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Original Research Article

The role of circular human resource management to circular economic performance: A mediation and moderation model

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Abstract: This study examines the role of Circular Human Resource Management (CHRM) in enhancing Circular Economic Performance (CEP) through the mediating effect of Green Knowledge Management (GKM) and the moderating role of ethical leadership. Grounded in Self-Determination Theory, this research adopts a quantitative approach by collecting data from 250 employees working in manufacturing companies in Indonesia across multiple sectors. Data were analyzed using Partial Least Squares Structural Equation Modeling (SEM-PLS) with SmartPLS 4.0. The findings indicate that CHRM has a significant positive effect on CEP and GKM, while GKM also significantly influences CEP. Furthermore, GKM partially mediates the relationship between CHRM and CEP, confirming that knowledge-based processes are critical mechanisms in translating HRM practices into circular performance outcomes. The results also reveal that ethical leadership strengthens the relationship between CHRM and CEP, highlighting the importance of leadership as a boundary condition. This study contributes to the literature by addressing the conceptual ambiguity of CHRM and providing an integrated framework that links HRM, knowledge management, and circular performance through a motivational perspective. Practically, the findings suggest that organizations should align HR practices with knowledge management systems and leadership strategies to achieve sustainable and circular performance in manufacturing contexts.
Keywords: circular human resource management; green knowledge management; circular economic performance; ethical leadership; quantitative

1. Introduction

In the modern era, organizations are increasingly required to address environmental challenges while maintaining competitiveness, innovation, and long-term value creation. The transition toward a circular economy (CE) has emerged as a strategic approach to achieve sustainability by emphasizing resource regeneration, reuse, and closed-loop production systems. Within this context, the manufacturing sector plays a critical role, particularly in emerging economies such as Indonesia, where industrial activities significantly contribute to both economic growth and environmental pressure. Indonesia's manufacturing sector contributes around 20% to national GDP and represents a major source of employment; however, it is also associated with substantial environmental challenges, including the generation of more than 60 million tons of waste annually and low recycling efficiency. Current estimates indicate that only around 10–15% of waste is effectively recycled, while a significant proportion remains mismanaged[1]. In addition, Indonesia generates approximately 7.8 million tons of plastic waste each year, with nearly 4.9 million tons classified as inadequately managed[2]. These conditions highlight the urgency of transitioning toward circular economy practices, particularly within the manufacturing sector.

Despite these challenges, the circular economy presents significant economic and environmental opportunities for Indonesia. National projections suggest that the implementation of circular economy principles could contribute between USD 42–45 billion to GDP and create up to 4.4 million jobs by 2030[3]. Furthermore, circular strategies are expected to reduce waste generation by up to 18–52% and lower greenhouse gas emissions substantially. However, the implementation of circular economy practices

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in Indonesia remains uneven and faces structural, technological, and institutional barriers, particularly in the manufacturing sector[4]. These gaps indicate that beyond technological and regulatory interventions, organizational-level capabilities especially those related to human resources are essential for driving circular transformation.

In response to these challenges, human resource management has been increasingly recognized as a strategic enabler of circular economy implementation. Circular Human Resource Management (CHRM) has emerged as a novel approach that aligns workforce practices with circular principles by emphasizing the regeneration, reuse, and continuous development of human capital. However, despite its growing relevance, the literature on CHRM remains fragmented and conceptually underdeveloped. Existing studies frequently conflate CHRM with broader green or sustainable HRM frameworks, thereby overlooking the distinctive circular logic embedded in the circular economy paradigm[5-6]. Consequently, prior research tends to focus on general pro-environmental HR practices without clearly articulating how HRM systems can support the renewal and circulation of human capital across organizational cycles[7]. Moreover, the absence of a widely accepted operational definition has constrained theoretical advancement, limiting insights into how HRM practices facilitate continuous reskilling, knowledge circulation, and sustainable value creation[8]. As a result, CHRM remains conceptually indistinct from green HRM, despite the fundamentally different resource logic underlying circular economy principles[9].

Beyond these conceptual limitations, the psychological mechanisms through which CHRM influences circular outcomes remain underexplored. Existing studies are largely dominated by direct-effect models, offering limited understanding of how HRM practices shape employees' motivation and engagement in circular activities[10]. In particular, insufficient attention has been given to the role of intrinsic motivation and knowledge-sharing behavior in driving circular economic performance. Additionally, boundary conditions that may strengthen or weaken the effectiveness of CHRM remain insufficiently theorized, limiting a comprehensive understanding of when and how CHRM contributes to circular outcomes.

Self-determination theory posit that autonomous motivation fostered by CHRM practices strengthens engagement with CE objectives, thereby enhancing CEP. Specifically, SDT predicts that satisfying drivers of autonomy, competence, and relatedness through CHRM such as participative decision-making, meaningful green training, and collaborative cultures enhances intrinsic motivation to adopt circular practices, leading to higher CEP[11-13]. This motivational pathway complements empirical findings that CHRM elements (training, recruitment of green talent, performance management, and rewards) positively influence CEP, with stronger effects when aligned to learning cultures and digital KM supports[12,14-15]. Moreover, SDT implies that when green HRM satisfies psychological needs, employees generate deeper green knowledge sharing and innovation, reinforcing CEP outcomes in CE contexts[16-17]. Notable nuance includes sectoral differences and cultural moderations in how autonomy support translates into circular performance gains, suggesting boundary conditions similar to those reported in banking and manufacturing studies[18]. Overall, integrating SDT with CHRM offers a coherent mechanism for understanding how intrinsic motivation mediates the CHRM–CEP link, contingent on organizational culture and digital HR capabilities[12-14].

Circular HRM practices positively influence circular economic performance through multiple channels, including enhanced green skills, training, and alignment of HR processes with CE goals. Synthesis of evidence from multiple studies indicates that green HRM components training, recruitment, design, and compensation consistently mediate or moderate the link between CE initiatives and firm performance, especially when augmented by organizational learning, culture, and technology integration (e.g., CE practices, Industry 4.0)[12-16]. Green HRM promotes employee pro-environmental behavior, which in turn strengthens CE performance outcomes such as waste reduction, resource efficiency, and sustainable operations[16-17]. The moderating roles of organizational culture, DEI, and big data can further amplify CE-linked performance gains[18-21]. Overall, empirical and conceptual work converges on the claim that circular HRM is a critical enabler of circular economic performance, with strongest effects when combined with green organizational culture, continuous learning, and technology-enabled CE practices [11,13,22-23]. Further nuance exists regarding industry context and boundary conditions, notably in banking and manufacturing sectors[11,15].

Evidence across GHRM and CE literatures suggests that HRM practices designed for environmental

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sustainability training, recruitment of green talent, and performance management mediate and strengthen knowledge management capabilities essential for GKM in CE contexts[12-15]. When CHRM is embedded in an organizational learning culture and supported by digitalization, it facilitates codification and diffusion of eco-innovations, enabling firms to convert circular initiatives into explicit green knowledge assets and capabilities[17,21,23]. Sectoral and contextual nuance exists: The strength of CHRM–GKM linkages may vary by industry maturity, governance pressures, and DEI considerations that shape knowledge flows and sustainability norms[16,18-19]. Overall, convergent evidence indicates CHRM is a critical lever for building and leveraging green knowledge within CE-oriented firms, with stronger effects where CE practices are integrated with learning, culture, and digital HRM capabilities[12,15, 17,21,11].

GKM strengthens CEP by converting environmental knowledge into actionable capabilities that support CE goals. Across the literature, GKM acts as a mediator and enabler: Green knowledge practices facilitate waste reduction, resource efficiency, and eco-innovation that drive CEP, while absorptive capacity and knowledge sharing amplify these effects in CE contexts[24,12,14]. When GKM is embedded in learning-oriented cultures and supported by digital tools, codified and tacit green knowledge is more effectively created, stored, and transferred to CE initiatives, enhancing circular performance outcomes[12,16]. Industry context matters: Sectors with mature knowledge ecosystems and strong DEI and governance pressures demonstrate stronger GKM–CEP linkages [17,6]. Overall, the evidence converges on GKM as a critical conduit through which environmental knowledge is transformed into measurable circular economic performance, particularly where HRM, learning processes, and digital KM infrastructures align with CE practices[24,13,16-17].

The importance of GKM as mediator between CHRM and CEP is supported by a cohesive set of studies showing that CHRM fosters the creation, sharing, and application of green knowledge, which in turn enhances CEP. Key mechanisms include: (1) CHRM practices (training, green recruitment, performance management) raise environmental knowledge stocks and capabilities, enabling more effective CE initiatives and waste/resource improvements; (2) GKM acts as a mediator by converting codified and tacit environmental knowledge into actionable processes and innovations that improve CEP indicators such as resource efficiency, waste reduction, and circular supply chain performance; (3) digital orientation and knowledge management capabilities amplify these effects by supporting knowledge diffusion and codification across the organization[24,11-15]. Sectoral context and DEI considerations can condition the strength of the CHRM–GKM–CEP pathway, with stronger links in firms under strong governance pressures and mature CE ecosystems[18-19]. Overall, the literature converges on CHRM shaping GKM, which in turn drives CEP, particularly when learning culture and digital KM infrastructures are in place [12,15,17,21,23]. The conceptual model illustrating the relationship among variables is presented in **Figure 1**.

This study proposes an integrative framework linking CHRM, green knowledge management, and circular economic performance through a mediating mechanism rooted in intrinsic motivation. By focusing on psychological processes, this research addresses the lack of theoretical clarity in prior studies and contributes to a more nuanced understanding of how CHRM drives circular outcomes.

In line with the objectives of the study, the following hypotheses proposed :

H1: CHRM has a significant effect on CEP,

H2: CHRM has a significant effect on GKM.

H3: GKM has a significant effect on CEP.

H4: CHRM has a significant effect on CEP through the GKM.

H5: EL moderates the relationship between CHRM and CEP.

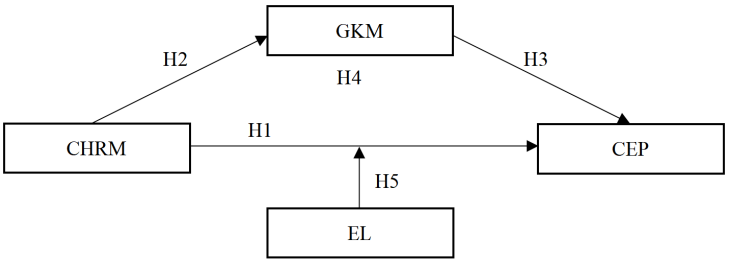

Figure 1. Research design.

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2. Materials and methods

2.1. Research design

This study adopts a quantitative research approach to examine the relationships between CHRM, GKM, and CEP. A survey-based method was employed to collect primary data from manufacturing firms in Indonesia. The quantitative design is considered appropriate as it enables the testing of hypothesized relationships and the examination of mediation effects within a structured model.

2.2. Population and sample

The population of this study consists of manufacturing companies in Indonesia across several key sectors, including electronic, metal and steel, food and beverage, automotive, plastic and packaging, and textile and garment industries. These sectors were selected due to their significant contribution to industrial activities and environmental impact, as well as the limited number of studies examining circular economy practices within the human resource management domain in these industries. The demographic respondent can be seen in **Table 1**.

A purposive sampling technique was applied to ensure that only relevant organizations were included in the study. Specifically, the sample was limited to companies that have implemented green initiatives, as these organizations are more likely to adopt circular practices and sustainability-oriented HRM systems. A total of 498 questionnaires were distributed, of which 250 valid responses were collected, resulting in a response rate of approximately 51%. This response rate is considered acceptable for organizational-level research and provides sufficient data for statistical analysis.

Table 1. Demographic respondent.

Demographic Respondent	Category	Frequency (n=250)	%
Gender	Male	133	53,2
	Female	117	46,8
Age	26-30	93	37,2
	31-35	105	42
	36-40	25	10
	>40	27	10,8
Type of Manufacturing Company	Electronic	36	14,4
	Metal and Steel	6	3,2
	Food and Beverage	86	34,4
	Otomotif	35	14
	Plastic and Packaging	5	2
	Textil and Garment	80	32

The demographic distribution of the 250 respondents indicates a relatively balanced gender composition, with male respondents accounting for 53.2% (n = 133) and female respondents comprising 46.8% (n = 117). This proportional representation suggests that the findings are unlikely to be significantly biased by gender dominance, thereby enhancing the generalizability of the results across male and female employees in the manufacturing sector. In terms of age, the majority of respondents fall within the productive age range of 26–35 years. Specifically, 42% (n = 105) are aged 31–35, followed by 37.2% (n = 93) in the 26–30 age group. Meanwhile, respondents aged 36–40 and above 40 contribute relatively smaller proportions, at 10% (n = 25) and 10.8% (n = 27), respectively. This indicates that the sample is dominated by early- to mid-career employees, who are typically more adaptable to organizational change and innovation practices. Regarding the type of manufacturing company, respondents are primarily drawn from the food and beverage sector (34.4%, n = 86) and textile and garment industry (32%, n = 80), followed by electronic (14.4%, n = 36) and automotive sectors (14%, n = 35). In contrast, metal and steel (3.2%, n = 6) as well as plastic and packaging industries (2%, n = 5) are underrepresented. This distribution suggests that the study findings are more reflective of labor-intensive and consumer-oriented manufacturing industries, which may have different organizational dynamics compared to capital-intensive sectors.

2.3. Data collection procedure

Data were collected using a structured questionnaire distributed through the Populix platform. The

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use of an online survey enabled efficient access to respondents across different regions and industries. All measurement items were assessed using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to capture respondents' perceptions of CHRM practices, knowledge management processes, and circular performance outcomes. Prior to full distribution, the questionnaire was reviewed to ensure clarity, relevance, and alignment with the research constructs.

2.4. Data analysis technique

The collected data were analyzed using Structural Equation Modeling based on Partial Least Squares (SEM-PLS) with the SmartPLS 4.0 software. SEM-PLS was selected due to its suitability for complex models involving mediation relationships, its robustness with relatively moderate sample sizes, and its ability to handle non-normal data distributions. The analysis procedure includes the evaluation of the measurement model (validity and reliability) and the structural model (path coefficients, coefficient of determination, and hypothesis testing) to assess the relationships among the constructs.

3. Results

3.1. Validity, reliability, Q square, f square, and Q^2 evaluation

Table 2. Validity and reliability.

Variables	Items	Loading	α	CR	AVE
Circular Human Resource Management (CHRM)	CHRM1	0.787	0.817	0.827	0.577
	CHRM2	0.766			
	CHRM3	0.818			
	CHRM4	0.719			
	CHRM5	0.710			
Green Knowledge Management (GKM)	GKM1	0.774	0.876	0.878	0.668
	GKM2	0.818			
	GKM3	0.816			
	GKM4	0.853			
	GKM5	0.825			
Ethical Leadership (EL)	EL1	0.820	0.915	0.931	0.671
	EL2	0.866			
	EL3	0.893			
	EL4	0.890			
	EL5	0.840			
	EL6	0.815			
	EL7	0.858			
Circular Economic Performance (CEP)	CEP1	0.807	0.897	0.901	0.621
	CEP2	0.843			
	CEP3	0.766			
	CEP4	0.826			
	CEP5	0.823			
	CEP6	0.781			
	CEP7	0.857			

Note.α: Cronbach's Alpha, CR: Composite Reliability, AVE: Average Variance Extracted.

The measurement model demonstrates robust psychometric properties (see **Table 2**). All indicator loadings exceed 0.70 (0.710–0.893), confirming strong indicator reliability with no items requiring elimination[25]. Internal consistency is well established, as both Cronbach's alpha (0.817–0.915) and composite reliability (0.827–0.931) surpass the recommended threshold of 0.70 (Hair et al., 2017)[25-26]. Convergent validity is also achieved, with AVE values ranging from 0.577 to 0.671, exceeding the minimum requirement of 0.50, indicating that each construct explains a substantial proportion of variance in its indicators[25-26]. Notably, Ethical Leadership exhibits the strongest measurement properties, reflecting a highly stable construct within the organizational context. Importantly, although Circular Human Resource Management (CHRM) shows relatively lower loadings on several items, all values remain acceptable. This suggests that CHRM captures a broader and more complex domain, supporting its positioning as

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an emerging construct within circular economy and sustainable HRM literature[27]. Furthermore, the measurement model satisfies the criteria for reliability and convergent validity, providing a solid foundation for subsequent structural model analysis and hypothesis testing[26].

Table 3. R square, f square and Q^2 evaluation.

R square	R-square	R-square adjusted
Circular Economic Performance (CEP)	0,813	0,810
Green Knowledge Management (GKM)	0,303	0,300
f-Square	GKM	CEP
Circular Human Resource Management (CHRM)	0,199	
Ethical Leadership (EL)	0,151	0,435
Green Knowledge Management (GKM)	0,213	
Construct	Q^2	
Green Knowledge Management (GKM)	0,353	
Circular Economic Performance (CEP)	0,813	

The R^2 value for CEP is 0.81, indicating that 81% of the variance in CEP is explained by the model, while the remaining 19% is attributed to external factors not included in this study. In contrast, the R^2 value for GKM is 0.30, suggesting that 30% of its variance is explained by the model, with 70% influenced by external variables. The evaluation of effect size (f^2) follows the criteria proposed by[25], where $f^2 < 0.02$ indicates a negligible effect, $f^2 > 0.02$ a small effect, $f^2 > 0.15$ a moderate effect, and $f^2 > 0.35$ a large effect. The results presented in **Table 3** indicate that CHRM has a significant and moderate effect on both GKM and CEP, with effect sizes exceeding 0.43. Furthermore, the predictive relevance (Q^2) values are 0.35 for GKM and 0.81 for CEP, both exceeding the threshold of 0.35. These results indicate that the model demonstrates strong predictive relevance for both endogenous constructs.

Table 4. Fornell-larcker criterion.

Variable	CEP	CHRM	EL	GKM
Circular Economic Performance	0.888			
Circular Human Resource Management	0.581	0.759		
Ethical Leadership	0.850	0.507	0.889	
Green Knowledge Management	0.873	0.550	0.880	0.818

The Fornell–Larcker criterion is considered valid when the square root of the Average Variance Extracted (AVE) for each construct exceeds its correlations with other constructs in the model[26]. The results of this study (see **Table 4**) indicate that the square root of AVE for each construct is higher than its corresponding inter-construct correlations. Therefore, the discriminant validity of the measurement model is established.

Table 5. Structural model result (direct and indirect effect).

Direct Effect		β	t-statistic	p-value	Result
H1	CHRM -> CEP	0.176	3.468	0.001	Supported
H2	CHRM -> GKM	0.550	6.335	0.000	Supported
H3	GKM -> CEP	0.446	5.085	0.000	Supported
Indirect Effect (Mediation)					
H4	CHRM -> GKM -> CEP	0.245	4.013	0.000	Supported
Indirect Effect (Moderation)					
H5	ELxCHRM -> CEP	0.094	2.532	0.011	Supported

The bootstrapping technique was employed to test the proposed hypotheses using 5,000 resamples in SmartPLS. **Table 5** and **Figure 2** present the results of the hypothesis testing. The findings indicate that CHRM has a significant positive effect on CEP (t-statistic = 3.468, p-value = 0.001), thus supporting H1. Furthermore, CHRM significantly influences GKM (t-statistic = 6.335, p-value = 0.000), confirming H2. The results also show that GKM has a significant positive effect on CEP (t-statistic = 5.085, p-value = 0.000), thereby supporting H3.

The indirect effect analysis reveals that GKM partially mediates the relationship between CHRM

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and CEP (t-statistic = 4.013, p-value = 0.000). This finding indicates that both the direct effect of CHRM on CEP and the indirect pathway through GKM are positive and statistically significant, confirming the presence of partial mediation. In addition, the moderation analysis demonstrates that ethical leadership (EL) strengthens the relationship between CHRM and CEP (t-statistic = 2.532, p-value = 0.011), indicating a significant moderating effect.

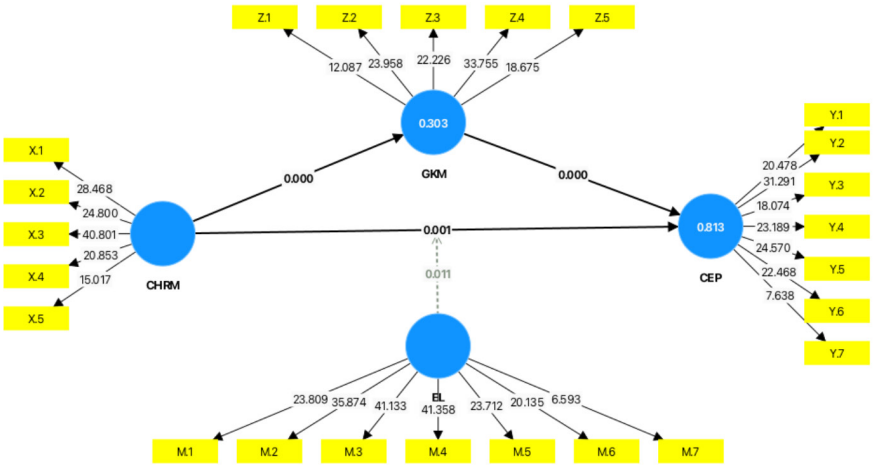

Figure 2. Boothstrapping analysis results.

4. Discussion

This study provides empirical and theoretical insights into the relationship between CHRM, GKM, and CEP, highlighting the critical mediating mechanisms underpinning sustainable organizational outcomes. The findings reinforce the growing consensus that sustainability-oriented HRM is not merely a supporting function but a strategic driver of circular performance.

First, the results confirm that CHRM plays a significant role in enhancing CEP, supporting prior studies that emphasize the importance of aligning HR practices with circular economy (CE) objectives[28-32]. CHRM practices such as green recruitment, environmental training, performance management, and reward systems contribute to the development of green skills and pro-environmental behavior, which ultimately improve resource efficiency and waste reduction outcomes[12,14,16,17]. This finding aligns with the argument that HRM systems designed around sustainability principles can directly influence organizational performance by embedding environmental values into employee behavior and operational routines[17,11]. Moreover, the integration of CHRM with organizational learning and digital technologies further strengthens its impact, suggesting that sustainability performance is contingent upon both human and technological capabilitie [13, 15].

Second, the findings demonstrate that CHRM significantly enhances GKM, reinforcing the argument that HRM practices are fundamental in building organizational knowledge capabilities[33-34]. CHRM contributes to the creation, dissemination, and application of green knowledge by fostering learning-oriented cultures and facilitating knowledge-sharing behaviors[12,21,23]. This result is consistent with prior studies suggesting that sustainability-oriented HRM acts as a catalyst for knowledge codification and diffusion, particularly when supported by digital infrastructures and Industry 4.0 technologies[13,15]. Therefore, CHRM can be viewed as a critical enabler of organizational learning processes that underpin green innovation and circular practices.

Third, this study confirms the pivotal role of GKM in enhancing CEP [35-36]. The findings indicate that GKM serves as a mechanism through which environmental knowledge is transformed into actionable capabilities, leading to improved circular performance outcomes such as resource efficiency, eco-innovation, and waste minimization[24,16,12]. This supports the notion that knowledge-based resources are central to achieving sustainable competitive advantage in circular economy contexts. Furthermore, the effectiveness of GKM is amplified in organizations with strong learning cultures and digital knowledge management systems, highlighting the importance of integrating human, technological, and organizational dimensions [15,13].

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Most importantly, the study reveals that GKM acts as a significant mediating variable in the relationship between CHRM and CEP. This finding extends previous literature by demonstrating that the impact of CHRM on circular performance is largely indirect, operating through knowledge-related mechanisms. CHRM enhances employees' environmental knowledge and capabilities, which are subsequently transformed into organizational processes and innovations through GKM, ultimately improving CEP . This mediation mechanism confirms that knowledge management is a crucial conduit linking HR practices to sustainability outcomes, as also highlighted in prior studies[12,17,21].

However, the strength of this mediating relationship is not uniform across contexts. The findings suggest that organizational culture, digital orientation, and governance pressures play moderating roles in shaping the effectiveness of the CHRM–GKM–CEP pathway[18-19]. Firms operating in environments with strong sustainability regulations and mature knowledge ecosystems tend to exhibit stronger relationships, indicating that external institutional factors are critical in reinforcing internal capabilities. This nuance highlights the importance of contextualizing sustainability strategies within specific industry and regional settings.

Overall, this study contributes to the literature by offering an integrated framework that links CHRM, GKM, and CEP through a motivational and knowledge-based lens. Unlike prior studies that examine these relationships in isolation, this research demonstrates how HRM practices, knowledge management, and circular performance are interconnected within a unified system. The findings underscore that achieving sustainable performance in the circular economy requires not only the implementation of green HR practices but also the effective management and utilization of environmental knowledge. Therefore, organizations must adopt a holistic approach that combines CHRM, learning culture, and digital capabilities to fully realize the potential of circular economy initiatives.

5. Conclusion

This study reveals that CHRM has a significant positive impact on CEP. Furthermore, GKM acts as a mediating mechanism in the relationship between CHRM and CEP. GKM has been proven to be a critical strategic asset, enabling organizations to transform environmental knowledge into actionable capabilities that enhance resource efficiency, waste reduction, and sustainable operational outcomes. For organizations operating within circular economy contexts, strategies that integrate sustainability-oriented HR practices, knowledge sharing, continuous learning, and digital knowledge systems are essential to strengthen competitive positioning in increasingly dynamic and sustainability-driven markets. The findings highlight that aligning human resource systems with knowledge management processes is key to generating sustainable value and achieving long-term circular performance. This study also recommends that future research explore the role of digital transformation, Industry 4.0 technologies, and circular business models in strengthening the effectiveness of CHRM and GKM in improving CEP.

This study is limited by its focus on GKM as a mediating variable in the relationship between CHRM and CEP. Other potentially influential factors, such as organizational culture, technological readiness, and institutional pressures, have not been fully examined. Moreover, the use of cross-sectional data limits the ability to capture dynamic changes and causal relationships over time.

Future research is encouraged to expand the model by incorporating additional internal and external variables that may influence circular economic performance. The use of longitudinal data is also recommended to provide a deeper understanding of the evolving relationships among variables. Expanding the research across different industries and regional contexts may further enhance the generalizability and robustness of the findings.

Author contributions

Conceptualization, M. and S.; methodology, V.L.R.; software, N.F.; validation, M.M., N.F. and S.; formal analysis, M.; investigation, V.L.R.; resources, N.F.; data curation, S.; writing—original draft preparation, M.; writing—review and editing, S.; visualization, N.F.; supervision, M.; project administration, V.L.R..; funding acquisition, N.F. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

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