Jurnal Minfo Polgan
Volume 14, Nomor 2, September 2025
DOI : https://doi.org/10.33395/jmp.v14i2.15938
e-ISSN : 2797-3298
p-ISSN : 2089-9424

Digital Readiness And Green Human Resource Management For Eco-Innovation In Indonesian Manufacturing

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Submitted : Aug 03, 25 | **Accepted** : Sep 25, 2025 | **Published** : Sep 27, 2025

ABSTRACT

This study examines how digital readiness and green human resource management (GHRM) shape eco-innovation in Indonesian manufacturing firms. Survey data were collected from 300 senior managers across HR, operations, information technology and sustainability functions and analysed using partial least squares structural equation modelling (PLS-SEM). Digital readiness is positively related to eco-innovation (β=0.349) and to the implementation intensity of GHRM (β=0.364), while GHRM is positively associated with eco-innovation (β=0.345). Mediation analysis indicates that GHRM partially transmits the effect of digital readiness on eco-innovation (indirect β=0.126). The hypothesised moderating effects of environmental regulatory pressure and green organisational culture, and the digital readiness-GHRM interaction, are not supported. The findings position HRM as an integrative capability within the twin transition and suggest that firms can strengthen eco-innovation by aligning digital capability development with coherent green HR systems

Keywords: *Digital Readiness; Eco-Innovation; Green Human Resource Management; Indonesia; Manufacturing.*

ABSTRAK

Penelitian ini mengkaji bagaimana kesiapan digital dan Green Human Resource Management (GHRM) membentuk eco-innovation pada perusahaan manufaktur di Indonesia. Data survei dikumpulkan dari 300 manajer senior yang mewakili fungsi sumber daya manusia, operasi, teknologi informasi, dan keberlanjutan, kemudian dianalisis menggunakan partial least squares structural equation modelling (PLS-SEM). Hasil penelitian menunjukkan bahwa kesiapan digital berhubungan positif dengan eco-innovation (β = 0,349) dan dengan intensitas implementasi GHRM (β = 0,364), sementara GHRM juga berasosiasi positif dengan eco-innovation (β = 0,345). Analisis mediasi menunjukkan bahwa GHRM secara parsial mentransmisikan pengaruh kesiapan digital terhadap eco-innovation (β tidak langsung = 0,126). Efek moderasi yang dihipotesiskan dari tekanan regulasi lingkungan dan budaya organisasi hijau, serta interaksi antara kesiapan digital dan GHRM, tidak didukung secara empiris. Temuan ini menempatkan manajemen sumber daya manusia sebagai kapabilitas integratif dalam kerangka twin transition dan menunjukkan bahwa perusahaan dapat memperkuat eco-innovation dengan menyelaraskan pengembangan kapabilitas digital dengan sistem GHRM yang koheren.

Kata Kunci: Eco-Innovation; Green Human Resource Management; Indonesia; Kesiapan Digital; Manufaktur.

INTRODUCTION

Manufacturing firms in Southeast Asia increasingly compete under the combined discipline of decarbonization and digitalization, as global buyers, investors, and regulators demand verifiable environmental performance along with cost and reliability (Kim et al., 2025; Nepal et al., 2021). In Indonesia, this dual pressure is amplified by industrial upgrading ambitions articulated in the "Making Indonesia 4.0" agenda, which encourages investment in connected production systems while elevating expectations of resource efficiency and environmental compliance (Hakim et al.,

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2023; Mursadi et al., 2024). For organizational leaders, the immediate challenge is not choosing between digital transformation and environmental responsibility but preventing the two initiatives from evolving into parallel programs with incompatible routines, fragmented accountability, and limited innovation yield.

Two research streams address this challenge but rarely converge. Work on digital transformation and sustainability commonly emphasizes how integrated systems, real-time monitoring, and analytics enable energy optimization, waste reduction, process control, and positioning digital maturity as an operational platform for environmental improvement (Liao et al., 2024; Trienens et al., 2024). In parallel, research on green human resource management highlights how staffing, training, performance management, rewards, and participation mechanisms can build environmental competence and strengthen employee engagement in sustainability. Digitalization studies often treat the workforce as an implementation constraint rather than a capability carrier, whereas green human resource management studies frequently underspecify the technological opportunity structure that determines whether environmental intentions become actionable experimentation and scalable innovation (Setyadi et al., 2025; Shamshuddin et al., 2025).

Capability-based framing has been adopted to address this deficit. The resource-based view argues that a sustained advantage depends on valuable, difficult-to-imitate resource bundles and organizational processes that integrate them into capabilities (Ciszewska-Mlinarič & Wasowska, 2015). Digital readiness is conceptualized as a platform capability that reflects the extent to which production and coordination are supported by integrated digital systems, connected equipment, interoperable data flows, and leadership commitment to digital experimentation (Qiao et al., 2024). Green human resource management is conceptualized as human capital capability that reflects the coherence and intensity of HR practices oriented toward environmental goals, including green recruitment and selection, green training and development, green performance management and rewards, and employee involvement in environmental improvement (Raja & Manoharan, 2024; Veerasamy et al., 2024). Eco-innovation can be more plausibly explained by the alignment of these capabilities than by either capability alone.

Complementarity logic is specified through the ability-motivation-opportunity theory, which explains how HR systems influence performance by strengthening abilities, shaping motivation, and creating opportunities for contribution through voice and participation mechanisms (Beltrán-Martín & Bou-Llusar, 2018; Gürbüz et al., 2025). In eco-innovation, the opportunity component is frequently constrained by the limited observability of environmental impact and coordination friction across functional boundaries. Digital readiness can expand an opportunity structure by enabling timely environmental data capture, cross-functional dashboards, and collaborative platforms that support experimentation and rapid iteration (Altassan, 2024; Din & Khan, 2025).

These three gaps motivate the empirical focus. Sustainability-oriented digital transformation research remains heavily operational in its explanatory emphasis, leaving HR system design underdeveloped as a primary mechanism shaping eco-innovation outcomes. Much of the evidence base remains concentrated in a limited set of East Asian contexts, offering incomplete insights into Indonesia, where industrial upgrading occurs alongside infrastructure asymmetries, evolving regulatory regimes, and uneven exposure to global buyer requirements across subsectors and ownership forms. Measurement practices frequently reduce digital transformation to adoption proxies, obscuring organizational conditions that are theoretically central to eco-innovation, including interoperability, analytics routines, workforce digital skills, and leadership support for experimentation and learning (Buntak et al., 2021; Dethine et al., 2025).

This study addresses these gaps by examining the relationships among digital readiness, green human resource management and eco-innovation in Indonesian manufacturing firms using a role-diversified survey of senior managers across HR, operations, information technology and sustainability functions, analysed with PLS-SEM. Digital readiness is operationalised as a multidimensional capability capturing digital infrastructure and systems, environmental data and analytics routines, workforce digital skills, and digital leadership and culture. Green human resource management is operationalised as an integrated HR system spanning recruitment and selection, training and development, performance management and rewards, and employee involvement in environmental management. Eco-innovation is assessed across product, process and organisational

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domains to reflect both technological and managerial changes that reduce environmental impact. Respondents were asked to answer with reference to their firm's policies and practices, and firm-level controls were included to account for observable differences in technology investment and environmental capabilities.

Against this backdrop, this study evaluates whether digital readiness is associated with eco-innovation, whether green human resource management is associated with eco-innovation, and whether green human resource management serves as a transmission mechanism linking digital readiness to eco-innovation in Indonesian manufacturing firms. Additional tests examine whether environmental regulatory pressure and green organizational culture condition these relationships.

LITERATURE REVIEW

Digital readiness has increasingly been theorized as the capability through which manufacturing firms restructure routines, accelerate learning cycles, and extend visibility across production systems. In sustainability-oriented manufacturing, connected equipment, interoperable information systems, and analytics routines enable firms to observe resource consumption, detect loss points, and evaluate process alternatives with greater temporal granularity than is possible under manual monitoring regimes (Bouyahrouzi et al., 2025; Huang et al., 2022). Empirical work in established industrial contexts suggests that such capabilities are associated with higher rates of green process improvements and, in some settings, green product development, largely because information friction and coordination costs are reduced when data can move across departments in near real-time (Fatorachian & Kazemi, 2025; Velmurugan et al., 2025). However, the dominant framing in this stream remains technology centric. Digital readiness is frequently treated as an asset that produces sustainability outcomes with limited theorization of how human systems shape the interpretation, adoption, and routinization of digitally enabled environmental improvement opportunities. This omission is consequential in manufacturing, where eco-innovation typically emerges from repeated experimentation, cross-functional negotiation, and frontline problem-solving rather than from technology acquisition (Bocken et al., 2014; Wijen & Duysters, 2005).

Green human resource management is commonly described as a system of HR practices designed to embed environmental objectives into workforce selection, development, evaluation, and participation (Din & Khan, 2025) . Evidence across sectors indicates that green recruitment, environmental training, performance management aligned with environmental metrics, rewards for green suggestions, and structured participation mechanisms can shape environmental capabilities and strengthen discretionary engagement with sustainability initiatives. Explanatory logic often relies on capability arguments, in which coherent practice bundles build rare and difficult-to-imitate human capital and behavioral routines relevant to environmental improvement, and on behavioral theories that connect HR signals to employee effort and initiatives (Finster & Hernke, 2014; Weller, 2019). However, literature tends to treat technology as peripheral. Digital systems are often included as control variables or background descriptors, rather than theorized as an enabling condition that alters what employees can do with green skills and motivation. Consequently, green human resource management is frequently linked to environmental performance without specifying whether the HR system operates within a digitally constrained environment or an environment that provides rich informational feedback and coordination infrastructure for eco-innovation (Ali et al., 2025; Raja & Manoharan, 2024).

An emerging body of work has begun to bridge digitalization and sustainable HRM by arguing that digital transformation reshapes skill requirements, managerial control systems, and participation channels, and that HR practices must adapt accordingly to deliver sustainability outcomes (Serna et al., 2025). This study suggests that digital tools can amplify environmental training through scalable learning platforms, strengthen feedback loops through dashboarding and monitoring, and widen employee participation through digital suggestion systems and collaboration platforms. However, the integration remains partial. Studies often examine digitalization and green HRM in parallel without placing eco-innovation at the center of the model or focus on isolated practices rather than treating green human resource management as an integrated system that converts digital capability into environmental innovation outcomes (Wu et al., 2023). Firm-level

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evidence clarifying whether digital readiness and green human resource management operate as complementary capabilities that jointly explain eco-innovation performance remains scarce.

These questions are particularly salient in the context of the emerging manufacturing economy. Eco-innovation in such settings often unfolds under constraints that differ from those in advanced industrial environments, including uneven digital infrastructure, heterogeneous managerial capacity, variable exposure to international buyer requirements, and domestic regulatory enforcement across sub-sectors and regions. In Indonesia, manufacturers face simultaneous demands for productivity upgrades and verifiable environmental performance, yet the capability base required for integrated green-digital transformation is not uniformly distributed. This creates a context in which the conversion of digital investments into eco-innovation plausibly depends on organizational systems that mobilize skills, incentives, and participation in environmental problem-solving, rather than toward efficiency gains (Lingling & Ye, 2023).

Integrative theoretical framework

A capability-based framework was used to integrate these studies. The resource-based view posits that sustained advantage arises when firms develop resource bundles that are valuable and difficult to imitate and when organizational processes integrate these resources into repeatable capabilities (Maijanen, 2020). Digital readiness is treated as a platform capability, because integrated systems, interoperable data flows, and digital leadership can expand the opportunity set for process redesign and performance monitoring. Green human resource management is treated as a human capital capability because coherent HR systems can build environmental competence, reinforce pro-environmental motivation, and institutionalize participation in environmental improvement routines (Deeksha et al., 2025). Eco-innovation is conceptualized as a performance domain that reflects product, process, and organizational changes that reduce environmental impacts and are not limited to compliance activities (García-Granero et al., 2020; Urbaniec, 2015).

To specify the mechanism through which capability alignment translates into eco-innovation, this study adopts ability–motivation–opportunity (AMO) theory as the primary microfoundation. AMO theory explains how HR systems influence performance-relevant behaviours by strengthening employees' abilities, shaping motivation and creating opportunities to contribute through participation and voice mechanisms (Jiang et al., 2012; Kang et al., 2025). In the eco-innovation domain, the opportunity component is frequently constrained by limited access to environmental data, slow feedback cycles and coordination frictions among production, maintenance, logistics and sustainability. Digital readiness can relax these constraints by enabling timely measurement of energy, emissions and waste, improving cross-functional visibility, and supporting structured experimentation through analytics and shared dashboards (Xu et al., 2023). Under this logic, green human resource management functions as an integrator that mobilises ability and motivation toward a digitally enabled opportunity structure, thereby increasing the likelihood that digital readiness yields eco-innovation rather than only incremental efficiency gains.

Hypotheses development

Digital readiness and eco-innovation

Digital readiness is expected to be positively associated with eco-innovation because integrated systems and analytics can reduce information asymmetries, improve the traceability of environmental impacts, and accelerate the evaluation of process alternatives (Sun et al., 2025; Zhang & Meng, 2023). From a resource-based view, these features constitute a higher-order capability that increases a firm's capacity to sense and exploit eco-innovation opportunities by making resource flows and loss points more visible and lowering coordination costs across functions (Liu et al., 2025; Wu et al., 2025).

H1: Digital readiness is positively related to eco-innovation performance in Indonesian manufacturing firms.

Green human resource management and eco-innovation

Green human resource management is expected to be positively associated with eco-innovation because it embeds environmental objectives into staffing, development, evaluation, rewards, and

e-ISSN : 2797-3298
p-ISSN : 2089-9424

participation, thereby shaping the competence and discretionary engagement required for innovation-oriented environmental improvement (Housheya & Atikbay, 2025; Song et al., 2021). Through the Ability-Motivation-Opportunity lens, green training and development strengthens ability, performance management, and rewards strengthen motivation, and involvement mechanisms expand opportunities for employees to propose and implement improvements that reduce environmental impact (Liu et al., 2024; Shoaib et al., 2021).
H2: Green human resource management is positively related to eco-innovation performance in Indonesian manufacturing firms.

Digital readiness and green human resource management
Digital readiness is expected to be positively related to green human resource management because digital infrastructure can expand the feasible set of HR processes and monitoring routines through which environmental objectives are operationalized. Digitally enabled learning systems can scale environmental training, digital performance tracking can support the integration of environmental indicators into appraisal cycles, and collaboration platforms can institutionalise participation and idea capture mechanisms that are otherwise costly to maintain (Mead et al., 2022; Tsai et al., 2025).
H3: Digital readiness is positively related to the implementation intensity of green human resource management practices.

Mediating role of green human resource management
Digital readiness can create informational and coordination advantages, yet eco-innovation requires behavioral mobilization: environmental data must be interpreted, acted upon, and translated into redesigned routines and products. Green human resource management is positioned as the mechanism through which digital readiness is converted into eco-innovation, because it builds green competencies and incentives that direct digitally enabled insights toward environmental improvement rather than toward narrow efficiency targets (Shukla & Pundhir, 2025).
H4: Green human resource management mediates the relationship between digital readiness and eco-innovation performance.

Boundary conditions
Environmental regulatory pressure can increase the salience of environmental objectives and shift managerial attention toward eco-innovation rather than treating digital investments solely as productivity levers. Under higher pressure, firms have stronger incentives to deploy digital capabilities to achieve measurable reductions in emissions, waste, and resource consumption, strengthening the relationship between digital readiness and eco-innovation (Qing et al., 2025; Zhang & Meng, 2023).
H5: Environmental regulatory pressure positively moderates the relationship between digital readiness and eco-innovation.

Green organizational culture can strengthen the credibility and acceptance of green HR practices by signalling that environmental objectives are valued beyond symbolic compliance. In such contexts, training, rewards, and participation mechanisms are more likely to be interpreted as authentic organisational commitments, which can increase discretionary engagement in eco-innovation efforts and reduce cynicism about green initiatives (Begum et al., 2025; Van Waeyenberg & Semeijn, 2025).
H6: Green organisational culture positively moderates the relationship between green human resource management and eco-innovation.

Capability complementarity
Eco-innovation is expected to be strongest when digital readiness and green human resource management are jointly high, because digital readiness increases the opportunity structure for environmental problem solving, while green human resource management provides the skills, motivation, and participation mechanisms required to exploit that opportunity (Liu et al., 2025; Sharma et al., 2025).

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e-ISSN : 2797-3298
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H7: The interaction between digital readiness and green human resource management is positively associated with eco-innovation.

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Conceptual framework

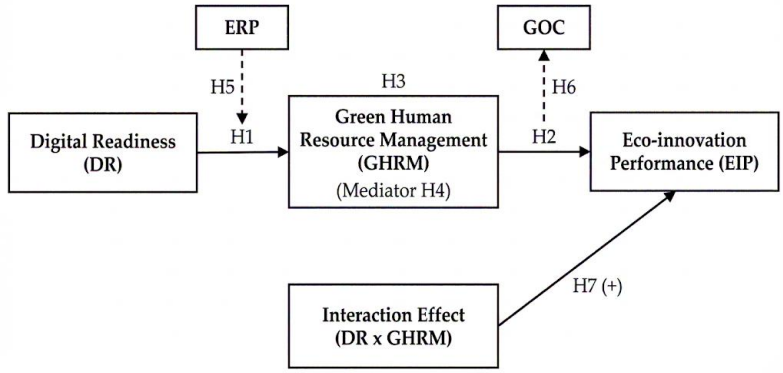

Figure 1. Conceptual framework linking digital readiness, green human resource management, and eco-innovation

RESEARCH METHOD

Research design and analytical approach

This study adopts a quantitative theory testing design and estimates the proposed relationships using partial least squares structural equation modelling (PLS-SEM). The analytical approach is appropriate for models with multiple latent constructs and an emphasis on prediction-oriented evaluation and supports inference via non-parametric bootstrapping to obtain confidence intervals for direct, indirect, and interaction effects (Shmueli et al., 2019).

Population, sampling frame, and respondents

The target population comprises medium and large manufacturing firms operating in Indonesia, with coverage across subsectors prominent in national industrial upgrading efforts, including automotive, food and beverage, palm oil processing, textiles and garments, and chemicals. The sampling frame was compiled from business directories and industry association lists to ensure the coverage of diverse industrial locations and ownership structures. A role-diversified key informant strategy was used to target senior managers with organizational visibility over digital systems, HR practices, and environmental initiatives. The respondents included HR managers, operations or production managers, information technology managers, and sustainability managers. The final dataset comprised 300 questionnaires.

To reduce shared-method artifacts, the survey emphasized confidentiality and aggregate reporting, used careful construct separation within the questionnaire, and incorporated attention checks and response pattern screenings during data cleaning. Firm size, firm age, ownership structure, export orientation, and subsector were included as controls, given their associations with technology investment and environmental innovation in manufacturing contexts.

Data collection procedures

Data collection used a structured online questionnaire complemented by follow-up contact to improve participation and reduce systematic non-responses from less-digitized firms. Instrument development incorporates expert reviews by academics and manufacturing practitioners to confirm the item clarity, contextual relevance, and content coverage. A pilot study of approximately 40 managers evaluated completion time, preliminary reliability, and item interpretability, leading to minor refinements.

Measures and operationalisation

All focal constructs were measured using multi-item Likert-type scales (1 = strongly disagree; 4 = strongly agree). The questionnaire was administered in Bahasa Indonesia, and translation and back-translation procedures were applied to ensure semantic equivalence.

Digital readiness was operationalized as a multidimensional capability reflecting digital infrastructure and systems, environmental data collection and analytics routines, workforce digital

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e-ISSN : 2797-3298
p-ISSN : 2089-9424

skills, and digital leadership and culture supportive of experimentation and cross-functional coordination (Khalayleh et al., 2024; Manana & Mawela, 2022). Green human resource management was operationalized as an integrated HR system spanning green recruitment and selection, green training and development, green performance management and rewards, and employee involvement in environmental management (Islam et al., 2022; Tari & Nirmala, 2023). Eco-innovation was operationalized as a multidimensional construct capturing green product innovation, green process innovation, and organizational eco-innovation practices, including formal environmental procedures and collaborative initiatives with external partners (Castiglione et al., 2021; Peng et al., 2024). Environmental regulatory pressure and green organizational culture were measured as contextual variables and modelled as moderators.

Data screening and analysis strategy

Data screening included checks for duplicate entries, inattentive responses, and logically inconsistent responses along with the evaluation of missingness patterns and item-level distributions. Potential non-response bias was assessed by comparing early and late respondents with key firm characteristics.

PLS-SEM estimation was conducted using SmartPLS 4 with a two-stage procedure. The measurement model was assessed for indicator reliability, internal consistency, convergent validity, and discriminant validity using the heterotrait-monotrait ratio, with thresholds treated as diagnostic guides rather than mechanical acceptance rules. The structural model was evaluated using bootstrapped path estimates with 5,000 resamples, reporting explanatory performance via coefficients of determination and local effect sizes, and predictive performance via predictive relevance indicators and PLS predictions where appropriate (Hair et al., 2021). Mediation was tested using bootstrapped indirect effects with confidence intervals. Moderation was tested using interaction terms and conditional effect estimations, with interaction plots used to support substantive interpretations.

RESULTS & DISCUSSION

The results were reported in a sequence that supported transparent inferences. Table 1 describes the characteristics of the sample and the firms. Table 2 presents the descriptive statistics and correlations for the composite construct scores. Tables 3 and 4 summarize the measurement model diagnostics. Tables 5-8 report the hypothesis tests, mediation evidence, and explanatory performance of the model.

Table 1. Sample and firm characteristics

Characteristic	Category	n	%
Respondent role	Ops/Production/Sustainability	116	38.7
	HR manager	97	32.3
	IT/Operations	31	10.3
	Sustainability manager	30	10.0
	General manager	26	8.7
Firm size (employees)	50–249	104	34.7
	<50	72	24.0
	250–499	49	16.3
	500–999	46	15.3
	≥1,000	29	9.7
Subsector	automotive	64	21.3
	food & beverages	59	19.7
	palm-oil processing	44	14.7
	textiles & garments	42	14.0
	chemicals	39	13.0
	other	52	17.3
Ownership	domestic	196	65.3
	foreign	56	18.7
	joint venture	48	16.0

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Characteristic	Category	n	%
Export orientation	mainly domestic	138	46.0
	balanced domestic & export	93	31.0
	mainly export	69	23.0
Environmental certification	Yes	194	64.7
	No	106	35.3

Table 2a. Descriptive statistics (composite construct scores)

Construct	Mean	SD	Min	Max
Digital readiness	3.017	0.314	2.0	4.0
Green human resource management	3.003	0.315	2.0	4.0
Eco-innovation	2.999	0.314	2.0	4.0
Environmental regulatory pressure	3.014	0.384	2.0	4.0
Green organisational culture	3.005	0.383	2.0	4.0

Table 2b. Correlations (composite construct scores)

Construct	Digital readiness	Green HRM	Eco-innovation	Regulatory pressure	Green culture
Digital readiness	1.0	0.364	0.494	0.424	0.394
Green human resource management	0.364	1.0	0.491	0.404	0.383
Eco-innovation	0.494	0.491	1.0	0.392	0.38
Environmental regulatory pressure	0.424	0.404	0.392	1.0	0.413
Green organisational culture	0.394	0.383	0.38	0.413	1.0

Table 3. Measurement model summary

Construct	Items	Cronbach alpha	Composite reliability	AVE	Loading min	Loading max
Digital readiness	16	0.913	0.936	0.495	0.344	0.782
Green human resource management	16	0.912	0.935	0.494	0.317	0.782
Eco-innovation	12	0.873	0.912	0.464	0.32	0.788
Environmental regulatory pressure	4	0.814	0.877	0.644	0.706	0.829
Green organisational culture	4	0.815	0.877	0.644	0.712	0.82

Table 4. Discriminant validity (HTMT)

Construct	Digital readiness	Green HRM	Eco-innovation	Regulatory pressure	Green culture
Digital readiness	1.000	0.419	0.577	0.503	0.468
Green human resource management	0.419	1.000	0.572	0.478	0.451
Eco-innovation	0.577	0.572	1.000	0.471	0.455

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Construct	Digital readiness	Green HRM	Eco-innovation	Regulatory pressure	Green culture
Environmental regulatory pressure	0.503	0.478	0.471	1.000	0.498
Green organisational culture	0.468	0.451	0.455	0.498	1.000

Measurement model diagnostics indicate high internal consistency reliability across constructs (Cronbach's alpha and composite reliability values exceed common thresholds). Discriminant validity is supported using the HTMT criterion (Table 4). Convergent validity for the broad, multidimensional focal constructs is marginal in the current specification (AVE values slightly below 0.50 in Table 3), and results are therefore interpreted with appropriate caution, with measurement refinement recommended in future research.

Table 5. Structural model results

Hypothesis	Path	Beta	CI 2.5%	CI 97.5%	Supported
H3	Digital readiness → Green HRM	0.364	0.257	0.471	Yes
H1	Digital readiness → Eco-innovation	0.349	0.242	0.457	Yes
H2	Green HRM → Eco-innovation	0.345	0.237	0.451	Yes
H5	Digital readiness × Regulatory pressure → Eco-innovation	-0.004	-0.112	0.105	No
H6	Green HRM × Green culture → Eco-innovation	0.038	-0.07	0.146	No
H7	Digital readiness × Green HRM → Eco-innovation	-0.052	-0.154	0.052	No

Table 6. Mediation results (bootstrapped confidence intervals)

Effect	Beta	CI 2.5%	CI 97.5%
Indirect: Digital readiness → Green HRM → Eco-innovation	0.126	0.081	0.176
Direct: Digital readiness → Eco-innovation	0.349	0.242	0.457

Table 7. Explained variance (R2)

Endogenous construct	R^2
Green HRM	0.174
Eco-innovation	0.371

Table 8. Conditional effects for moderation (simple slopes; standardised)

Hypothesis	Conditional path	Condition	Slope	CI 2.5%	CI 97.5%
H7	Digital readiness → Eco-innovation	Green HRM low (-1 SD)	0.401	0.26	0.543
H7	Digital readiness → Eco-innovation	Green HRM high (+1 SD)	0.297	0.162	0.434
H5	Digital readiness → Eco-innovation	Regulatory pressure low (-1 SD)	0.353	0.221	0.484
H5	Digital readiness → Eco-innovation	Regulatory pressure high (+1 SD)	0.344	0.212	0.476
H6	Green HRM → Eco-innovation	Green culture low (-1 SD)	0.307	0.174	0.44

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H6	Green HRM → Eco-innovation	Green culture high (+1 SD)	0.383	0.25	0.517

Digital readiness was positively associated with eco-innovation and green human resource management, and green human resource management was positively associated with eco-innovation (Table 5). The indirect effect of digital readiness on eco-innovation through green human resource management was supported, and the direct effect remained consistent with partial mediation (Table 6). Interaction terms involving regulatory pressure, green culture, and digital readiness by green human resource management complementarity were not supported, and the conditional effect patterns were modest (Tables 5 and 8).

DISCUSSION

The positive relationship between digital readiness and eco-innovation is consistent with the premise that digital infrastructure, interoperable systems, and data visibility lower the informational and coordination costs that often constrain environmental improvement in manufacturing. In Indonesia, where many firms operate under cost pressure and infrastructural unevenness, digital readiness plausibly functions to convert fragmented operational knowledge into actionable insights about energy, waste, and process variance. This interpretation aligns with the resource-based view, in which advantage is increasingly linked to the firm's ability to configure complementary assets into a coherent capability bundle rather than to acquire isolated technologies (Lee et al., 2021; Stieglitz & Heine, 2007). Digital readiness, framed as an organizational-level capability rather than as a checklist of tools, appears to support eco-innovation through improved sensing and internal integration, thereby enabling firms to identify and implement greener products, processes, and managerial practices.

Green HRM as a behavioural engine of eco-innovation.

The positive association between green human resource management and eco-innovation reinforces the argument that environmentally oriented HR systems are not solely symbolic. When recruitment, training, performance management, and employee involvement are aligned with environmental priorities, they appear to cultivate a workforce that is more likely to initiate and sustain eco-innovation. The results are consistent with AMO theory, which emphasizes that ability and motivation must be paired with opportunities for contribution. Green HRM plausibly shapes the skill base and incentive structure for environmental problem solving while also legitimizing the time and attention required to pursue improvements that may not yield immediate operational payoffs (Din & Khan, 2025; Raja & Manoharan, 2024). Social exchange theory further suggests that employees interpret sustained investment in green development as a signal of organizational commitment, which can encourage reciprocation through discretionary behaviors including participation in environmental initiatives and process improvement. The positive link observed between green HRM and eco-innovation is consistent with this reciprocity mechanism, although the present design does not directly observe employee-level reciprocity processes (Housheya & Atikbay, 2025).

Green HRM as a partial transmission mechanism

A central contribution of the model lies in clarifying how digital readiness translates into eco-innovation rather than assuming direct technological determinism. Mediation evidence indicates that green HRM transmits a meaningful portion of the effect of digital readiness on eco-innovation, while the direct effect of digital readiness remains. This partial mediation pattern suggests that HR systems constitute an important organizational conduit through which digital capability becomes environmentally productive but not the only conduit. One interpretation is that digital readiness enables eco-innovation through at least two pathways. The first is a sociotechnical pathway in which digital tools expand the opportunity space for employee involvement, training uptake, and performance monitoring, thereby strengthening green HRM practices and eco-innovation. The second is a more operational pathway in which digital readiness improves monitoring, traceability, and optimization directly at the process level, producing eco-innovation outcomes, even when the HR system intensity varies. This dual-path interpretation resonates with contemporary socio-

Jurnal Minfo Polgan
Volume 14, Nomor 2, September 2025 e-ISSN : 2797-3298
DOI : https://doi.org/10.33395/jmp.v14i2.15938 p-ISSN : 2089-9424

technical arguments that treat sustainability transitions as multi-level and multi-mechanism rather than as single-channel effects.

The positive relationship between digital readiness and green HRM strengthens this interpretation. Digital readiness appears to operate as a precursor to more sophisticated HR implementation, potentially by enabling scalable training platforms, data-supported appraisal routines, and more visible feedback loops on environmental performance. Digital readiness may reduce the transaction costs of embedding environmental objectives into HR processes, thus supporting the institutionalization of green HRM. The implication is conceptually important: digital transformation may not merely coexist with HRM, but may reshape the feasibility and fidelity of HR system implementation.

Boundary conditions and the absence of moderation effects

The moderation hypotheses were not supported, with interaction terms failing to exhibit robust effects despite the positive conditional slopes across high and low levels of moderators. This pattern warrants interpretation, rather than dismissal. The first possibility is substantive: in the Indonesian manufacturing setting, regulatory pressure and green organizational culture may operate more as baseline conditions that elevate overall environmental salience rather than as true boundary conditions that differentially strengthen or weaken focal capability-performance links. When regulatory regimes and cultural norms function as pervasive constraints and expectations, incremental variation may have limited leverage in moderating relationships driven by core capabilities (Ishwardat et al., 2024; Macgregor & Madsen, 2018).

A second possibility is measurement-related: moderators are often more difficult to detect in survey-based models, owing to attenuation from measurement errors and restricted variance. Even when the main effects are stable, interaction effects require stronger variance and higher precision to emerge as statistically distinct. The overlapping confidence intervals observed in the simple slope patterns are consistent with the view that conditional differences, if present, are small relative to the main effects. Under this interpretation, the practical message becomes clearer: the main effects of digital readiness and green HRM appear to be broadly relevant across varying levels of regulatory pressure and green culture, rather than being confined to a narrow set of contextual conditions. A third possibility concerns timing. Moderation effects may be more visible during periods of regulatory discontinuity or major cultural-change initiatives. If regulatory expectations and cultural norms evolve gradually, cross-sectional measurements may capture the presence of these conditions but not the moments when they sharply amplify capability deployment. Future multiwave designs that align measurements with regulatory changes or organizational culture interventions may be better positioned to capture such conditional dynamics (Bojesson & Fundin, 2020; Lucas & Kline, 2008).

Theoretical implications for HRM and the twin transition

The results contribute to the theory by positioning HRM as a strategic integrator within the twin transition rather than as an administrative support function. This mediation finding is particularly relevant to the long-standing critique that digitalization studies often undertheorize the human and organizational mechanisms through which technology produces outcomes. By empirically supporting green HRM as a pathway from digital readiness to eco-innovation, the evidence reinforces the argument that sustainability-oriented outcomes depend on the alignment between technical systems and HR architecture. This strengthens a capability-based view, in which eco-innovation emerges from the configuration of digital and human resources and not from technology adoption.

This study also refines AMO logic within sustainability research by suggesting that the opportunity component may be increasingly digitally constituted. When digital readiness is conceptualized as providing opportunity structures, such as real-time data access, cross-functional coordination, and performance visibility, it becomes easier to explain why green HRM succeeds in some settings and stalls in others. Under this interpretation, green HRM supplies ability and motivation, while digital readiness expands opportunities, thereby offering a coherent micro-foundational narrative of how firms mobilize eco-innovation. This integrated account responds to

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e-ISSN : 2797-3298
p-ISSN : 2089-9424

fragmentation in prior literature by explaining not only whether digital and HR systems matter, but also how they combine to produce environmental innovation outcomes.

Applied relevance in the Asia-Pacific context.

From an Asia-Pacific HRM perspective, the findings suggest that eco-innovation in manufacturing is shaped by both global pressure and local organizational capabilities. Indonesian firms face heightened expectations from international buyers and evolving domestic standards; however, the results imply that capability development within a firm remains decisive. The broad relevance of the main effects also indicates that digital readiness and green HRM are not niche strategies suitable only for highly regulated or culturally "green" organizations. Instead, they appear to constitute general-purpose foundations for eco-innovation across diverse organizational conditions. This contextual insight is aligned with the journal's applied orientation by identifying actionable organizational levers that are plausible within the constraints of emerging economy manufacturing.

The discussion suggests that the strategic question is not whether to pursue digitalization or sustainability, but how to sequence and integrate them through HR architecture. Digital readiness appears to provide infrastructure for environmental visibility and coordination, while green HRM provides a behavioral and capability base through which infrastructure is used productively. This framing provides a coherent platform for the subsequent implications section, where managerial logic can be translated into concrete guidance for HR leaders and operational decision-makers in Indonesian manufacturing.

Implications for practice and policy

Several applied implications follow for HR leaders and operational decision-makers in Indonesian manufacturing. First, digitalization initiatives should be treated as an organizational capability-building agenda rather than an isolated technology project. Investments in connected equipment, interoperable systems, and environmental dashboards are most likely to support eco-innovation when accompanied by routines that translate digital signals into structured experimentation and cross-functional problem-solving. Second, green human resource management should be designed as a coherent system, rather than as a series of disconnected initiatives. Selection criteria that prioritize environmental awareness, targeted training that links digital tools to environmental tasks, appraisal practices that include environmental objectives, and recognition for improvement ideas can jointly increase the likelihood that eco-innovation moves beyond compliance activities and becomes embedded in operations.

Third, the partial mediation pattern indicates that strengthening green human resource management can increase the probability that digital readiness is deployed toward environmental innovation rather than toward narrow efficiency gains. This suggests that digital capability programs should incorporate explicit HR components, including role-based training pathways, managerial coaching on interpreting environmental data, and participation mechanisms that capture and evaluate employee suggestions. Fourth, the absence of supported moderation implies that capability investments may remain valuable across varying levels of perceived regulatory pressure and green culture. This does not eliminate the importance of institutional and cultural contexts but suggests that HR architecture and digital readiness can provide a relatively general foundation for eco-innovation, even when external enforcement is uneven.

For policymakers and industry associations, these findings support interventions that lower the costs of capability development. Training partnerships subsidized digital upskilling aligned with environmental management, and sector-level guidance on integrating environmental indicators into workforce systems can help firms convert digital investments into credible eco-innovation outcomes. Where regulatory regimes are evolving, clearer guidance on measurement expectations and reporting standards can further increase the return on digital monitoring investments by making performance targets legible and comparable.

This study has limitations that inform interpretation and suggest opportunities for future research. First, the cross-sectional survey design does not permit strong causal inference; longitudinal or time-lagged designs could clarify temporal ordering and capability development dynamics. Second, although respondents were senior managers drawn from multiple functions, the design

remains perceptual; future studies could triangulate with objective environmental indicators, archival innovation measures, or verified multi-respondent aggregation at the firm level to further mitigate common method concerns. Third, convergent validity for the broad, multidimensional focal constructs is marginal in the current measurement specification (e.g., AVE values slightly below 0.50), suggesting that future work should refine measurement (for example, modelling higher-order dimensions and pruning weak items) and assess whether results replicate with alternative operationalisations. Finally, boundary conditions may operate at higher levels (e.g., industry-level regulation intensity, supply-chain governance or international customer requirements), which would be suitable for multi-level research designs.

CONCLUSION

This study examined how digital readiness and green human resource management (GHRM) shape eco-innovation in Indonesian manufacturing firms. The findings show that digital readiness is positively associated with eco-innovation and with the implementation intensity of GHRM, and that GHRM is positively associated with eco-innovation. Mediation results indicate that GHRM partially transmits the effect of digital readiness on eco-innovation, suggesting that digital capability development is more environmentally productive when it is aligned with coherent HR systems that build green abilities, motivate pro-environmental effort and create opportunities for employee participation. The boundary-condition tests for environmental regulatory pressure, green organisational culture and the digital readiness×GHRM interaction were not supported in the current specification, indicating that the core capability relationships are broadly relevant across varying perceived contextual conditions.

REFERENCES

Ali, S., Haidery, A., Dawood, J., Kamran, A., & Ahmed, O. (2025). Sustainable Banking: Exploring the Interplay of Eco-Friendly Behaviors, Cultural Dynamics, and Green HRM Strategies in Pakistan's Financial Landscape. In J. Xu, S. Dabo-Niang, N. A. Binti Ismail, & N. Gao (Eds.), The Nineteenth International Conference on Management Science and Engineering Management (Vol. 264, pp. 726–744). Springer Nature Singapore. https://doi.org/10.1007/978-981-95-1595-0_53

Altassan, M. (2024). The moderating mediating model of green climate and green innovation's effect on environmental performance. Uncertain Supply Chain Management, 12(1), 345–358. https://doi.org/10.5267/j.uscm.2023.9.016

Begum, S., Dong, W., Shahzad, K., Luu, T. T., & Ashfaq, M. (2025). How green training drives green process innovation and green product innovation: Testing the underlying mechanisms. Business Process Management Journal. https://doi.org/10.1108/BPMJ-10-2024-0985

Beltrán-Martín, I., & Bou-Llusar, J. C. (2018). Examining the intermediate role of employee abilities, motivation and opportunities to participate in the relationship between HR bundles and employee performance. BRQ Business Research Quarterly, 21(2), 99–110. https://doi.org/10.1016/j.brq.2018.02.001

Bocken, N. M. P., Farracho, M., Bosworth, R., & Kemp, R. (2014). The front-end of eco-innovation for eco-innovative small and medium sized companies. Journal of Engineering and Technology Management, 31, 43–57. https://doi.org/10.1016/j.jengtecman.2013.10.004

Bojesson, C., & Fundin, A. (2020). Exploring microfoundations of dynamic capabilities – challenges, barriers and enablers of organizational change. Journal of Organizational Change Management, 34(1), 206–222. https://doi.org/10.1108/JOCM-02-2020-0060

Bouyahrouzi, E. M., Benmimoun, R., El Kihel, Y., & Bajjou, M. S. (2025). Integrating industry 4.0 technologies and maintenance 4.0 for sustainable manufacturing: A systematic literature review. The International Journal of Advanced Manufacturing Technology, 140(1–2), 35–61. https://doi.org/10.1007/s00170-025-16194-3

Buntak, K., Kovačić, M., & Mutavdžija, M. (2021). Measuring Digital Transformation Maturity of Supply Chain. Tehnički Glasnik, 15(2), 199–204. https://doi.org/10.31803/tg-20200414191933

Castiglione, C., Yazan, D. M., Alfieri, A., & Mes, M. (2021). A holistic technological eco-innovation methodology for industrial symbiosis development. Sustainable Production and Consumption, 28, 1538–1551. https://doi.org/10.1016/j.spc.2021.09.002

Chen, D., & Wang, S. (2024). Digital transformation, innovation capabilities, and servitization as drivers of ESG performance in manufacturing SMEs. Scientific Reports, 14(1), 24516. https://doi.org/10.1038/s41598-024-76416-8

Ciszewska-Mlinarič, M., & Wasowska, A. (2015). Resource-Based View (RBV). In C. L. Cooper (Ed.), Wiley Encyclopedia of Management (1st ed., pp. 1–7). Wiley. https://doi.org/10.1002/9781118785317.weom060174

Deeksha, Mukherji, R. K., & Sharma, R. (2025). Employee Engagement in CSR: The Role of Green HRM in Building a Sustainable Culture. In V. Kandpal, A. K. Tripathy, & N. S. Bisht (Eds.), Developments in Corporate Governance (pp. 175–190). Springer Nature Singapore. https://doi.org/10.1007/978-981-96-6366-8_9

Dethine, B., Monticolo, D., Galvez, D., & Enjolras, M. (2025). Towards a tridimensionality model to measure the digital maturity of industrial small and medium enterprises. International Journal of Business Information Systems, 49(4), 571–600. https://doi.org/10.1504/IJBIS.2025.147812

Din, M. U., & Khan, M. F. (2025). Green HRM Bridging Sustainability and Workforce Management: In S. A. R. Khan & M. Tanveer (Eds.), Industrial Ecology and the Sustainable Development Goals (SDGs) (pp. 91–138). IGI Global. https://doi.org/10.4018/979-8-3373-0139-6.ch003

Fatorachian, H., & Kazemi, H. (2025). Green Manufacturing: Real-Time Monitoring with Smart Sensors for Enhanced Energy Efficiency. In M. Venkatesh, S. S. Appadoo, & M. R. Khan (Eds.), Green Manufacturing Technologies in Industry 5.0 (pp. 41–67). Springer Nature Singapore. https://doi.org/10.1007/978-981-95-0363-6_3

Finster, M. P., & Hernke, M. T. (2014). Benefits Organizations Pursue when Seeking Competitive Advantage by Improving Environmental Performance. Journal of Industrial Ecology, 18(5), 652–662. https://doi.org/10.1111/jiec.12106

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1), 39–50. https://doi.org/10.1177/002224378101800104

García-Granero, E. M., Piedra-Muñoz, L., & Galdeano-Gómez, E. (2020). Measuring eco-innovation dimensions: The role of environmental corporate culture and commercial orientation. Research Policy, 49(8), 104028. https://doi.org/10.1016/j.respol.2020.104028

Gürbüz, S., Bakker, A. B., & Brouwers, E. P. M. (2025). Shaping Work, Shaping Success: How HR Practices Drive Task Performance via Proactive Behaviors and Work Engagement. Human Resource Management Journal, 1748-8583.70010. https://doi.org/10.1111/1748-8583.70010

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R: A Workbook. Springer International Publishing. https://doi.org/10.1007/978-3-030-80519-7

Hakim, I. M., Singgih, M. L., & Gunarta, I. K. (2023). Critical Success Factors for Internet of Things (IoT) Implementation in Automotive Companies, Indonesia. Sustainability, 15(4), 2909. https://doi.org/10.3390/su15042909

Housheya, N., & Atikbay, T. (2025). The Role of Green HRM in Promoting Green Innovation: Mediating Effects of Corporate Environmental Strategy and Green Work Climate, and the Moderating Role of Artificial Intelligence. Sustainability, 17(16), 7238. https://doi.org/10.3390/su17167238

Huang, A., Triebe, M., Li, Z., Wu, H., Joung, B. G., & Sutherland, J. W. (2022). A review of research on smart manufacturing in support of environmental sustainability. International Journal of Sustainable Manufacturing, 5(2/3/4), 132–163. https://doi.org/10.1504/IJSM.2022.134556

Ishwardat, S., Van Steenbergen, E., Coffeng, T., & Ellemers, N. (2024). Stimulating Regulatory Compliance and Ethical Behavior of Organizations: A Review. Business Ethics and Leadership, 8(3), 151–172. https://doi.org/10.61093/bel.8(3).151-172.2024

Islam, M. A., Hack-Polay, D., Haque, A., Rahman, M., & Hossain, M. S. (2022). Moderating role of psychological empowerment on the relationship between green HRM practices and millennial

employee retention in the hotel industry of Bangladesh. Business Strategy & Development, 5(1), 17–29. https://doi.org/10.1002/bsd2.180

Jiang, K., Lepak, D. P., Hu, J., & Baer, J. C. (2012). How Does Human Resource Management Influence Organizational Outcomes? A Meta-analytic Investigation of Mediating Mechanisms. Academy of Management Journal, 55(6), 1264–1294. https://doi.org/10.5465/amj.2011.0088

Kang, S., Han, J. H., Oh, I.-S., Van Iddekinge, C., & Li, J. (2025). Do human resource systems indeed have "system" effects? The dual internal fit model of a high-performance work system. Journal of Applied Psychology, 110(4), 575–597. https://doi.org/10.1037/apl0001241

Khalayleh, W., Rohaida, S., & Al-Khazaleh, S. M. (2024). The Impact of Leadership Practices on the Adoption of Digital Transformation: The Moderating Role of Organizational Culture in Jordanian Manufacturing Sector. International Review of Management and Marketing, 14(6), 178–185. https://doi.org/10.32479/irmm.17079

Kim, H., Lee, Y., Koo, J.-H., & Yeo, M. J. (2025). Changes in future carbon dioxide emissions and contributing factors in Southeast Asia under the shared socioeconomic pathways. Energy for Sustainable Development, 86, 101721. https://doi.org/10.1016/j.esd.2025.101721

Lee, J. M., Narula, R., & Hillemann, J. (2021). Unraveling asset recombination through the lens of firm-specific advantages: A dynamic capabilities perspective. Journal of World Business, 56(2), 101193. https://doi.org/10.1016/j.jwb.2021.101193

Liao, F., Hu, Y., Chen, M., & Xu, S. (2024). Digital transformation and corporate green supply chain efficiency: Evidence from China. Economic Analysis and Policy, 81, 195–207. https://doi.org/10.1016/j.eap.2023.11.033

Lingling, L., & Ye, L. (2023). The impact of digital empowerment on open innovation performance of enterprises from the perspective of SOR. Frontiers in Psychology, 14, 1109149. https://doi.org/10.3389/fpsyg.2023.1109149

Liu, M., Huang, X., Wang, P., & Liao, Y. (2025). Enterprise digitalization, organizational slack, and green innovation. International Review of Economics & Finance, 103, 104443. https://doi.org/10.1016/j.iref.2025.104443

Liu, Y., Li, Y., Wang, H., & Liu, J. (2024). How does green culture impact corporate environmental responsibility? A dual perspective from ability-motivation-opportunity and organizational learning theory. Environment, Development and Sustainability, 27(7), 16155–16179. https://doi.org/10.1007/s10668-024-04627-0

Lucas, C., & Kline, T. (2008). Understanding the influence of organizational culture and group dynamics on organizational change and learning. The Learning Organization, 15(3), 277–287. https://doi.org/10.1108/09696470810868882

Macgregor, N., & Madsen, T. L. (2018). Regulation/Deregulation. In M. Augier & D. J. Teece (Eds.), The Palgrave Encyclopedia of Strategic Management (pp. 1411–1416). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-137-00772-8_440

Maijanen, P. (2020). 3 Approaches from strategic management: Resource-based view, knowledge-based view, and dynamic capability view. In M. B. Rimscha (Ed.), Management and Economics of Communication (pp. 47–68). De Gruyter. https://doi.org/10.1515/9783110589542-003

Manana, T., & Mawela, T. (2022). Digital Skills of Public Sector Employees for Digital Transformation. 2022 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT), 144–150. https://doi.org/10.1109/3ICT56508.2022.9990765

Mead, M. I., Bevilacqua, M., Loiseaux, C., Hallett, S. H., Jude, S., Emmanouilidis, C., Harris, J., Leinster, P., Mutnuri, S., Tran, T. H., & Williams, L. (2022). Generalised network architectures for environmental sensing: Case studies for a digitally enabled environment. Array, 14, 100168. https://doi.org/10.1016/j.array.2022.100168

Mursadi, R. A., Sin, T. C., Ramli, M. F., Hilmi, A. H. B., Ahmad, R., & Azmi, H. (2024). A review of industry 4.0 development progress in Indonesia. 050006. https://doi.org/10.1063/5.0180600

Nepal, R., Phoumin, H., & Khatri, A. (2021). Green Technological Development and Deployment in the Association of Southeast Asian Economies (ASEAN)—At Crossroads or Roundabout? Sustainability, 13(2), 758. https://doi.org/10.3390/su13020758

Peng, X., Fang, P., Lee, S., & Zhang, Z. (2024). Does executives' ecological embeddedness predict corporate eco-innovation? Empirical evidence from China. Technology Analysis & Strategic Management, 36(7), 1621–1634. https://doi.org/10.1080/09537325.2022.2106421

Qiao, G., Li, Y., & Hong, A. (2024). The Strategic Role of Digital Transformation: Leveraging Digital Leadership to Enhance Employee Performance and Organizational Commitment in the Digital Era. Systems, 12(11), 457. https://doi.org/10.3390/systems12110457

Qing, L., Ma, L., & Shen, Z. (2025). Digital technology and synergistic emissions reduction: CEOs' green experience. Journal of Innovation & Knowledge, 10(6), 100821. https://doi.org/10.1016/j.jik.2025.100821

Raja, L., & Manoharan, G. (2024). Nurturing Green Human Resource Management in Facilitating Organizational Effectiveness. 2024 3rd International Conference on Computational Modelling, Simulation and Optimization (ICCMSO), 188–192. https://doi.org/10.1109/ICCMSO61761.2024.00047

Serna, H. A. T., Calderón, R. R. D., León, D. H. C., & Pérez, G. H. (2025). The Digital Era and Job Performance: A Review of Recent Studies (2020–2024). In H. Masri, N. Elkadhi, K. Abdellah, & S. Aldulaimi (Eds.), Projects, Processes, Systems and Networks in the Digital Age (Vol. 1548, pp. 112–123). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-99025-0_9

Setyadi, A., Pawirosumarto, S., Damaris, A., & Syarif, D. (2025). Integrating green HRM and sustainable operations: The moderating role of digital transformation in the Indonesian energy sector. Discover Sustainability, 6(1), 924. https://doi.org/10.1007/s43621-025-01764-y

Shamshuddin, S., Baburao, C., Shaik, H., & Prasad, Y. V. V. V. S. S. S. V. (2025). Sustainable Employee Engagement and Retention: A Review of Green HRM and Digital Integration for Modern Workplaces. In P. Pujari, S. A. Khan, A. Kumar, & A. Naim (Eds.), Advances in Logistics, Operations, and Management Science (pp. 357–380). IGI Global. https://doi.org/10.4018/979-8-3693-8492-3.ch017

Sharma, C., Ahmad, S., Nisha, Kumar, S., Kumari, N., & Ahmad, R. (2025). Antecedents of environmental sustainability based on E-HRM approach: An empirical investigation. Green Technologies and Sustainability, 3(3), 100175. https://doi.org/10.1016/j.grets.2025.100175

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. European Journal of Marketing, 53(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189

Shoaib, M., Abbas, Z., Yousaf, M., Zámečník, R., Ahmed, J., & Saqib, S. (2021). The role of GHRM practices towards organizational commitment: A mediation analysis of green human capital. Cogent Business & Management, 8(1), 1870798. https://doi.org/10.1080/23311975.2020.1870798

Shukla, A., & Pundhir, S. K. S. (2025). Harnessing the Power of Digital Transformation to Promote Sustainable Growth Enabling Companies and Societies to Build a Durable and Inclusive Future: In S. Poddar & W. Ansar (Eds.), Sustainable Development Goals (SDG) and Its Intersection With Health and Well-Being (pp. 233–264). IGI Global. https://doi.org/10.4018/979-8-3693-9755-8.ch009

Song, W., Yu, H., & Xu, H. (2021). Effects of green human resource management and managerial environmental concern on green innovation. European Journal of Innovation Management, 24(3), 951–967. https://doi.org/10.1108/EJIM-11-2019-0315

Stieglitz, N., & Heine, K. (2007). Innovations and the role of complementarities in a strategic theory of the firm. Strategic Management Journal, 28(1), 1–15. https://doi.org/10.1002/smj.565

Sun, Z., Zhao, L., Mehrotra, A., Salam, M. A., & Yaqub, M. Z. (2025). Digital transformation and corporate green innovation: An affordance theory perspective. Business Strategy and the Environment, 34(1), 433–449. https://doi.org/10.1002/bse.3991

Tari, S. D., & Nirmala, R. (2023). Analyzing the effect of green human resource management to attain organizational sustainability. International Journal of System Assurance Engineering and Management, 14(6), 2095–2119. https://doi.org/10.1007/s13198-023-02033-9

Trienens, M., Rasor, R., Kharatyan, A., Dumitrescu, R., & Anacker, H. (2024). Digital twins to increase sustainability throughout the system life cycle: A systematic literature review. Proceedings of the Design Society, 4, 2277–2286. https://doi.org/10.1017/pds.2024.230

Tsai, S.-K., Chuang, T.-Y., & Lin, Z.-J. (2025). Enhancing Environmental Literacy Through Digital Game-Based Learning: A Technology-Integrated Attitude Change Approach. Sustainability, 17(16), 7416. https://doi.org/10.3390/su17167416

Urbaniec, M. (2015). Towards Sustainable Development through Eco-innovations: Drivers and Barriers in Poland. ECONOMICS & SOCIOLOGY, 8(4), 179–190. https://doi.org/10.14254/2071-789X.2015/8-4/13

Van Waeyenberg, T., & Semeijn, J. H. (2025). Different Shades of Green? The Role of Green HRM and Its Authenticity in Cultivating Employee Commitment to Environment and Organization. Business & Society, 00076503241312752. https://doi.org/10.1177/00076503241312752

Veerasamy, U., Joseph, M. S., & Parayitam, S. (2024). Green human resource management practices and employee green behavior. Journal of Environmental Planning and Management, 67(12), 2810–2836. https://doi.org/10.1080/09640568.2023.2205005

Velmurugan, R., Sudarvel, J., Bhuvaneswari, R., & Senthilkumar, S. (2025). Performance Optimization and Resource Management: Industrial IoT Applications and Smart Manufacturing. In Minakshi, T. Kumar, K. Joshi, A. Saxena, & D. K. J. B. Saini (Eds.), Building Data-Driven Edge Systems for Business Success (pp. 275–298). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3373-1147-0.ch011

Weller, I. (2019). Specific human capital: A matching perspective. In A. J. Nyberg & T. P. Moliterno (Eds.), Handbook of Research on Strategic Human Capital Resources. Edward Elgar Publishing. https://doi.org/10.4337/9781788116695.00018

Wijen, F., & Duysters, G. (2005). Negotiating innovation: Product renewal as the outcome of a complex bargaining process. R and D Management, 35(1), 73–87. https://doi.org/10.1111/j.1467-9310.2005.00373.x

Wu, Q., Wang, S., Zhou, A., Xia, B., Abruquah, L. A., & Chen, Z. (2023). Effects of digital transformation and environmental resource integration capability on medical equipment suppliers' green innovation performance. Scientific Reports, 13(1), 17559. https://doi.org/10.1038/s41598-023-44274-5

Wu, Y., Alsagr, N., Aman, A., & Suhail, A. (2025). Accelerating the Green Shift: How Green Digital Transformation Capabilities Foster Sustainable Innovation Performance Through Circular Economy Readiness and Business Innovation Environment. Corporate Social Responsibility and Environmental Management, csr.70340. https://doi.org/10.1002/csr.70340

Xu, J., Yu, Y., Zhang, M., & Zhang, J. Z. (2023). Impacts of digital transformation on eco-innovation and sustainable performance: Evidence from Chinese manufacturing companies. Journal of Cleaner Production, 393, 136278. https://doi.org/10.1016/j.jclepro.2023.136278

Zhang, W., & Meng, F. (2023). Enterprise Digital Transformation and Regional Green Innovation Efficiency Based on the Perspective of Digital Capability: Evidence from China. Systems, 11(11), 526. https://doi.org/10.3390/systems11110526

Zhao, Q., Li, X., & Li, S. (2023). Analyzing the Relationship between Digital Transformation Strategy and ESG Performance in Large Manufacturing Enterprises: The Mediating Role of Green Innovation. Sustainability, 15(13), 9998. https://doi.org/10.3390/su15139998