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From Technology Leadership to Sustainability Commitment: Serial Mediation in Indonesia's Corrugated Box Industry

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ABSTRACT

This study examined how technology leadership was converted into organizational commitment to sustainability through green human resource management (Green HRM) and circular economy capability, while testing green knowledge sharing as a boundary condition. A descriptive quantitative survey involved 250 permanent middle- and upper-level managers, ranging from supervisors to general managers, who had worked for more than five years in corrugated carton-box manufacturing firms in Tangerang Regency, Indonesia. Forty reflective indicators were analyzed with partial least squares structural equation modeling in SmartPLS 3 and 5,000 bootstrap subsamples. Technology leadership positively affected Green HRM ($\beta = .479$, $p < .001$) and sustainability commitment ($\beta = .295$, $p < .001$). Green HRM predicted circular economy capability ($\beta = .556$, $p < .001$) and sustainability commitment ($\beta = .190$, $p = .001$), whereas circular economy capability was the strongest direct predictor of commitment ($\beta = .430$, $p < .001$). The serial indirect effect through Green HRM and circular economy capability was significant ($\beta = .115$, $p < .001$). Green knowledge sharing strengthened the Green HRM–commitment relationship ($\beta = .224$, $p < .001$). The model explained 60.2% of the variance in sustainability commitment. The findings identify circular economy capability as the operational mechanism that connects technology-oriented leadership and people-management architecture with durable sustainability commitment in resource-intensive manufacturing.

1. INTRODUCTION

Manufacturing firms are increasingly evaluated by how intelligently they use materials, energy, information, and human capability. This shift is particularly consequential for corrugated carton-box producers because their operations combine recovered fiber, paper, starch, ink, water, energy, trimming losses, and quality waste. Circular economy principles seek to retain material value and design out waste rather than accept a linear take–make–dispose pattern (Geissdoerfer et al., 2017; Ghisellini et al., 2016; Kirchherr et al., 2017; Korhonen et al., 2018). Indonesia's national waste policy and circular-economy agenda add institutional urgency to firm-level implementation (Bappenas, 2021; Republic of Indonesia, 2017).

Circular transition is not produced by technology alone. Digital production records, automated quality control, enterprise systems, energy monitoring, and traceability can reveal environmental losses, but their value depends on managerial priorities and employee routines. Technology leadership concerns leaders' capacity to formulate a technology-oriented vision, allocate digital resources, develop users' competence, support experimentation, and align technology with strategic objectives (Bongomin et al., 2020; Raman & Thannimalai, 2019; Weng & Tang, 2014). Upper echelons theory suggests that such choices reflect leaders' cognition, values, and attention structures (Chuang et al., 2009; Hambrick, 2007; Hambrick & Mason, 1984; Waldman et al., 2004).

The mechanism through which this leadership orientation becomes sustainability commitment remains insufficiently specified. Green human resource management embeds environmental priorities in recruitment, training, appraisal, rewards, participation, and work design (Jabbour & Santos, 2008; Renwick et al., 2013; Tang et al., 2018). Shaikh et al. (2024) demonstrated that Green HRM mediates the relationship between technology leadership and organizational commitment to sustainability and that green knowledge sharing strengthens the Green HRM–commitment relationship. Their higher-education context, however, differs from manufacturing, where sustainability requires material-flow, equipment, product-design, and interorganizational reconfiguration.

This study addresses that gap by introducing circular economy capability as a second mediator. It conceptualizes the capability as a firm's capacity to sense circular opportunities, seize them through

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coordinated investments, and reconfigure routines and relationships (Khan et al., 2021; Scarpellini et al., 2020; Teece, 2007). It also retains green knowledge sharing as a moderator because operational environmental knowledge is distributed across production, quality, maintenance, procurement, design, sales, and HR (Khan et al., 2022; Nahapiet & Ghoshal, 1998; Rubel et al., 2021). The study consequently explains how technology leadership affects sustainability commitment through a serial people-to-process mechanism and under what knowledge conditions Green HRM becomes more influential.

2. LITERATURE REVIEW AND HYPOTHESIS

Theoretical integration

Four perspectives structure the model. Upper echelons theory locates technology leadership at the strategic apex. The ability–motivation–opportunity framework explains how Green HRM converts leadership priorities into workforce competencies, incentives, and participation opportunities (Appelbaum et al., 2000). Social capital theory explains why shared relationships and cognitive frames enable environmental knowledge to circulate (Allameh, 2018; Nahapiet & Ghoshal, 1998; Swanson et al., 2020). Finally, the dynamic capabilities view explains how firms sense, seize, and transform in response to circular opportunities (Eisenhardt & Martin, 2000; Teece et al., 1997; Teece, 2007). Together, these perspectives link managerial direction, people-management systems, knowledge exchange, operational reconfiguration, and strategic commitment.

Green HRM research consistently shows that environmental recruitment, development, performance management, rewards, and participation can support green behavior, citizenship, innovation, and organizational performance (Abbas et al., 2022; Ahmad & Umrani, 2019; Ahmad et al., 2021; Dumont et al., 2017; Fawehinmi et al., 2020; Haldorai et al., 2022; Hameed et al., 2020; Hooi et al., 2022; Kim et al., 2019; Obeidat et al., 2020; Pham et al., 2019; Ren et al., 2020; Saeed et al., 2019; Song et al., 2020). Reviews nevertheless emphasize the need to connect Green HRM with strategic and operational systems rather than treating it as an isolated bundle of practices (Mukherji & Bhatnagar, 2022; Renwick et al., 2016; Stahl et al., 2020; Yong et al., 2022).

Technology leadership, Green HRM, and sustainability commitment

Technology leadership establishes direction, legitimizes experimentation, and makes sustainability measurable through data visibility and digitally enabled accountability. It should therefore strengthen organizational commitment directly. It should also stimulate Green HRM because technology-oriented leaders need recruitment, training, appraisal, rewards, and employee involvement that support new digital-environmental routines. Green HRM then makes sustainability part of role expectations and daily problem solving, increasing persistent organizational commitment (Jansson et al., 2017; Lee et al., 2013; Shaikh et al., 2024).

H1: *Technology leadership has a positive effect on organizational commitment to sustainability.*

H2a: *Technology leadership has a positive effect on Green HRM.*

H2b: *Green HRM has a positive effect on organizational commitment to sustainability.*

H2c: *Green HRM mediates the relationship between technology leadership and organizational commitment to sustainability.*

Green knowledge sharing as a moderator

Green HRM does not automatically generate a shared sustainability orientation. Its influence should be stronger when employees donate environmental knowledge, request solutions, disseminate lessons, and apply colleagues' experience. Knowledge sharing allows training or appraisal targets to become collective problem-solving capacity rather than isolated compliance (Khan et al., 2022; Rubel et al., 2021).

H3: *Green knowledge sharing positively moderates the relationship between Green HRM and organizational commitment to sustainability.*

Circular economy capability and serial mediation

Circular transition requires sensing regulatory, technological, material, and market signals; seizing viable opportunities; and reconfiguring products, routines, assets, and interfirm relationships. These activities form a dynamic capability rather than a checklist of recycling practices (Amui et al., 2017; Khan et al., 2021; Kristoffersen et al., 2020; Santa-Maria et al., 2022). Green HRM supplies microfoundations for this capability by developing environmental competence, directing attention through appraisal and rewards, and enabling participation. Empirical work increasingly connects the human side of management with circular implementation and performance (Jabbour et al., 2019; Marrucci et al., 2022; Mishra et al., 2021; Prieto-Sandoval et al., 2019).

Circular economy capability should strengthen sustainability commitment because it converts aspiration into feasible action and organizational learning. When the firm can repeatedly identify opportunities, allocate resources, and reorganize operations, sustainability is more likely to survive short-term pressures. The proposed serial logic is therefore technology leadership → Green HRM → circular economy capability → sustainability commitment.

H4: *Green HRM has a positive effect on circular economy capability.*

H5: *Circular economy capability has a positive effect on organizational commitment to sustainability.*

H6: *Technology leadership positively affects organizational commitment to sustainability through the serial mediation of Green HRM and circular economy capability.*

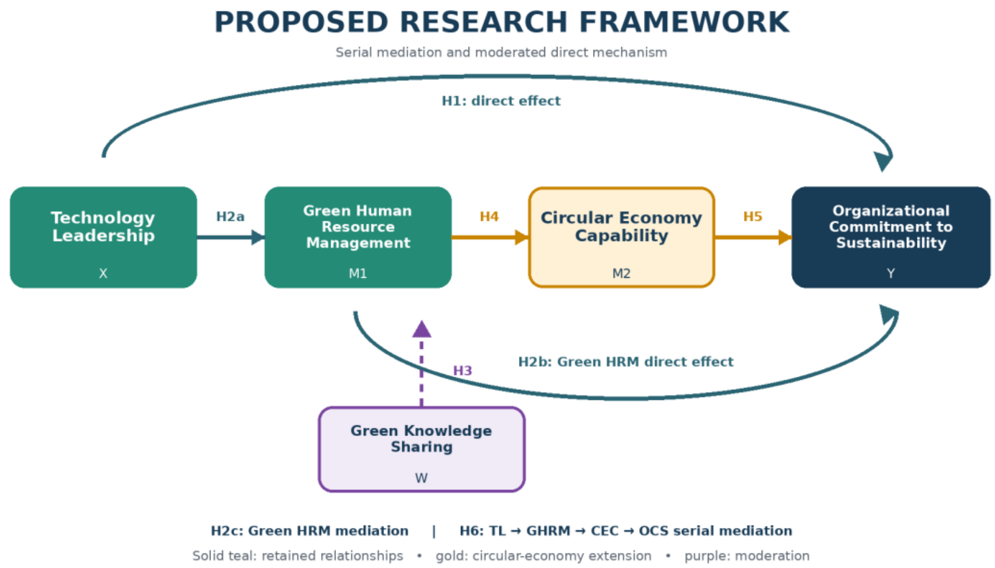

Figure 1. Proposed research framework

3. METHODS

The study employed a descriptive quantitative and explanatory survey design in corrugated carton-box manufacturing firms located in Tangerang Regency, Banten, Indonesia. Purposive sampling targeted permanent middle- and upper-level managers ranging from supervisors to general managers. Eligible respondents had worked for more than five years in the focal organization and possessed knowledge of operational, technological, human-resource, or sustainability practices. The final SmartPLS file contained 250 valid observations. With 40 substantive indicators, the sample exceeded the specified minimum of 200 based on five respondents per indicator and was adequate for the model's complexity (Cohen, 1992; Hair et al., 2017). Participation was voluntary, responses were confidential, and the organization was the conceptual referent of all items.

All substantive variables used a five-point agreement scale. Technology leadership was measured with eight indicators adapted from Weng and Tang (2014) and Shaikh et al. (2024). Green HRM used ten indicators based on Renwick et al. (2013), Tang et al. (2018), and Hooi et al. (2022). Green knowledge sharing comprised five indicators adapted from Rubel et al. (2021). Circular economy capability used nine indicators spanning sensing, seizing, and reconfiguring activities based on Khan et al. (2021), Scarpellini et al. (2020), and Teece (2007). Organizational commitment to sustainability was measured with eight indicators adapted from Jansson et al. (2017), Lee et al. (2013), and Shaikh et al. (2024). The field instrument was prepared for Bahasa Indonesia administration using conceptual translation and back-translation principles (Brislin, 1970).

The model was estimated in SmartPLS 3 (Ringle et al., 2015). Reflective measurement quality was assessed using outer loadings, Cronbach's alpha, rho_A, composite reliability, average variance extracted (AVE), the Fornell–Larcker criterion, and the heterotrait–monotrait ratio (HTMT). Preferred thresholds were .708 for loadings, .70–.95 for internal consistency, .50 for AVE, and .85 for HTMT (Bagozzi & Yi, 1988; Hair et al., 2012, 2019; Henseler et al., 2015, 2016). Structural assessment covered inner VIF, R^2, adjusted R^2, f^2, direct paths, specific indirect effects, and the Green HRM × green knowledge sharing interaction. Significance was evaluated with 5,000 bootstrap subsamples, two-tailed tests, and 95% confidence intervals. SRMR and NFI were treated as supplementary model-representation statistics, while predictive and common-method claims were bounded by the absence of PLSpredict, marker-variable, and full-collinearity outputs (Kock, 2015; Podsakoff et al., 2003; Shmueli et al., 2019; Spector, 2006).

4. RESULTS AND DISCUSSIONS

Results

All 40 indicators exceeded the .708 loading benchmark and were significant at $p < .001$. Loading ranges were .815–.872 for technology leadership, .807–.868 for Green HRM, .800–.899 for green knowledge sharing, .818–.863 for circular economy capability, and .838–.878 for organizational commitment to sustainability. Internal consistency and convergent validity were supported because alpha, rho_A, and composite reliability exceeded .70 and every AVE exceeded .50. Composite reliability marginally exceeded .95 for four constructs, indicating that future scale purification should examine possible item redundancy. Discriminant validity was supported because each square root of AVE exceeded the relevant correlations and all HTMT values were below .85; the maximum was .659.

Table 1. Reflective measurement-model assessment

Construct	α	rho_A	CR	AVE	Loading range
Technology leadership	.941	.944	.951	.710	.815–.872
Green HRM	.957	.957	.962	.719	.807–.868
Green knowledge sharing	.918	.950	.938	.751	.800–.899
Circular economy capability	.950	.951	.958	.715	.818–.863
Sustainability commitment	.947	.948	.956	.730	.838–.878

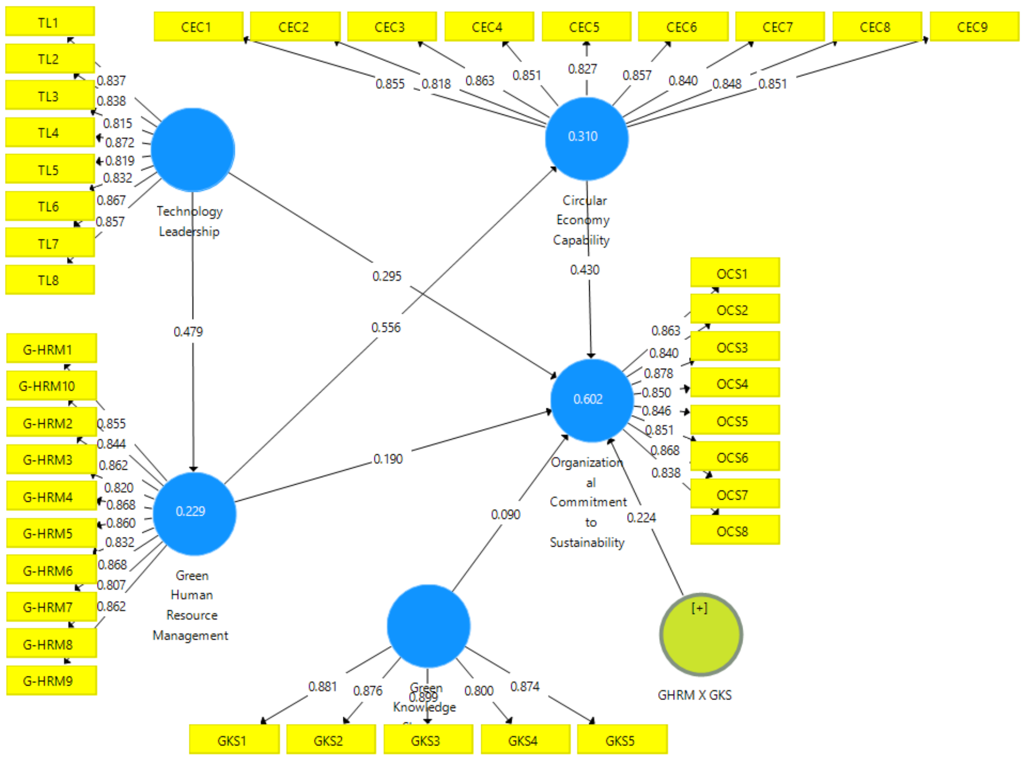

Figure 2. SmartPLS algorithm results: loadings, path coefficients, and R^2

Inner VIF values ranged from 1.000 to 1.693, indicating no problematic structural collinearity. The model explained 22.9% of Green HRM, 31.0% of circular economy capability, and 60.2% of organizational commitment to sustainability. The strongest local effects were Green HRM on circular economy capability ($f^2 = .449$) and circular economy capability on sustainability commitment ($f^2 = .317$). Technology leadership produced medium effects on Green HRM ($f^2 = .298$) and commitment ($f^2 = .160$), whereas the direct Green HRM effect was small ($f^2 = .053$) and the interaction was small-to-moderate ($f^2 = .132$).

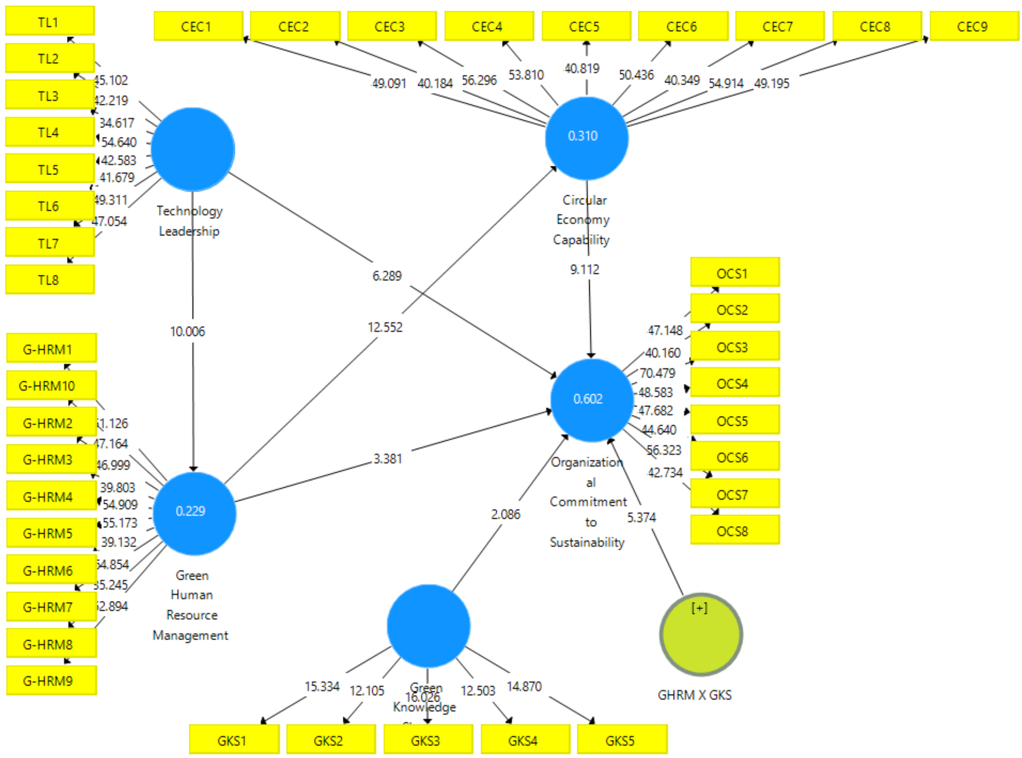

Figure 3. SmartPLS bootstrapping results based on 5,000 subsamples

Table 2. Structural, mediation, and moderation results

H	Effect	β	t	p	95% CI	f²	Decision
H1	TL → OCS	.295	6.289	<.001	[.208, .387]	.160	Supported
H2a	TL → GHRM	.479	10.006	<.001	[.391, .572]	.298	Supported
H2b	GHRM → OCS	.190	3.381	.001	[.088, .292]	.053	Supported
H3	GHRM × GKS → OCS	.224	5.374	<.001	[.140, .299]	.132	Supported
H4	GHRM → CEC	.556	12.552	<.001	[.467, .635]	.449	Supported
H5	CEC → OCS	.430	9.112	<.001	[.333, .532]	.317	Supported
H2c	TL → GHRM → OCS	.091	3.170	.002	[.041, .148]	—	Supported
—	GHRM → CEC → OCS	.239	7.441	<.001	[.185, .306]	—	Significant
H6	TL → GHRM → CEC → OCS	.115	6.022	<.001	[.082, .157]	—	Supported
—	Total indirect TL → OCS	.205	6.382	<.001	[.144, .273]	—	Significant
—	Total effect TL → OCS	.501	12.609	<.001	[.427, .581]	—	Significant

All hypothesized direct effects were positive and significant. Circular economy capability was the strongest direct predictor of sustainability commitment (β = .430), followed by technology leadership (β = .295), the interaction (β = .224), and Green HRM (β = .190). The indirect Technology Leadership → Green HRM → Commitment effect supported H2c. Because the direct technology-leadership effect remained significant, Green HRM provided complementary partial mediation. The serial indirect effect supported H6 and represented approximately 22.9% of the total technology-leadership effect; all indirect routes together represented about 41.0%. The significant interaction supported H3. Conditional standardized slopes calculated from the model were approximately −.034 at low green knowledge sharing, .190 at its mean, and .414 at high green knowledge sharing. SRMR was .039 for the saturated model and .042 for the estimated model, while NFI was approximately .903.

Discussion

Technology leadership affected sustainability commitment both directly and through Green HRM. This finding extends upper echelons reasoning by showing that leaders' technology orientation shapes not only digital adoption but also environmental priorities, resource allocation, information visibility, and accountability. In carton-box manufacturing, digital yield, quality, energy, maintenance, and traceability information can connect sustainability targets with operational control. The technology leadership–Green HRM path further shows how strategic priorities become institutionalized through workforce systems, consistent with Shaikh et al. (2024) and established Green HRM evidence.

The central contribution lies in the serial people-to-process mechanism. Green HRM strongly predicted circular economy capability, and circular economy capability was the most influential direct predictor of commitment. Environmental recruitment, training, appraisal, rewards, and participation develop the competence and motivation required to identify material losses, evaluate circular opportunities, coordinate projects, and reconfigure routines. The result integrates AMO theory and the dynamic capabilities view: Green HRM provides microfoundations, while circular economy capability converts those human contributions into repeatable operational change. Commitment becomes credible when the organization can act on its environmental aspirations rather than merely communicate them.

Green knowledge sharing strengthened the Green HRM–commitment relationship. At a high level of sharing, the conditional Green HRM slope was more than twice the slope at the mean; at a low level, it was essentially absent. Social exchange across production, quality, maintenance, procurement, design, sales, and HR therefore activates the potential of formal environmental HR practices. Training and incentives are less likely to create collective commitment when lessons remain local, whereas cross-functional exchange turns experience with trim waste, defects, recyclable design, and customer requirements into organizational knowledge.

The model's 60.2% explained variance indicates that leadership, HR architecture, operational capability, and knowledge conditions jointly provide substantial insight into sustainability commitment. For theory, the results distinguish commitment, capability, and HR practices as related but non-substitutable constructs. For practice, leaders should connect technology investment with explicit sustainability use cases; HR managers should incorporate environmental competencies and targets into the employee lifecycle; and operations managers should organize circular initiatives as a portfolio of sensing, seizing, and reconfiguration activities. Cross-functional green kaizen meetings, lessons-learned repositories, shift handovers, supplier–customer design forums, and recognition for knowledge contribution can reinforce the moderation mechanism.

5. CONCLUSION

Technology leadership strengthened organizational commitment to sustainability directly and through Green HRM. Green HRM also developed circular economy capability, which provided the strongest direct route to commitment. The significant serial pathway demonstrates that technology-oriented leadership becomes durable sustainability commitment when it is translated first into people-management architecture and then into the capability to sense, seize, and reconfigure circular opportunities. Green knowledge sharing amplified the contribution of Green HRM, confirming that formal practices and collective learning operate as complements.

Managers in corrugated carton-box manufacturing should therefore align digital investments, Green HRM, circular project governance, and cross-functional knowledge infrastructure. Future research should apply longitudinal or intervention designs, combine managerial perceptions with objective measures such as fiber yield, trim waste, recycled-content use, energy intensity, and project completion, and replicate the model across packaging sectors and regions. The observational, single-sector design and absence of PLSpredict, marker-variable, firm-clustering, and demographic-profile outputs limit causal, predictive, and subgroup conclusions. Further studies should also compare first-order and higher-order circular-capability specifications and refine potentially redundant scale items.

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Appendix. Research Measurement Instrument

All items use a five-point agreement scale: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree. Respondents answer with reference to their current organization.

Table A. Technology Leadership (8 items)

Code	Dimension	Questionnaire statement
TL1	Strategic vision	Top management communicates a clear vision for using technology to improve operational and environmental performance.
TL2	Strategic alignment	Technology priorities are explicitly aligned with our organization's sustainability objectives.
TL3	Investment	Leaders allocate adequate resources to technologies that improve material, energy, and process efficiency.
TL4	Infrastructure	Leaders ensure that relevant production and environmental information is supported by reliable digital infrastructure.
TL5	Capability support	Managers provide employees with opportunities to develop the technological competencies required for their work.
TL6	Experimentation	Leaders encourage responsible experimentation with technologies that may reduce waste or improve circularity.
TL7	Data governance	Leaders expect operational and sustainability decisions to be supported by accurate and timely data.
TL8	Evaluation	Management regularly evaluates the benefits, risks, and sustainability contribution of technology initiatives.

Table A. Green Human Resource Management (10 items)

Code	Dimension	Questionnaire statement
GHRM1	Recruitment	Environmental responsibilities are considered when recruiting or selecting employees for relevant positions.
GHRM2	Job design	Environmental duties are clearly incorporated into relevant job descriptions and work roles.
GHRM3	Training	Employees receive training that develops the knowledge and skills needed to achieve environmental goals.
GHRM4	Development	Leadership and career-development activities prepare managers to handle environmental and circular-economy challenges.
GHRM5	Objectives	Environmental objectives are included in the performance expectations of relevant employees and managers.
GHRM6	Appraisal	Performance appraisal considers contributions to environmental improvement.
GHRM7	Recognition	Employees who contribute useful environmental improvements receive recognition.
GHRM8	Rewards	Reward practices encourage the achievement of environmental and resource-efficiency targets.
GHRM9	Participation	Employees are given opportunities to propose and participate in environmental improvement initiatives.
GHRM10	Culture	HR practices consistently communicate that environmental responsibility is part of how our organization works.

Table A. Green Knowledge Sharing (5 items)

Code	Dimension	Questionnaire statement
GKS1	Knowledge donation	Employees willingly share ideas for reducing material, energy, water, or waste impacts.
GKS2	Experience sharing	Employees share lessons learned from environmental successes and failures.
GKS3	Knowledge collection	When facing an environmental problem, employees actively seek relevant knowledge from colleagues.
GKS4	Cross-functional exchange	Environmental knowledge is exchanged across departments and managerial levels.
GKS5	Application	Green knowledge shared within the organization is used in operational or managerial decisions.

Table A. Circular Economy Capability (9 items)

Code	Dimension	Questionnaire statement
CEC-S1	Sensing	Our organization systematically monitors material losses, production waste, and recovery opportunities.
CEC-S2	Sensing	Our organization identifies emerging customer, regulatory, and technological requirements related to circular packaging.
CEC-S3	Sensing	Our organization combines information from employees, suppliers, customers, and operations to identify circular opportunities.
CEC-Z1	Seizing	Our organization can rapidly evaluate the technical, environmental, and financial value of circular-economy opportunities.
CEC-Z2	Seizing	Management commits people, budgets, and technology to promising waste-prevention, reuse, recycling, or resource-efficiency initiatives.

Code	Dimension	Questionnaire statement
CEC-Z3	Seizing	Our organization coordinates internal functions and external partners to implement selected circular solutions.
CEC-R1	Reconfiguring	Our organization redesigns products or specifications to reduce material use and improve recyclability where feasible.
CEC-R2	Reconfiguring	Our organization modifies production routines and assets to prevent waste and retain material value.
CEC-R3	Reconfiguring	Our organization reconfigures supplier and customer relationships to support recovered materials, take-back, reuse, or closed-loop flows.

Table A. Organizational Commitment to Sustainability (8 items)

Code	Dimension	Questionnaire statement
OCS1	Strategic integration	Sustainability is explicitly integrated into our organization's strategy and major plans.
OCS2	Leadership priority	Senior management consistently treats sustainability as an organizational priority.
OCS3	Resource commitment	Our organization commits sufficient resources to pursue its sustainability objectives.
OCS4	Decision criterion	Environmental and social consequences are considered in important business decisions.
OCS5	Accountability	Managers are held accountable for progress toward sustainability objectives.
OCS6	Persistence	Our organization continues sustainability initiatives even when benefits require time to materialize.
OCS7	Stakeholder engagement	Our organization works with employees, suppliers, customers, and other stakeholders to advance sustainability.
OCS8	Continuous improvement	Our organization regularly reviews and strengthens its sustainability policies and practices.