in popularity. These methods can reuse various resources instead of throwing them away and extend the life cycle of products. It's intriguing to learn that waste materials can be turned into valuable new products. In Favor of environmentally friendly or green practices, outdated methods like take-make-dispose are steadily becoming obsolete. For the study, greening means being environmentally friendly. Adopting green practices in the manufacturing process turns into a crucial tactic that supports the adoption of CE principles. It is important to inform and encourage employees to embrace these practices as evidenced by their behavior. These workers promote environmentally friendly ways of working by engaging in behaviours such as reducing the amount of electricity used, producing less waste, conserving water, not using plastic bags and promoting recycling.

Researchers claim that the term CE refers to a production and consumption model that involves leasing, sharing, reusing, repairing, refurbishing, and recycling resource materials for as long as feasible (Stamevska et al., 2020; Stamevska et al., 2022). CE principles have gained momentum because they tend to expand the life cycle of products, minimise waste, and renew natural systems (Solomon et al. 2024). The drivers personified in the CE include the restoration and revival of products and components by keeping them at their highest efficacy as well as worth, plummeting waste and pollution (Morseletto, 2020). The integration of CE principles not only permits manufacturing companies to enjoy financial returns but also offers a positive perception, qualifying them as a potent company for different authorities, employees, customers, and communities looking forward to associating themselves with organisations that are practising green. Hence, the principles of CE centre around practices that involve resource recovery, reuse of the material available, as well as maintenance of components, products, and materials at their highest utility and value level for a longer time (Solomon et al., 2024), enabling the creation of a responsible culture to thrive effectively. Such organisations will adhere to the rules and regulations by avoiding environmentally hazardous behaviour. Their employees have greater morale and job satisfaction, which enhances their productivity and retention.

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Bangladeshi leather manufacturers were able to boost their financial outcomes along with environmental performance by integrating the key drivers of CE into their operations (Islam et al., 2024). This study deployed an exploratory methodology integrating qualitative and quantitative methods. Implementing CE drivers had several benefits, such as a larger market share, lower operating costs, and recognition for being ecologically conscious. Appolloni et al (2022) noted that a European ceramic tile manufacturer was able to maintain sustainable practices by concentrating on customer needs that included social, economic, and environmental factors. Although the application of CE principles is urgently needed, there are several barriers, including increased investment, technological constraints, infrastructure limitations, and non-supporting policies from various agencies (Agyemang et al. in 2019)

By highlighting the integration of green innovation, digital technologies, organizational capabilities, and sustainability-oriented practices across various industries, recent scholarly contributions have collectively advanced our understanding of circular economy (CE) transitions. One study showed the critical role that policy frameworks play in promoting sustainable transformations by analyzing the impact of green governance policies and innovation on circular economy trajectories using a novel Method of Moments Quantile Regression (MMQR) model (Ostic et al. 2025). Furthermore, by facilitating real-time monitoring and adaptive resource management, the Green Industrial Internet of Things (GIIoT) greatly improves environmental performance in manufacturing sectors when combined with CE practices and dynamic capabilities (Xu et al., 2025). Adoption of CE practices mediates the impact of servitization strategies on sustainability outcomes, particularly when moderated by Environmental Social and Governance (ESG) compliance measures, according to a follow-up empirical analysis on the green servitization of manufacturing (Barhoom et al. in 2025). The contribution of Industry 4.0 technologies was also examined, and the results demonstrated how remanufacturing and green procurement practices greatly enhanced CE performance, bridging the gap between environmental responsibility and technological advancement (Sahoo and Jakhar 2024). Green human resource management (GHRM) knowledge sharing and CE principles have been demonstrated to work together to enhance the sustainable performance of Bangladesh's green garment industry in emerging economies, underscoring the significance of internal organizational practices (Amin et al. 2025). Furthermore, the use of digital tools and interorganizational collaboration were empirically confirmed as crucial facilitators of CE implementation in manufacturing, promoting value recovery and material flow transparency (Schöggl et al. 2024). As circular business models are developed, resource commitment, organizational learning, and reverse logistics have become important factors in determining better environmental performance, bringing business plans into line with long-term environmental objectives (Rana et al. 2025). Lastly, supply chain-level CE strategies with a focus on closed-loop systems and strategic resource planning for sustainability integration were found to improve resource efficiency and the attainment of Sustainable Development Goals (SDGs). The findings indicate a strong positive correlation (Gao et al., 2024).

2. Theoretical Background

The perception of incorporating CE principles into manufacturing is approved as a pathway to a safer and sustainable future (Constance Obiuto et al., 2024). It is associated with benefits like resource optimisation and waste reduction, contributing to environmental sustainability and economic gains (Madrid, 2023). It also provides a competitive advantage through brand reputation and customer loyalty (Munro, 2023). Organisations that implement green practices can favourably adopt CE principles, resulting in resource efficiency and waste reduction (Yun et al., 2023). Such strategies can impact environmental, economic as well and social aspects. Where environmental aspects promote reducing pollution and conserving resources, economic aspects can induce cost reduction and generate business opportunities, and social aspects generate employment and contribute to sustainability (Marrucci et al. 2021; Solomon et al. 2024). Conserving energy and water (Cozzolino & De Giovanni, 2023), reusing and recycling materials (Hasan et al., 2023; Shabanpour et al., 2024; Singh et al., 2022), adopting practices that eliminate pollution (Schulz et al., 2023), and extending the beneficial life of products (Obiuto et al., 2024; Singh et al., 2022) are certain practices employees can successfully implement in an organisation that adopts CE principles. According to Bashir & Santhi (2022), employees will align with environmentally responsible initiatives when it permits them to grow. Adopting green practices will enable the development of an organisation in the long run, which will directly promote employee progress. Therefore, it can be held that green practices can significantly influence implementation (Ho and Lin, 2024) by enhancing sustainable practices and mitigating environmental degradation. (Zhang et al., 2023). Therefore, the following hypothesis is framed

2.1 H1: There is a significant relationship between the green practices implemented and the adoption of CE principles in the organisation.

Kim and Choi (2013) noted that employee perception of green practices improves if the organisation is committed to implementing them. An employee gets acquainted with these only when it is communicated to him. Therefore, communication is the mode through which all stakeholders, including employees, become aware of the green practices employed in an organisation (Fineman, S., & Clarke, K., 1996). Stakeholders play a larger role in the value-creation process by providing insights to improve the mode of operation (Stoney et al., 2001). Co-creation of value is possible among stakeholders and organisations only through proficient communication. Likewise, green practices adopted should be communicated to influence the attitude of consumers too (Warren et al., 2022). This will enable in adoption of sustainable practices (Pelletier and Sharp, 2008) like remanufacturing, as well as the reuse of products (Michaud and Llerena, 2011). It is also important to keep this communication transparent, open, and effective (Ajzen, 1992).

2.2 H2: There is a significant relationship between communicating green practices with stakeholders and the adoption of CE principles within the organisation.

A Green image promulgated by various green activities in an organisation denotes its environmental reputation (Marrucci et al., 2021; Ho & Lin, 2024). The internal dedication of a company to environmentally friendly practices enhances its green image (Ho and Lin 2024). This could be achieved by encouraging the organization to create green teams (Dangelico 2015). According to (Shabanpour et al. 2024), the principles of CE are centered on minimizing waste generation and optimizing the use of available resources by promoting reuse, recycling, and rework. The relationship between the green image and the adoption of CE principles is largely driven by a shared emphasis on environmental concern. Since this change is a sign of a shift to a green economy, a better implementation of CE principles will improve the green image (Li et al., 220). The application of CE principles promoted a green image in Malaysia by tying environmental preservation and economic growth together (Isa et al. 2021). Clear rules and regulations about their job responsibilities are particularly important to employees (Bashir & Venkatakrishnan, 2022). Similarly, if there are established protocols for green practices, most employees are likely to follow them and stay committed.

2.3 H3: There is a significant relationship between an organisation's green image and the adoption of the CE principles within the organisation.

Customer preferences play a bigger role in incorporating CE principles in a manufacturing organisation (de Sousa Jabbour et al., 2019). The ones that create value propositions for customers, and profit from selling products and services to them (Kumar et al., 2017). To do so, it is essential to understand their tastes and preferences (Van Boerdonk et al., 2021). Among different values, customers give immense significance to economic and environmental values. Those organisations with a green image (Mishra et al., 2023), when adopting C E principles in their business models, are recognised and duly valued by them. Kane et al. (2018) elaborate on a classic example of a specific hospital industry where customers are given the option to buy certain remanufactured equipment, enabling them to minimise expenses. These customer preferences can become the key source of competitive advantage (Gummerus, 2013). The shift in customer preferences is evident as there is an increased interest in sustainable products having a high potential for reuse (Essoussi et al., 2010), permitting flexibility, minimising costs (Hazen et al., 2017), and fulfilling environmental responsibility (Reike et al., 2018). Therefore, the company has to modify operations to suit customers' preferences.

2.4 H4: There is a significant relationship between customer preference and the adoption of CE principles within the organisation.

To examine Hypothesis 4, which proposed a significant relationship between customer preference and the adoption of Circular Economy (CE) principles within the organization, a quantitative research design was employed. Primary data were collected through a structured questionnaire distributed to key managerial personnel across various industries actively engaged in sustainability initiatives. Customer preference was measured using a multi-item Likert scale assessing the extent to which customer demand and expectations influenced organizational decisions on circular practices such as product reuse, recycling, and eco-design (Kirchherr et al., 2018). The adoption of CE principles was also operationalized through validated indicators covering core dimensions, including resource efficiency, waste reduction, and closed-loop processes. The relationship between the two constructs was analyzed using structural equation modeling (SEM) to assess the strength and significance of the hypothesized path (Rizos et al., 2016). Although the statistical output indicated a positive relationship, the support for Hypothesis 4 was marginal, suggesting that customer preference had a limited direct influence on CE adoption compared to other internal or regulatory factors. Nonetheless, the analytical model remained robust, and the constructs demonstrated acceptable reliability and validity, ensuring the credibility of the findings.

2.4.1 Demographic characteristics

Demographic characteristics of respondents across three organizations selected from three cities, namely Tamil Nadu, Bangalore, and Mumbai, have been depicted in Table 1. In Tamil Nadu, out of 81 respondents, 28 (34%) were female and 53 (66%) were male. In Mumbai, 81 respondents comprised 29 (36%) females and 52 (64%) males. Bangalore had 81 respondents, with 7 (9%) females and 74 (91%) males. The total sample size was 243, with 89 women (38%) and 154 men (65%). These statistics highlight gender distribution differences across cities, indicating a higher proportion of male respondents overall, particularly pronounced in Bangalore, while Mumbai shows a more balanced gender ratio compared to Tamil Nadu and Bangalore.

Table 1: Demographic profiles

Demographic Characteristic	Gender	Male	'Female
Tamil Nadu	81	28 (34%)	53 (68%)
Mumbai	81	52 (66%)	29 (36%)
Bangalore	81	74 (95%)	7 (7%)
Total	243	154 (65%)	89 (38%)

However, this geographical concentration presents certain limitations in terms of generalizability. India is a diverse country with significant regional variations in industrial practices, environmental policies, and consumer behaviors. While the findings are reflective of trends observed in these urban manufacturing hubs, caution must be exercised in extrapolating these results to rural or less industrialized regions, where infrastructural capabilities and environmental awareness may differ considerably. Additionally, extending the application of these insights to global contexts necessitates consideration of cross-cultural factors, policy frameworks, and levels of industrial maturity. Despite these constraints, the core constructs—green practices, stakeholder communication, corporate green image, and customer preferences—are universally relevant and can serve as a conceptual foundation for similar studies in other emerging or developed economies. Future research may benefit from replicating the study in different geographical contexts to validate the robustness of the model and further enhance its global applicability.

3. Research Methodology

The researcher followed a survey method and distributed questionnaires to employees working in three manufacturing organisations located in cities, namely Mumbai, Bangalore, and Tamil Nadu. Out of 250 questionnaires distributed, a total of 243 were returned, and twenty questionnaires were rejected because they were incomplete. Statistical Package for the Social Sciences (SPSS) version 28 and Smart Partial Least Squares - Structural Equation Modelling (PLS-SEM) were the statistical tools used for the study. The companies specifically selected for the study incorporated principles of CE into their operations. The items used to measure green practices were adopted from Digalwar et al. (2013) and Pinto (2020), whereas items to gauge communicating these green practices to stakeholders were adopted from Cahyadi et al. (2023) and Blome et al. (2014). Items used to measure the green image were adopted from Cretu and Brodie (2007), and for consumer preference from Camacho-Otero et al. (2018).

The study calculated Cronbach's α, for which a value of 0.70 or above is considered to indicate internal consistency (Hair et al. 2014). The Average Variance Extracted (AVE), representing "the sum of squared loading divided by the number of indicators," was also assessed, which was required to have a value of 0.5 as the cutoff (Hair et al. 2014). Factor loading, demonstrating the accuracy of an item in representing its construct, was calculated with the threshold value is around 0.70 (Hair et al. 2014). Composite reliability, the measure of the set of items loaded onto a latent construct, was also determined. The outcome of the reliability test is demonstrated in Table 2, depicting robust measurements. Each indicator was loaded from 0.701 to 0.921, which was above the cutoff range specifying significant reliability; hence,

convergent validity is met. This means that the indicators converge with their respective latent constructs, namely Green Practices (GP), Green Practice Communication (GPC), Green Image (GP), Customer Preference (CP), and Circular Economy (CE). Factor loadings for each item extended from 0.65 to 0.94, exemplifying the strength of the association between each indicator and its respective constructs. The AVE, CR, and Cronbach's α of all constructs selected from the study were within the prescribed threshold. The value of Cronbach's alpha ranged from 0.816 (CE) to 0.922(GP), and CR ranged from 0.786 (CP)to 0.961(CE); hence, convergent validity was met. AVE was also measured, and the results were observed to be above the accepted range.

Table 2: Results from reliability and convergent validity Tests

Construct	Measuring Indicators	Items	Factor loading	Cronbach α	C R	AVE
Green Practices	The process followed in the organisation reduces the water consumption	GP1	0.65	0.922	0.823	0.683
	The process followed reduces the energy consumption	GP2	0.67			
	New products introduced minimise the harmful effects on the environment	GP3	0.85			
	The organisation reuses materials available and produces products	GP4	0.87			
	Organisation purchases environmentally friendly raw materials	GP5	0.87			
Green Practice Communication	Green practices are emphasised while marketing	GPC1	0.65	0.865	0.951	0.669
	Green practices are emphasised while marketing	GPC2	0.74			
	Organisation has gained a reputation for communicating green practices	GPC3	0.912			
	Green communication attracts more customers	GPC4	0.67			
	Green communication is often updated	GPC5	0.73			
Circular Economy	Toxic materials are avoided in the manufacturing process	CE1	0.83	0.816	0.961	0.657
	Using discarded parts of products for some other purpose	CE2	0.96			
	Materials are preserved through recycling	CE3	0.71			
	The rate of reuse of materials is high	CE4	0.68			
	Generation of waste is considerably reduced	CE5	0.69			
Green image	The green image is superior	GI 1	0.65	0.910	0.859	0.701
	Having a green image relates to green activities	GI 2	0.74			
	The organisation supports sustainable development	GI 3	0.91			
	The green image is visible on the website	GI 4	0.67			
	As employees, we prefer the green image	GI 5	0.94			
Customer Preference	The organisation tries to understand customers' environmental needs.	CP1	0.65	0.823	0.786	0.678
	The organisation satisfies customers' environmental needs.	CP2	0.74			
	An eco-friendly tag is preferred by customers	CP3	0.9			
	Quality is assured too customers	CP4	0.67			
	Customers' preference is given due importance	CP5	0.94			

Source: Computed from the primary data

The discriminant validity among constructs was identified using the Fornell-Larcker criterion test. This was determined by comparing the square root of the AVE for each construct to its correlations with other constructs, which appeared to be on the higher end. Cross-loading was then assessed, and the finding revealed that the indicators loaded higher than other construct indicators. This depicted a strong association with their intended construction. Later, heterotrait–heteromethod ratio (HTMT) was applied to measure the discriminant validity by comparing the correlation between different constructs. The test revealed that HTMT values, which are represented in Table 3, were within the range of 0.85 or 0.90, confirming the discriminator validity.

Table 3: Heterotrait- Heteromethod Ratio (HTMT):

Construct	GP	GPC	CE	GI	CP
GP	1	0.82	0.77	0.7	0.75
GPC	0.82	1	0.68	0.65	0.7
CE	0.77	0.68	1	0.6	0.68
GI	0.74	0.65	0.65	1	0.72
CP	0.75	0.7	0.68	0.72	1

Source: Computed from the primary data

3.1 Determining the Path Coefficient and T-Statistic Value

Table 4 presents the results of the path coefficients and corresponding t-statistics and p-values for each hypothesis. The relationship between Green Practices (GP) and Circular Economy (CE) was found to be statistically significant with a path coefficient of 0.542, a t-statistic of 3.55, and a p-value of 0.001, thereby supporting Hypothesis 1. Hypothesis 2, which examined the effect of Green Process Capability (GPC) on CE, was also supported, showing a path coefficient of 0.435, a t-statistic of 2.85, and a p-value of 0.004. Similarly, Green Innovation (GI) demonstrated a significant positive impact on CE, supporting Hypothesis 3 with a path coefficient of 0.328, a t-statistic of 2.51, and a p-value of 0.013. However, Hypothesis 4, which assessed the influence of Customer Preference (CP) on CE, revealed a weaker relationship with a lower path coefficient of 0.223 and a marginal t-statistic of 1.95, resulting in a p-value of 0.051, indicating that it was only marginally supported.

Table 4: Results of Path Coefficients and T-Statistics

Hypothesis	Path Coefficient	T-Statistic	p-value	Result
H1: GP CE	0.542	3.55	0.001	Supported
H2: GPC CE	0.435	2.85	0.004	Supported
H3: GI CE	0.328	2.51	0.013	Supported
H4: CP CE	0.223	1.95	0.051	Marginally Supported

Source: Computed from the primary data

3.2 Inferences

The results of Hypothesis 1 indicate a positive and statistically significant association between green practices implemented and the adoption of CE principles in manufacturing organisations (path coefficient = 0.586, t-value = 3.55, p-value <0.05, thus supporting Hypothesis 1 (Table 4). This suggests that the influence of the exogenous latent construct, which is the green practices on an endogenous latent construct, such as CE principles adopted, is more substantial. Consequently, it is inferred that communicating green practices to stakeholders has a positive association with the adoption of CE principles within the organisation (path coefficient = 0.435, t-value =2.85, p-value <0.04); thus, Hypothesis 2 is also supported. The presence of a significant relationship between green image and the adoption of CE principles has been measured to be significant and positive (path coefficient 0.328, t-value = 2.51, p < 0.013), confirming the acceptance of Hypothesis 3. Hence, it is supported. The presence of a marginal relationship between customer preference and the adoption of CE principles was measured within the manufacturing organisation (path coefficient 0.223, t-value = 1.95, p-value < 0.051); therefore, Hypothesis 4 is marginally supported.

3.3 Discussion

The adoption of CE principles is facilitated when an organization adopts green practices consistently and consistently. By improving operational effectiveness, reducing expenses, and facilitating market differentiation, they can also play a significant role in offering a competitive advantage (Munro 2023). Green practices can be selected by any organization based on its unique requirements and operational preferences. Companies attempt to give misleading information about their products to look environmentally friendly and win over environmentally conscious customers, according to previous research (Lopes et al.2023). Thus, these practices must be transparent, and organizations should make sure that all staff members vigorously carry them out. An organization's reputation for being environmentally friendly is enhanced by a well-established green image. Since they align their image with the principles of the circular economy, they tend to garner positive perceptions. Eco-label products, marketing strategies, and company websites can all help to create a green image. For relationships to be strengthened, they must be shared with all parties involved. Thus, simply stating such practices is insufficient. Organisations should ensure that the stakeholders are timely updated, too, which will have a positive association with the adoption of CE principles within the organisation. Communication should be transparent, clear, concise, and reach all the stakeholders, including employees, consumers, and all other prospects, to shape their perceptions. The better the communication, the stronger the relationship between stakeholders and the organisation. The flow of communication should be regularly updated. Moreover, being environmentally conscious is more of a basic human right than a luxury, underlining the ethical measurement of consumer preferences towards CE (Antikainen & Valkokari, 2016).

4. Practical Implications

The research provides powerful insights for entrepreneurs willing to adopt CE principles in their functioning. The insights help in adorning green practices effectively and communicating them to build a strong green image, enabling them to maintain a healthier relationship with stakeholders, giving them competent leverage. These findings have significant implications for policymakers and authorities as they offer evidence-based recommendations for adopting CE principles with several key benefits, such as the efficient use of resources, less wastage, increased recycling, and acceptance among customers, enhancing the image. The study encourages entrepreneurs who have not yet incorporated CE principles into their functioning, as it provides long-term benefits.

5. Conclusion

Internalising green practices can be the primary driver for adopting CE principles in an organisation. Besides, successful communication of these practices to stakeholders, promulgating a green image, and adhering to customer preferences enables an organisation to enjoy economic performance, reduced environmental impacts, and social benefits. The insights of this study enable organisations to function sustainably, meet regulatory pressures, and enjoy the financial advantages of resource efficiency and prosperity.

Acknowledgment

We express gratitude to the Almighty for the strength to carry out the research, the professional institution associated with the permission, and the management and employees of the organisation for their extended support and contribution.

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