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Green transformational leadership and financial performance in micro and small enterprises: the interplay of circular economy practices and environmental uncertainty

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Circular economy (CE) practices have become a central issue in management and entrepreneurship research, particularly in emerging economies where micro and small enterprises (MSEs) dominate the business landscape. This study explores how green transformational leadership impacts financial performance through the mediation of corporate entrepreneurship practices, while also examining the moderating role of environmental uncertainty. Data was collected using a two-phase, time-lagged survey design involving 353 Indonesian MSEs. Partial least squares structural equation modeling (PLS-SEM) was employed to test the model. The analysis reveals that GTL has a significant positive effect on CE practices ($\beta = 0.37$, $p < 0.01$) and CE practices strongly enhance financial performance ($\beta = 0.44$, $p < 0.01$). The findings also confirm that CE practices mediate the relationship between green transformational leadership and financial performance ($\beta = 0.16$, $p < 0.01$). Moreover, environmental uncertainty was found to significantly weaken the positive relationship between GTL and CE practices ($\beta = -0.21$, $p < 0.01$). However, it did not have a significant moderating effect on the CE practices-financial performance relationship. This study offers valuable insights for MSE owners and policymakers in emerging Asian economies on leveraging leadership strategies to balance sustainability and financial goals.

KEYWORDS

green transformational leadership, circular economy practices, financial performance, environmental uncertainty, micro and small enterprises, Indonesia, emerging markets

Introduction

The Circular Economy (CE) has transitioned from a theoretical concept to a practical business model, with global adoption accelerating significantly in the last 10 years in Europe (Erdiaw-Kwasie et al., 2023). The circular economy replaces the linear "take–make–dispose" model with closed-loop "reduce–reuse–recycle" systems, offering advantages for resource-constrained small enterprises (Bayram, 2024). From an environmental perspective, CE implementation reduces ecological impacts through pollution prevention and material

circularity (Kulakovskaya et al., 2023). Economically, CE enables micro and small enterprises to lower material costs, minimize waste disposal expenses, and generate new revenue streams through innovative product life extension strategies, for example, using leftover fabric to make new clothing or recycling plastic waste into useful household products. The approach directly contributes to SDGs 8 (economic growth) and 12 (responsible consumption), though successful adoption requires overcoming transition costs and regulatory gaps (Ma et al., 2025) through comprehensive policy support and stakeholder engagement, particularly in developing country contexts where micro and small enterprises predominate (de Souza Campos et al., 2023; Ho et al., 2023).

In contrast to more advanced practices in Europe, the implementation of CE in developing countries such as Asia experiences various obstacles, including technological, economic, regulatory, cultural, and market. First, developing countries experience major obstacles in terms of technology, especially in advanced recycling and waste management technologies (Mishra et al., 2025) and inadequate digital infrastructure for SMEs, hindering efficient material recovery (Akahome, 2025). A comprehensive study comparing CE implementation in 10 ASEAN countries found that Vietnam has the highest level. At the same time, Brunei, Laos, and Myanmar are stagnant. Other countries (i.e., Indonesia, Malaysia, Singapore, and Thailand) are progressing adequately (Herrador and Van, 2024). Most recently, a study in four countries (Thailand, Laos, the Philippines, and Vietnam) found that CE implementation, measured by material use, waste generation, emissions, resource efficiency, and circularity rate, found that Laos and Vietnam exhibited lower efficiency levels than the ASEAN average (Emami et al., 2025). From an economic perspective, high upfront costs, restricted funding access (Mishra et al., 2025), and low market demand for recycled materials create financial disincentives, particularly for MSMEs (Mishra et al., 2025; Sharma et al., 2025). A study examining the relationship between circular economy and economic growth in the South Asian region found mixed results, with biomass energy consumption only significantly impacting economic growth in two countries (Pakistan and Bangladesh) in the long term. In contrast, a relationship was found between biomass energy consumption and GDP for India and Bangladesh (Apostu et al., 2022).

Second, regulatory weaknesses on CE, including inconsistent policies, poor enforcement of environmental laws (Nath et al., 2025; Rashid et al., 2025), and insufficient government support (e.g., government subsidies), further complicate adoption. A study of the Asia Pacific region found that East Asia, certain Southeast Asian countries, and two Oceanian countries have clear plans to establish a circular economy. In contrast, other regions are still just starting to develop their plans (Mohan et al., 2024). Third, cultural and social barriers such as low public awareness, consumer reluctance toward recycled products (Kirchherr et al., 2018; Rexhepi Mahmutaj et al., 2025), and risk-averse business mindsets (Guo et al., 2019) slow progress, while market and supply chain limitations—such as fragmented systems and competitive pressures (Ndoka et al., 2025; Sharma et al., 2025)—amplify these challenges. From the internal and contextual factors, companies often struggle with internal barriers such as a lack of expertise, resources, and commitment from top management. Moreover, short-term orientation and unwillingness to engage in trade-offs for long-term sustainability (Rashid et al., 2025; Takacs et al., 2022). Hence, the obstacles in implementing CE have a complexity that is still a concern for researchers, especially in the micro and small sectors, which have many resource limitations.

Despite these persistent challenges, recent studies emphasize that leadership commitment—particularly in navigating cultural, financial, and technological barriers—is critical for overcoming organizational inertia and driving CE adoption. Leadership commitment is needed to address various barriers, including cultural barriers, mitigating financial concerns, and technological limitations, and overcoming organizational change. Prior studies have confirmed that leadership (i.e., digital, ambidextrous, inclusive, and ethical leadership) is vital to ensure organizational change, sustainability goals, and facilitate a successful transition to circular and sustainable business models in their organization (Al-Ghazali et al., 2022; Cheffi et al., 2023; Droege et al., 2021; Elshaer et al., 2025; Gao et al., 2023; Guo et al., 2019; Katou et al., 2023; Khan et al., 2024; Ly, 2025; Nath et al., 2025); consequently, exploring effective leadership models for CE implementation is crucial. However, the specific mechanism linking green transformational leadership to financial performance through CE practices in the context of MSEs remains underexplored (Elshaer et al., 2025; Özgül and Zehir, 2023). Furthermore, empirical evidence on how environmental uncertainty may contingently affect these relationships within emerging markets is notably scarce. Hence, this study seeks to fill these critical gaps.

On the one hand, the costs linked to the transformation from a linear economy to CE on financial performance provide mixed results, negatively (Gonçalves et al., 2022; Marques-McEwan and Türnau, 2024; Sun et al., 2025) and positively affect (Liu et al., 2025; Rehman Khan et al., 2022; Shavkatov et al., 2024). To fill this gap, the present study was conducted on 353 Indonesian micro and small enterprises. In general, these sectors are important and constitute more than 90% of Indonesia's businesses, generating 95% of employment and 61% of GDP, making them crucial for sustainable development. Specifically, the present study focuses on the textile and apparel industries, as well as their processing. These two sectors are interesting because they not only contribute to more than 2.5 million jobs but are also the two micro and small industry groups with the largest value-added in 2023 and 2024, amidst global economic uncertainty (KADIN Indonesia, 2024). Hence, the first aim of this research is to better understand the function of green transformational leadership in MSEs as a catalyst for CE implementations and financial performance, as shown in Figure 1. Furthermore, this study also aims to uncover the role of CE practices as an intermediate and, at the same time, propose external factors (e.g., environmental uncertainty) as a boundary condition in the relationship between green leadership, CE practices, and financial performance.

This study offers three key contributions that advance current understanding of sustainability leadership and circular economy practices in emerging markets. First, we contribute to green leadership theory by empirically validating CE practices as a critical mediating mechanism that translates GTL into improved financial performance. This study extends beyond existing research that has established GTL's positive effects on sustainable performance (Reniati et al., 2023), green organizational culture (Özgül and Zehir, 2023), and environmental outcomes (Kebe et al., 2025; Sánchez-García et al., 2024) by demonstrating how CE implementation serves as the intermediate between green leadership and financial performance. Hence, this study addresses an important theoretical gap relative to studies

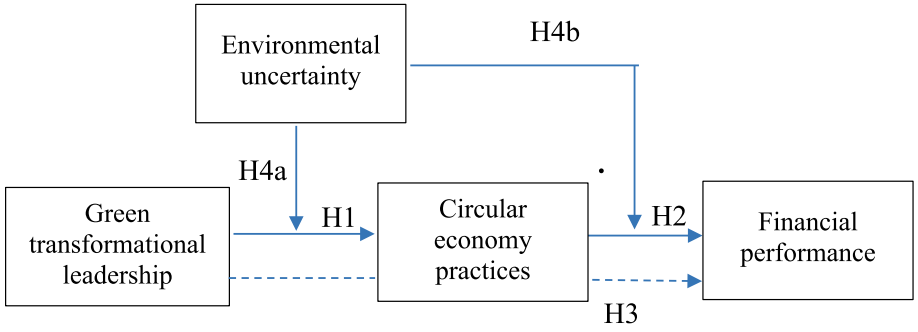

FIGURE 1
Research framework.

examining alternative leadership approaches like green digital leadership (Elshaer et al., 2025) or inclusive leadership (Ly, 2025).

Second, the present study provides novel theoretical insights into the contingent role of environmental uncertainty in sustainability transitions. The present study proposes a dual effect of environmental uncertainty: as initial barriers to CE adoption and subsequently diminishing the financial returns from implemented CE practices. Hence, this study significantly extends prior work focused predominantly on internal organizational factors such as green efficacy (Elshaer et al., 2025; Ho and Lin, 2024), digital technology adoption, innovation capabilities, and workforce commitment (Muafi, 2021; Oktrivina et al., 2025), offering a more complete theoretical framework for understanding sustainability implementation.

Third, we address a critical contextual gap by providing robust empirical evidence from Indonesia's micro and small enterprise (MSE) sector, representing an understudied emerging market context. Moreover, this study also responds directly to recent scholarly calls for more sustainability studies in developing economies (Khan et al., 2025; Ostic et al., 2025), while offering practical insights for MSE managers operating in resource-constrained environments. In sum, the demonstrated effectiveness of GTL and CE practices in this context has important implications for both theory and practice in emerging markets.

Theoretical background and hypotheses

This study's framework integrates the Resource-Based View (RBV) (Hart, 1995) and Dynamic Capabilities Theory (DCT) (Teece, 2007) to examine how leadership can drive circular economy (CE) adoption and its effect on financial performance. RBV posits that sustainable competitive advantage stems from unique, valuable resources—such as human capital, green technological assets, and eco-innovative organizational culture—which enable firms to implement CE practices effectively (Ly, 2025; Subramanian and Suresh, 2022). For instance, green transformational leadership (GTL) leverages these resources to align internal capabilities to gain the CE implementation as unique values to gain the competitive advantage. In the same vein, DCT emphasizes the critical role of adaptive capabilities in reconfiguring resources to address evolving CE challenges, such as regulatory, market, and supply chain disruptions.

Teece (2007) highlights that dynamic capabilities (e.g., sensing market trends, seizing eco-innovations, and transforming processes) allow firms to adapt their resource base for circularity continuously. Together, these theories explain why some organizations succeed in CE transitions: RBV provides the resource foundation, while DCT enables strategic agility to exploit these resources amid changing sustainability demands (e.g., through closed-loop system redesign or stakeholder collaboration). Empirical studies confirm this synergy, showing that firms combining robust green resources with adaptive capabilities achieve higher CE performance (Ly, 2025; Subramanian and Suresh, 2022).

The green transformational leadership and circular economy practices

Scholars increasingly recognize the circular economy as a transformative and viable alternative that keeps materials in continuous use through reduction, reuse, and recycling (Koech and Munene, 2019; Sehrawat et al., 2025). This approach not only tweaks existing systems but also fundamentally rethinks how we manage resources to boost efficiency while protecting the environment (Karstensen et al., 2019; Oktrivina et al., 2025). The circular economy concept is generating much attention for a solid reason: it offers a direct solution to significant problems such as dwindling resources, environmental degradation, and climate change (Gama et al., 2017). It is not just theory; big players are pushing it hard. The CE was started by the European Commission in 2015, which launched an extensive Circular Economy Package to promote this transition, believing it would enhance global competitiveness, drive sustainable economic development, and generate new employment opportunities. Since 2015, there has been a notable rise in research and publications emphasizing the significance of these principles for fostering a sustainable future (Şahin et al., 2024).

In the same vein, the green transformational leadership concept has gained popularity over the last decade due to global environmental concerns and a growing emphasis on sustainability. Research indicates that studies on GTL have been increasing since approximately 2013, with a rise in publications and interest from scholars and practitioners (Doan and Wu, 2025). This rise is motivated by the need for leadership styles that support worldwide sustainability goals, such as the United Nations Sustainable

Development Goals (SDGs). GTL builds on the idea of transformational leaders (Avolio, 1999; Bass, 1990), linking it to environmental sustainability. GTL is defined as the actions of leaders who encourage their followers to achieve environmental targets and inspire them to exceed expectations in terms of environmental outcomes (Chen et al., 2014; Chen and Chang, 2013). Green transformational leadership (GTL) is a leadership style that drives environmental sustainability by inspiring eco-friendly practices within organizations. GTL combines visionary leadership—articulating a clear sustainability vision (Elshaer et al., 2025; Sánchez-García et al., 2024)—with employee empowerment, fostering a culture where staff actively adopt green initiatives (Priyadarshini et al., 2023). GTL also promotes innovation by encouraging creative solutions to environmental challenges, such as resource efficiency or waste reduction (Sánchez-García et al., 2024). Prior studies highlight GTL as a vital role in embedding sustainability into corporate strategies, motivating teams through role modeling, environmental responsibility, and leveraging green organizational environmental culture and intellectual capital to achieve competitive advantage (Ismail, 2025; Poperwi, 2024; Priyadarshini et al., 2023). This leadership approach is efficient in transitioning toward circular economies, as it mobilizes collective action and adapts to evolving sustainability demands (Reniati et al., 2023).

> *H1*: Green transformational leadership has a positive influence on CE practices.

The circular economy practices and financial performance

Various researchers have differing perspectives on Circular Economy Initiatives and their potential positive effects on a company's long-term, including financial performance. For example, a longitudinal analysis of European manufacturing companies showed a significant positive relationship between the CE practices and various financial metrics (Shavkatov et al., 2024); Meanwhile, another study using data from the same regions' companies showed that CE performance had only a small impact on a company's financial performance (Sarfraz et al., 2023).

Circular economy practices have been found to enhance corporate performance in general, including environmental and sustainability aspects, based on a study of 25 countries over 20 years (Liu et al., 2025; Pan et al., 2024). Implementing the circular economy can enhance financial performance by reducing waste and pollution, benefiting environmental, cost, social, financial, and operational outcomes (Liu et al., 2025; Pan et al., 2024). Additionally, circulating products and materials further improve these performances (Bocken et al., 2025; Pan et al., 2024; Rehman Khan et al., 2022). Hence, the implementation of circular models into business models demonstrates particular strength in securing long-term financial resilience, proving that environmental sustainability and profitability (Liu et al., 2025; Rehman Khan et al., 2022; Shavkatov et al., 2024). We therefore hypothesize:

> *H2*: CE practices have a positive influence on financial performance.

The mediating roles of circular economy practices

This study argues that CE practices mediate the relationship between GTL and financial performance, based on the following reasons. First, several previous studies have confirmed that CE practices act as mediators. For example, CE practices mediate the relationship between digital leadership and organizational performance (Khan et al., 2024), as well as mediate the relationship between GHRM and organizational sustainable development (Amin et al., 2025; Iqbal et al., 2025). Second, according to prior works, GTL provides the strategic vision and support needed to implement strategic sustainability in their daily operations, including circular models (Cheffi et al., 2023; Elshaer et al., 2025; Katou et al., 2023; Khan et al., 2024; Ly, 2025; Reniati et al., 2023; Sánchez-García et al., 2024). Third, prior research shows that adopting circular economy (CE) practices can improve various financial outcomes (Liu et al., 2025; Rehman Khan et al., 2022; Shavkatov et al., 2024). When organizations increase their CE practices, they become more efficient with resources, create less waste, decrease compliance and environmental risks, and strengthen their financial stability and competitiveness (Bertelli et al., 2025; Oktrivina et al., 2025; Wang et al., 2025). Thus, GTL indirectly contributes to superior financial outcomes by cultivating CE practices that lower costs, optimize resource utilization, and improve operational effectiveness.

> *H3*: CE practices mediates the link between GTL and financial performance.

The moderating effect of environmental uncertainty

Environmental uncertainty—the unpredictable shifts in external conditions affecting organizations—manifests in three key forms: *state* (unclear environmental changes), *effect* (unknown impacts on operations), and *response* (uncertainty about viable solutions) (Abu-Allan and Alghizzawi, 2024; Ashill and Jobber, 2014; Korinth and Lueg, 2022; Lueg and Borisov, 2014). Lack of consumer demand, insufficient government support and regulatory fluctuations, market and supply-chain instability, and ecological disruptions are primary drivers of this uncertainty (López-Gamero et al., 2011), with managerial perceptions varying by industry context (Lueg and Borisov, 2014). For CE initiatives, environmental uncertainty presents a double-edged sword. Although CE practices such as material reuse and waste minimization promote efficiency and support environmental sustainability (Liu et al., 2025; Milhem et al., 2025; Pan et al., 2024), unpredictable regulations and shifting market demands can undermine long-term investments. For instance, abrupt policy changes might deter companies from implementing innovations that reduce pollution (Hoffmann et al., 2008), while rebound effects—where gains in efficiency can backfire due to external disruptions—become increasingly probable (Levänen et al., 2021). Hence, companies facing these uncertainties need to find a balance between being adaptable and remaining committed to circular principles to maintain their performance.

> *H4*: Environmental uncertainty moderates the relationship between: (a) GTL and CE practices and (b) CE practices and financial performance.

Methodology

Sample and procedures

This study focuses on Indonesia's textile/apparel and processing industries, which represent the most economically significant segment of micro and small enterprises (MSEs) in terms of value added during the 2022–2024 period (KADIN Indonesia, 2024). The sample selection process combined purposive and convenience sampling approaches to ensure both relevance and feasibility (Sekaran and Bougie, 2016). This study specifically targeted MSEs that were officially registered in the regional industry and trade local government and had initiatives promoting environmentally friendly production practices in their business operation. The voluntary nature of participation was also a key consideration in the sampling process. The study was conducted in Indonesia's two largest MSE hubs, Jakarta and West Java, to capture a representative sample of the country's MSE sector.

Data collection occurred in two distinct phases using different methodologies to enhance data quality and reduce common method bias (Podsakoff et al., 2012). The first phase (December 2024) involved paper-and-pencil questionnaires administered to MSE owners/managers. This initial phase gathered comprehensive information about company profiles, including business type, operational duration, size, and owner biographical data, along with assessments of circular economy practices and perceived environmental uncertainty. A total of 451 MSEs participated in this first phase. The second phase (May 2025) used online questionnaires distributed via email and WhatsApp to maintain continuity with the original participants from phase 1. During phase 2, owners/managers provided financial performance data. At the same time, employee representatives completed assessments of green transformational leadership within their organizations. After checking the completeness of the data and duplication, 353 data pairs between phases 1 and 2 were determined as final data.

A business profile analysis (see Table 1) revealed the gender distribution of owners/managers of MSEs; males constituted 63.50% (224 respondents), while females accounted for 36.50% (129 respondents). Regarding industry type, the majority operated in the textile sector (55.80%), followed by wood processing (28.90%) and metal processing (15.30%). In the category of company size, micro-enterprises represented 61.50% (217 MSEs), whereas small enterprises made up 38.50% (136 MSEs). Finally, in terms of business longevity, most firms were established for over 10 years (56.90%), followed by those operating between 5 and 10 years (27.80%). The most minor proportion was businesses under 5 years old (15.30%).

TABLE 1 Characteristics of micro and small enterprises in this study.

Characteristics	Frequency	Percentage
Gender		
Male	224	63.50%
Female	129	36.50%
Industry		
Textile	197	55.80%
Wood processing	102	28.90%
Metal processing	54	15.30%
Size		
Micro	217	61.50%
Small	136	38.50%
Company age		
<5 yrs	54	15.30%
5–10 yrs	98	27.80%
>10 yrs	201	56.90%

TABLE 2 Exploratory factor analysis (n = 353).

Construct	Number of items	% Variance
Factor 1: Circular economy practices	6	18.9
Factor 2: Green transformation	6	17.4
Factor 3: Environmental uncertainty	4	14.8
Factor 4: Financial performance	3	10.8
Cumulative%		61.9
KMO measure of sampling adequacy	0.89	
Bartlett's test of sphericity (p-value)	<0.01	
RMSEA	0.04	
TLI	0.96	

Measurement

The measurement instrument for this study was developed through a rigorous, multi-stage process that combined a literature review and expert consultation (see Table 2). Circular economy practices (CEP) were measured using six assessment matrices covering design, procurement, production, distribution, usage, and reverse logistics (Dey et al., 2022; Kalmykova et al., 2018). Environmental uncertainty is measured based on four relevant items regarding consumer demand, government support, regulatory fluctuations, market and supply-chain instability (López-Gamero et al., 2011; Rexhepi Mahmutaj et al., 2025). MSE owners were asked to provide ratings on a scale ranging from 1 (very low) to 4 (very high) for CEP and environmental uncertainty.

The six items of green transformational leaders were used based on originality from Chen et al. (2014) and recently used in several studies (Chen et al., 2025; Mansoor et al., 2021; Seema et al., 2025), resulting in good internal consistency. An example of an item is "my manager inspires me with a business environmental plan." Lastly, financial performance is measured by three indicators, including liability, cash flow, and profitability (Tehseen et al., 2023) and recently

used by Oktrivina et al. (2025) to assess the financial performance of MSE in Indonesia. MSE owners were asked to give a 4-point rating: 1 = decreasing, 2 = constant, 3 = slightly increasing, 4 = significantly increasing.

The exploratory factor analysis (EFA) was applied to test the initial factor structure and evaluate potential common method variance (CMV) in the data study (Table 2). The analysis revealed that the first factor, green transformation, explained only 19.0% of the total variance, which falls substantially below the 50% threshold commonly associated with significant CMV (Podsakoff et al., 2012). The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy yielded a value of 0.89, Bartlett's test of sphericity was statistically significant ($p < 0.01$), confirming that the data were suitable for factor analysis. In the same vein, the model has been confirmed by fit indices, including RMSEA (0.04) and TLI (0.97), further supporting the robustness of the 4-factor structure.

Data analysis strategy

Partial least squares structural equation modeling (PLS-SEM) was used in this study to examine the proposed model, following established analytical procedures from several authors (Hair et al., 2017; Legate et al., 2023; Sarstedt et al., 2021). This method was particularly suitable as it enables simultaneous assessment of multiple outcome variables while estimating direct, indirect (mediation), and interaction (moderation) effects within an integrated framework, while also addressing measurement error and eliminating the need for separate regression analyses (Legate et al., 2023; Sarstedt and Cheah, 2019). The analysis proceeded through two phases: initial evaluation of the measurement model and structural model assessment as recommended by Hair et al. (2017). Furthermore, robustness checks were conducted for potential unobserved heterogeneity and endogeneity concerns using advanced techniques (Sarstedt et al., 2020). The entire analysis process uses the SMART-PLS version 4.0.

Results

Measurement model evaluation

The measurement model assessment for all constructs (green transformation leadership, circular economy practices, financial performance, and environmental uncertainty) demonstrated strong psychometric properties. First, all indicator loadings exceeded the recommended threshold of 0.708 ($p < 0.05$), confirming adequate item reliability (Legate et al., 2023). Second, all constructs exhibited excellent internal consistency with Cronbach's alpha (α) and composite reliability (CR) values all surpassing 0.70, while average variance extracted (AVE) exceeded 0.50, supporting convergent validity. Third, discriminant validity was confirmed through heterotrait-monotrait ratio (HTMT) analysis, with all values remaining below the conservative threshold of 0.90 (maximum HTMT = 0.48) (Franke and Sarstedt, 2019; Legate et al., 2023). These results collectively establish the reliability and validity of the measurement model for subsequent structural analysis (Table 3).

TABLE 3 Reliability and validity of the measures (n = 353).

	Outer loading	VIF	CA	CR	AVE
Green transformational leadership			0.88	0.89	0.62
GTL1	0.70	1.80			
GTL2	0.75	1.80			
GTL3	0.81	2.23			
GTL4	0.83	2.08			
GTL5	0.82	2.17			
GTL6	0.82	2.10			
Circular economy practices			0.89	0.89	0.65
CEP1	0.77	1.84			
CEP2	0.77	1.78			
CEP3	0.84	2.32			
CEP4	0.78	1.92			
CEP5	0.81	2.32			
CEP6	0.85	2.55			
Financial performance			0.84	0.85	0.76
FP1	0.85	1.96			
FP2	0.88	1.96			
FP3	0.88	2.12			
Environmental uncertainty			0.90	0.93	0.77
ENV1	0.81	2.10			
ENV2	0.90	2.97			
ENV3	0.88	2.74			
ENV4	0.91	2.36			
Heterotrait–monotrait ratio (HTMT)	CEP	ENV	FP	GTL	
CEP	–				
ENV	0.42	–			
FP	0.35	0.21	–		
GTL	0.48	0.10	0.41	–	

GTL, Green transformational leadership; environmental uncertainty; CEP, circular economy practices, FP, financial performance, CA, Cronbach alpha, CR, Composite reliability, AVE, Average variance explained.

Structural model evaluation

This study investigates the structural relationships between green transformational leadership, circular economy practices, environmental uncertainty, and financial performance using PLS-SEM. First, we confirm the absence of multicollinearity through variance inflation factors (VIF < 5). Next, we evaluate the structural model by examining standardized path coefficients (significance determined via 5,000 bootstrap samples) and assessing the explanatory

power (R^2 values) of endogenous constructs. We further analyze effect sizes (f^2) to determine the substantive impact of predictor variables and establish predictive relevance through the Stone-Geisser Q^2 test (blindfolding procedure with an omission distance of 7). Finally, we assess the model's out-of-sample predictive power using PLSpredict, comparing the root mean square error (RMSE) of PLS-SEM predictions against linear regression benchmarks (Legate et al., 2023).

The analysis results are displayed in Table 4. The initial analysis commenced with diagnostic checks confirming the absence of multicollinearity (all VIFs < 5). In response to the research question on the influence of GTL on CE practices, we found a significant positive relationship ($\beta = 0.37$, $t = 6.86$, $p < 0.01$), accounting for 19% variance ($R^2 = 0.19$) with a substantial effect size ($f^2 = 0.24$), supporting H1. Next, the circular economy practices were also confirmed to be positively related to financial performance ($\beta = 0.44$, $t = 7.66$, $p < 0.01$), explaining 20% of the variance and demonstrating a moderate effect ($f^2 = 0.21$); hence, Hypothesis 2 is supported. Both relationships show strong predictive relevance ($Q^2 > 0$).

For the mediating effect, we found that CEP mediates the GTL-FP relationship ($\beta = 0.16$, $t = 4.38$, $p < 0.01$), confirming an indirect value-creation pathway (H3 is supported). Next, the moderating effect reveals mixed results: first, the interaction of ENV x GTL shows a negative and significant coefficient ($\beta = -0.21$, $t = 4.40$, $p < 0.01$), indicating environmental uncertainty is proven to weaken the GTL-CEP relationship, supporting Hypothesis 4a. However, the moderating effect of environmental uncertainty (ENV × CEP) proves negative and insignificant ($\beta = -0.09$, $t = 1.57$, $p = 0.12$), indicating that the role of environmental uncertainty as a moderator of CE practices—financial performance linkage is not statistically confirmed; hence, H4b is rejected.

Finally, we evaluated out-of-sample predictive validity using the PLSpredict procedure (Hair and Alamer, 2022). Table 5 demonstrated generally strong predictive performance, with positive Q^2 predict values across all indicators of both financial performance and circular economy practices. For circular economy practices, the PLS-SEM model consistently showed lower root mean square error (RMSE) values compared to linear model (LM) benchmarks, confirming robust predictive validity. However, the predictive capability for financial performance revealed a limitation, particularly for indicator PF3, where PLS-SEM's RMSE values were comparable to (though still lower than) the LM benchmark, suggesting constrained predictive power for this specific financial performance measure (Legate et al., 2023).

Furthermore, the Cross-Validated Augmentation Test (CVAT) indicated that the PLS-SEM model had lower prediction errors when compared to the indiscriminate antecedents model (see Table 5). For circular economy practices, the PLS loss value (0.93) is lower than the IA loss value (1.05). The difference is statistically significant ($t = 3.75$, $p < 0.001$), indicating that the proposed model captures predictive variance more effectively. A similar pattern is observed for financial performance, where the PLS loss (0.87) is lower than the IA loss (0.92), with a highly significant result ($t = 5.31$, $p < 0.001$), suggesting that the structural relationships meaningfully enhance the predictive relevance in explaining firm outcomes. The predictive error at the overall model level decreased from 1.01 to 0.91 ($t = 4.40$, $p < 0.001$), indicating that the proposed pathways improve the model's explanatory and predictive power. These results confirm the model's strong predictive validity regarding green transformational practices, the circular economy, and financial performance in MSEs (Sharma et al., 2023).

Robustness check

The Gaussian Copula analysis revealed no significant endogeneity concerns for the primary model relationships: the GTL-CEP linkage ($\beta = 0.02$, $p = 0.94$) and CEP-financial performance path ($\beta = 0.04$, $p = 0.89$), both of which showed statistically insignificant coefficients. Hence, these results support the model's robustness against endogeneity threats. Complementing these findings, the FIMIX-PLS analysis of unobserved heterogeneity yielded inconclusive segmentation evidence across information criteria: while AIC3 suggested three segments (1,727.31). CAIC indicated two (1,800.92), the MDL5 (2,411.95 for three segments), and other indices (AIC4 = 1,753.31, BIC = 1,801.84) failed to converge on a consistent solution. The moderate EN = 0.42–0.48 and NFI = 0.43–0.55 further confirmed the absence of strong latent segments. Following Sarstedt and Cheah (2019), we conclude that unobserved heterogeneity does not critically affect our results, validating the aggregate-level analysis of the full dataset (see Appendix 2).

Discussion

This study examines how green transformational leadership (GTL) contributes to circular economy (CE) practices and subsequently influences financial performance through these practices. Moreover, the moderating role of perceived

TABLE 4 Structural model results.

	coeff.	SD	*t*-values	*p*-values	*f*-square	*r*-square	*q*-square
GTL ≥ CEP	0.37	0.05	6.86	0.00	0.24	0.19	0.23
CEP ≥ FP	0.44	0.06	7.66	0.00	0.21	0.20	0.15
Moderating							
ENV × GTL ≥ CEP	−0.21	0.05	4.40	0.00	0.07		
ENV × CEP ≥ FP	−0.09	0.06	1.57	0.12	0.01		
Mediating							
GTL ≥ CEP ≥ FP	0.16	0.04	4.38	0.00			

GTL, Green transformational leadership; environmental uncertainty; CEP, circular economy practices, FP, financial performance.

TABLE 5 Out-of-sample predictive ability evaluation using PLSpredict.

	Q^2predict	RMSE		ΔRMSE
		PLS-SEM	LM	
Circular economy practices				
CEP1	0.22	0.92	0.92	0.84
CEP2	0.16	0.83	0.84	0.72
CEP3	0.25	0.90	0.91	0.85
CEP4	0.23	0.92	0.93	0.87
CEP5	0.24	0.94	0.94	0.90
CEP6	0.23	0.91	0.93	0.85
Financial performance				
FP1	0.11	0.93	0.91	0.80
FP2	0.10	0.89	0.86	0.71
FP3	0.11	0.91	0.89	0.76

CVAT	PLS loss	IA loss	*t* value	*p* value
Circular economy practices	0.93	1.05	3.75	0.00
Financial performance	0.87	0.92	5.31	0.00
Overall	0.91	1.01	4.40	0.00

environmental uncertainty was examined in both the relationship between GTL-CE practices and the relationship between CE practices and financial performance. Involving 353 micro and small enterprises (MSEs) in Indonesia, the PLS-SEM analysis reveals that GTL was confirmed as a significant predictor of CE practices for MSEs. There is a positive relationship between CE practices and financial performance. The mediation analysis demonstrates that CE practices act as an essential mechanism connecting GTL to financial performance. Furthermore, moderation tests indicate that environmental uncertainty significantly moderates the relationship between GTL-CE practices, but does not significantly moderate the relationship between CE practices and financial performance.

Theoretical implications

First, the present study reveals that green transformational leadership (GTL) positively influences circular economy (CE) practices, aligning with and extending current theoretical understanding in several important ways. Our results corroborate recent scholarship recognizing CE as a transformative paradigm that fundamentally reconfigures resource management systems (Koech and Munene, 2019; Sehrawat et al., 2025), while providing empirical evidence of the specific leadership mechanisms enabling this transition in organizational contexts. The significant GTL-CE practices relationship substantiates conceptual frameworks positioning transformational leadership as a catalyst for sustainability transitions (Elshaer et al., 2025; Sánchez-García et al., 2024).

The study validates that GTL effectively leads to concrete CE practices in MSEs (Priyadarshini et al., 2023). These results also support the emerging perspective that CE implementation requires more than technical solutions—it demands leadership capable of reshaping organizational values and routines (Ismail, 2025; Reniati et al., 2023). The results offer important theoretical refinements by supporting the transformational leadership-eco-innovation bridge in circular economy transitions (Karstensen et al., 2019), empirically validating organizational practices as key mediators between leadership and sustainability outcomes, while highlighting the necessity for contingency frameworks that incorporate external uncertainty factors and calling for greater integration between leadership theories and circular economy transition models.

Second, this study reveals the significant role of CE practices in enhancing financial performance, contributing to ongoing debates about the economic returns of sustainability initiatives. While prior research presents mixed findings—with some studies reporting strong positive relationships (Shavkatov et al., 2024) and others noting modest impacts (Sarfraz et al., 2023)—our results align with evidence that CE implementation drives financial gains. This positive relationship is likely due to multiple pathways of CE practices: waste/pollution reduction (Liu et al., 2025), optimized resource flows (Bocken et al., 2025), and improved operational efficiencies (Pan et al., 2024). The observed performance benefits support the theoretical proposition that CE practices create value by simultaneously narrowing (reducing resource inputs), slowing (extending product lifecycles), and closing (recycling) material loops (Bocken et al., 2025), which collectively enhance cost structures and market competitiveness (Rehman Khan et al., 2022). Particularly noteworthy is our validation of these relationships in the MSE context, extending beyond the predominantly large-enterprise focus of existing studies (Shavkatov et al., 2024; Sarfraz et al., 2023). These results suggest that even resource-constrained smaller firms can achieve the "sustainability-profitability paradox" (Liu et al., 2025) through CE adoption. The findings ultimately reinforce CE's role in building long-term financial resilience while addressing ecological constraints.

Third, as expected, the study confirms that CE practices mediate the relationship between GTL and financial performance, substantiating contemporary theoretical frameworks that position leadership as an enabler of circular transitions through multiple organizational pathways (Cheffi et al., 2023; Sánchez-García et al., 2024). This mediation effect aligns with prior research that shows demonstrably that GTL fosters ecosystem collaborations and institutionalizes circular business models (Katou et al., 2023; Ly, 2025). The GTL has also been cultivating an organizational culture conducive to green initiatives (Reniati et al., 2023; Elshaer et al., 2025)—all prerequisites for successful CE implementation. The mediated effect in this study also supports evidence that CE adoption leads to financial gains via waste reduction and resource efficiency (Liu et al., 2025). This finding theoretically advances leadership research by delineating CE practices as a concrete mechanism through which leaders' sustainability vision translates into economic outcomes, while empirically validating the GTL → CE practices → financial performance chain in emerging market MSEs—a novel contribution given existing studies' focus on large corporations (Khan et al., 2024). The results imply that leadership development programs aiming to

enhance financial performance through sustainability should prioritize competency-building in CE implementation strategies rather than focusing solely on generic green leadership attributes.

Finally, this study provides robust empirical evidence that environmental uncertainty significantly weakens the positive relationship between GTL and CE practices in MSEs. The negative moderating effect substantiates prior conceptual work by Abu-Allan and Alghizzawi (2024) and Ashill and Jobber (2014) that categorized environmental uncertainty into three disruptive dimensions: (1) unpredictable changes in regulations/policies, (2) market/demands, and (3) sustainable supply chain. Our findings particularly validate López-Gamero et al.'s (2011) assertion that regulatory fluctuations and market instability—key manifestations of state uncertainty—create implementation barriers for sustainability initiatives. When environmental conditions become volatile, even highly transformational green leaders face diminished capacity to institutionalize CE practices because: (a) sudden policy shifts increase compliance costs and alter ROI calculations for circular investments, (b) unstable supply chains disrupt material reuse/recycling loops, and (c) ambiguous market signals weaken stakeholder commitment to circular transitions.

Contrary to expectations, the present study reveals that environmental uncertainty has no significant impact on the relationship between CE practices and financial performance. The different results in this study suggest that when circular economy practices are successfully implemented within an organization, their positive financial impacts remain robust even in the face of external uncertainties. Hence, the finding challenges conventional wisdom about environmental uncertainty's universally constraining effects (Hoffmann et al., 2008; Levänen et al., 2021) and instead supports the alternative perspective that CE practices may create self-reinforcing systems that are resilient to external shocks (Liu et al., 2025; Milhem et al., 2025).

The non-significant moderation effect can be theoretically explained through several mechanisms: First, CE Practices' is closely related to the efficiency through travel reduction and resource optimization (Pan et al., 2024), and external uncertainties. Second, the operational flexibility built into many CE approaches (such as adaptable material sourcing and modular production) may naturally mitigate the potential disruptions of uncertainty (Levänen et al., 2021). Third, firms committed to CE principles may develop superior environmental scanning capabilities that allow them to anticipate and adapt to external changes more effectively (Milhem et al., 2025). This finding makes key theoretical contributions. It qualifies the "double-edged sword" perspective on environmental uncertainty (Hoffmann et al., 2008) by showing its asymmetric effects—while uncertainty may hinder the adoption of CE practices (as shown in our GTL relationship), it does not necessarily undermine their financial benefits once implemented. Moreover, it supports the resilience hypothesis in CE literature (Liu et al., 2025) that circular systems may be inherently more robust to external shocks than linear systems.

Practical implications

The findings of this study offer several important practical implications for managers, policymakers, and business support organizations working with micro and small enterprises (MSEs). First, the confirmed positive relationship between green transformational leadership and circular economy practices highlights the need for leadership development programs focused on sustainability vision, employee empowerment, and innovation capabilities. In addition, MSE owners and managers in Indonesia should invest in training that enhances their abilities to drive circular principles while fostering an organizational culture that embraces sustainable transformation. Next, the industry associations, the university, and the government agencies can support this through targeted capacity-building initiatives tailored for smaller businesses.

Second, the present study also confirmed that the financial benefits of circular economy practices provide a strong business case for MSEs to integrate circularity into their core strategies. Managers/owners should develop structured implementation plans with clear performance metrics, emphasizing waste reduction, resource efficiency, and product lifecycle extension. Government and policymakers in Indonesia can support the transition to sustainability by offering incentives based on clear and measurable outcomes. This is especially important for micro and small businesses that face challenges in adopting these changes.

Third, the mediating role of circular practices suggests that leadership programs should combine transformational leadership training with practical tools for circular business implementation. Integrated approaches that link sustainability vision with actionable practices will be most effective in driving both ecological and financial results. Leadership development should move beyond generic green principles to focus on specific competencies for circular model innovation.

Finally, the study's nuanced findings on environmental uncertainty provide important strategic guidance. While external volatility may challenge initial circular economy adoption, successfully implemented circular practices deliver resilient financial benefits regardless of market conditions. MSEs should strengthen their environmental monitoring and adaptive planning while recognizing that circular investments maintain their value in uncertain environments. Policymakers can support this by providing stable regulatory frameworks and risk-mitigation mechanisms for sustainable business models during market disruptions.

Limitations and future research

This study offers valuable insights into how green transformational leadership helps micro and small enterprises (MSEs) implement a circular economy and improve financial performance. However, there are some limitations that future research should address. First, the cross-sectional design of this study prohibits definitive conclusions regarding causality. Although the proposed model is grounded in theory, the relationships between GTL, CE practices, and financial performance could be reciprocal and possibly different in short and long-term contexts (Chen and Ma, 2021; Shuwaikh et al., 2023). For example, strong financial performance might provide the slack resources needed for leaders to invest in green initiatives (Jackson et al., 2015). To address this, future research should employ longitudinal or experimental designs to track these relationships over time and establish causal precedence, particularly across different phases of business development and economic conditions.

Second, our findings are limited by the singular focus on Indonesian MSEs, which restricts their generalizability, especially to other

countries, such as developed economies with more mature sustainability frameworks. Therefore, we recommend that future studies conduct cross-cultural and comparative research across diverse institutional settings (e.g., comparing developed and emerging economies) to validate the model and identify boundary conditions. Third, the financial performance measurements in this study are based on self-reported survey data from MSE owners/managers, which is potentially biased. We recommend utilizing multi-source data (e.g., pairing manager surveys with objective financial performance data from company records) or more objective measures of financial performance.

Finally, while we examined environmental uncertainty as a moderating factor, we treated it as a broad, aggregate construct. This approach masks the potential distinct effects of its various dimensions, such as regulatory uncertainty, market volatility, technological disruption, or competitive dynamics. Therefore, future studies can examine these specific dimensions to identify more specific factors of environmental uncertainty as boundary conditions.

Conclusion

This study establishes green transformational leadership as a crucial driver of circular economy practices in micro and small enterprises, with compelling evidence showing that these sustainable practices subsequently enhance financial performance via CE practices. This study reveals that while environmental uncertainty significantly weakens the relationship between green transformational leadership and the implementation of circular economy practices in micro and small enterprises, the financial benefits derived from successfully implemented circular systems demonstrate remarkable resilience to external volatility. Notably, the research confirms circular economy practices as the key mediating mechanism through which sustainability-focused leadership achieves financial outcomes, while simultaneously challenging conventional assumptions about environmental uncertainty's uniform impact across different stages of the sustainability transition. These insights contribute valuable theoretical understanding of the complex dynamics between leadership, sustainability practices, and external factors, while offering practical guidance for enterprises navigating uncertain business environments through circular economy approaches.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Prof. Dr. apt. Ni Made Dwi Sandhiutami (Head of the Institute for Research and Community Service, Pancasila University). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

AO: Conceptualization, Data curation, Funding acquisition, Methodology, Writing – original draft. LS: Conceptualization, Data curation, Formal analysis, Investigation, Supervision, Writing – original draft. Hendryadi: Conceptualization, Formal analysis, Methodology, Validation, Writing – original draft. SE: Data curation, Formal analysis, Validation, Writing – review & editing. HB: Data curation, Formal analysis, Investigation, Writing – review & editing. SA: Formal analysis Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/frsus.2025.1684185/full#supplementary-material

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