Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Green HRM, Green Leadership and Work Engagement in the Age of Artificial Intelligence: A Bibliometric–Systematic Review and Research Framework for Environmental Sustainability

Tumsela Asghar

muhammadali.latvia@gmail.com

Virtual University of Pakistan, Lahore, Pakistan

Research Article

Keywords: Green human resource management, Green transformational leadership, Green work engagement, Artificial intelligence, Environmental sustainability, Employee green behaviour, Job demands–resources theory, Bibliometric analysis, Systematic literature review, VOSviewer

Posted Date: October 29th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-11529229/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: The authors declare no competing interests.

Abstract

Purpose

Green human resource management (GHRM), green leadership and employee work engagement are each well established as levers of organisational environmental sustainability, and artificial intelligence (AI) is now entering the HR and leadership practices through which they operate. This review asks how these four literatures are structured, how far they have been connected, and what the available evidence implies about when AI strengthens or weakens the human pathway to environmental sustainability.

Design/methodology/approach

: A bibliometric–systematic review was conducted on 8,153 OpenAlex records (2010–2026). After PRISMA 2020-guided screening, 4,681 journal articles and reviews were mapped in VOSviewer 1.6.21 (term co-occurrence, overlay, density, reference co-citation and country co-authorship). A review set of 916 studies was coded for theory, design, sector and construct roles, and 87 intersection studies were critically appraised in depth.

Findings

The field has grown at 49.4% per year since 2015, yet its four streams remain weakly integrated: only 1.1% of documents examine GHRM, green leadership and engagement together, and only three also involve AI. Term mapping places AI in a firm-level capability cluster that is structurally distant from the leadership–engagement–behaviour cluster, and AI-linked studies rely on capability lenses (resource-based view, dynamic capabilities) rather than the employee-level theories that explain engagement. The few studies that test AI at the employee level report positive, null and negative effects, including AI awareness lowering green work engagement through job stress and AI substituting for green leadership.

Originality/value

The review provides the first quantitative evidence of the disconnection between AI research and the leadership–engagement mechanism of GHRM, and it develops a job demands–resources framework with seven propositions in which AI can act either as a green job resource or as a techno-demand. A theory–context–characteristics–methodology agenda and responsible-AI guidance for green people management are derived.

1 Introduction

Organisations are under sustained regulatory, investor and societal pressure to decarbonise operations, reduce waste and demonstrate credible progress on environmental targets. Because environmental strategies are ultimately enacted, or neglected, in employees' everyday decisions, human resource management (HRM) and leadership have become recognised levers of corporate environmental performance (Jackson et al., 2011; Renwick et al., 2013; Zacher et al., 2023). Green human resource

management (GHRM) the alignment of recruitment, training, performance management, rewards and involvement with environmental objectives is now one of the most active research streams in sustainable management, and a large body of evidence links it to employee green behaviour and to environmental performance (Dumont et al., 2017; Roscoe et al., 2019; Saeed et al., 2019; Yong et al., 2020). Two neighbouring streams have grown alongside it. Research on green leadership shows that leaders who articulate an environmental vision, role-model green behaviour and support followers' environmental initiatives promote pro-environmental behaviour and green innovation (Chen & Chang, 2013; Robertson & Barling, 2013; Singh et al., 2020). Research on work engagement, a positive, energised state of vigour, dedication and absorption (Schaufeli et al., 2002) has begun to examine *green* work engagement, the investment of this energy in environmental tasks, as a mechanism through which GHRM and leadership become behaviour (Aboramadan, 2022; Tran, 2023).

A fourth development is changing the conditions under which these mechanisms operate. Artificial intelligence (AI) machine learning, natural-language processing, predictive analytics and generative systems is being built into recruitment, learning, performance management and day-to-day leadership work (Budhwar et al., 2023; Pereira et al., 2023; Tambe et al., 2019). In principle, AI could make green HR practices more targeted, continuous and measurable, for example by personalising environmental training or providing real-time eco-feedback (Alherimi et al., 2025; Singh & Sinha, 2026). In practice, AI also reshapes work in ways that can undermine the psychological conditions on which engagement rests: algorithmic control, opacity and techno-stress are well documented in the broader AI-at-work literature (Kellogg et al., 2020; Parker & Grote, 2022; Tarafdar et al., 2019), and the energy demands of large models sit uneasily with claims that AI is inherently "green" (Strubell et al., 2019).

These literatures have developed rapidly but separately, and existing reviews mirror this separation. Bibliometric and systematic reviews have mapped GHRM as a whole (Bahuguna et al., 2023; Benevene & Buonomo, 2020), its links with employee green behaviour (Zhang, Panatik, & Zhang, 2024) and green climate (San Román-Niaves et al., 2025), its economic and innovation outcomes in meta-analyses (Bindeeba et al., 2025; Carballo-Penela et al., 2023), and, most recently, AI-enabled GHRM (Alherimi et al., 2025; Shetty et al., 2026; Singh & Sinha, 2026). None of them examines whether the AI literature has engaged with the leadership–engagement mechanism that the GHRM literature itself identifies as central, and none tests the degree of integration between the four streams empirically rather than asserting it. This matters for three reasons. First, if AI research treats AI mainly as a firm-level capability, its claims about environmental outcomes rest on an untested micro-foundation. Second, if engagement and leadership are studied without reference to AI, their findings may not transfer to increasingly algorithm-mediated workplaces. Third, without an integrative framework, the field cannot specify when AI amplifies and when it erodes the human pathway to environmental sustainability.

This article addresses these problems through a bibliometric–systematic review that combines science mapping of 4,681 documents with a coded review of 916 studies and in-depth appraisal of the studies at the intersections of the four streams.

It answers four research questions (RQs):

RQ1. How has research on GHRM, green leadership and work engagement for environmental sustainability developed, and what are its intellectual, conceptual and social structures?

RQ2. To what extent have the four streams GHRM, green leadership, engagement and AI been integrated, and where is AI located in the conceptual structure of the field?

RQ3. Which theories, designs and contexts dominate the integrative studies, and what do the studies that model AI at the employee level actually find?

RQ4. What integrative framework and research agenda can explain when AI strengthens or weakens the effects of GHRM and green leadership on green work engagement and environmental sustainability?

The study makes three contributions. First, it supplies the first quantitative evidence of the structural disconnection between AI research and the leadership–engagement mechanism of GHRM, using construct-intersection analysis, term co-occurrence and theory profiling rather than narrative assertion. Second, it re-reads the evidence through job demands–resources (JD-R) theory (Bakker & Demerouti, 2017; Demerouti et al., 2001) to propose that GHRM and green leadership influence environmental outcomes largely by shaping green job resources and demands, and that AI acts on exactly these resources and demands sometimes adding to them, sometimes depleting them. Third, it translates the synthesis into seven testable propositions and a theory–context–characteristics–methodology agenda that addresses the field's methodological weaknesses.

The article builds on, but is distinct from, the authors' earlier work. A 2026 conference paper with a similar title (Ali, Aziz, & Younis, 2026) offered a narrative overview of the same constructs without a systematic search, bibliometric analysis or verifiable corpus; the present article replaces it entirely with a reproducible evidence base. An empirical study by Ali, Peiseniece, and Mikelsone (2026) tested green HR practices and green leadership with green work *commitment* as the mediator in Pakistan and Uzbekistan; the present review does not re-analyse those data and focuses on engagement, a distinct construct, and on AI. A related preprint (Ali, Asghar, et al., 2026) mapped AI-enabled GHRM and employee engagement; the present article differs in scope (it adds green leadership and analyses the full GHRM corpus), in method (construct-intersection and theory-profile analyses, and a manually appraised evidence base on AI) and in theory (a JD-R dual-pathway framework).

The remainder of the article is organised as follows. Section 2 defines the constructs and theoretical lenses. Section 3 details the review protocol. Section 4 reports the bibliometric results, and Section 5 provides the critical synthesis. Section 6 develops the framework and propositions, Section 7 discusses contributions, the research agenda and implications, and Section 8 states limitations and conclusions.

2 Conceptual and theoretical foundations

2.1 Environmental sustainability and employee green behaviour

Organisational environmental sustainability refers to an organisation's capacity to reduce its ecological footprint while maintaining its operations over time. In the GHRM literature it is usually operationalised as environmental performance reductions in waste, emissions, energy and resource use, and compliance with environmental standards (Paillé et al., 2014; Roscoe et al., 2019). Its micro-foundation is employee green behaviour: the scalable actions that employees take that contribute to, or detract from, environmental sustainability (Norton et al., 2015; Ones & Dilchert, 2012). These include task-related green behaviours prescribed by the role and voluntary behaviours such as organisational citizenship behaviour for the environment (OCBE) (Boiral & Paillé, 2012). Meta-analytic evidence shows that employee green behaviour is related to a range of individual and contextual predictors, with effect sizes that vary by measurement and context (Katz et al., 2022). Distinguishing these levels matters: many studies infer "sustainability" from self-reported behaviour, which is a proximal and not a sufficient indicator of organisational environmental performance (Zacher et al., 2023).

2.2 Green human resource management

GHRM denotes HRM policies and practices that build employees' ability, motivation and opportunity to contribute to environmental objectives (Jackson et al., 2011; Renwick et al., 2013). Its practice domains include green recruitment and selection, green training and development, green performance management, green rewards and green employee involvement (Ren et al., 2018; Tang et al., 2018). Early work established that environmental management systems succeed only when supported by HR factors (Daily & Huang, 2001; Jabbour & Santos, 2008), and later research positioned GHRM as a coherent system rather than a collection of isolated practices (Dumont et al., 2017; Guerci et al., 2016). Its effects on environmental performance are well documented across manufacturing, hospitality, healthcare and services (Kim et al., 2019; Pham et al., 2020; Pinzone et al., 2016; Yong et al., 2020). Recent reviews nonetheless warn that GHRM can also have unintended negative consequences for employees, particularly when green claims are not matched by action (Ahmad & Sadiq, 2025).

2.3 Green leadership

Green leadership refers to leader behaviours that promote environmental objectives. The most studied form, green transformational leadership, comprises an inspiring environmental vision, intellectual stimulation of green ideas, individualised consideration of followers' environmental initiatives and role modelling (Chen & Chang, 2013; Mittal & Dhar, 2016). Environmentally specific transformational leadership predicts employees' pro-environmental behaviour through their harmonious environmental passion (Robertson & Barling, 2013), and green transformational leadership predicts green creativity and green innovation (Begum et al., 2022; Li et al., 2020). Servant, inclusive and ethical variants have been "greened" in a similar way (Luu, 2019, 2020). Two relations between leadership and GHRM appear in the literature: leadership as an antecedent of GHRM adoption and implementation (Haider et al., 2026; Singh et al., 2020) and leadership as a complement that makes GHRM credible to employees (Al-Swidi et al.,

2021). Leadership can also work through GHRM, as when green leadership fosters employees' green advocacy via green HR practices (Alzuman et al., 2025).

2.4 Work engagement and green work engagement

Engagement is the simultaneous investment of an individual's physical, cognitive and emotional energy in role performance (Kahn, 1990), measured as vigour, dedication and absorption (Schaufeli et al., 2002). It is empirically distinct from job satisfaction and organisational commitment and predicts task and contextual performance (Christian et al., 2011). HR practices that provide resources, support and meaningful work are among its strongest antecedents (Albrecht et al., 2015; Saks, 2006). Green work engagement is the domain-specific form, directed at environmental tasks; it mediates the effect of GHRM on employee green behaviour (Aboramadan, 2022) and is predicted jointly by GHRM and green leadership (Siddique et al., 2026; Tran, 2023). Engagement should not be conflated with *green commitment*, which denotes attachment and obligation rather than an energised state; the authors' prior empirical work examined the latter (Ali, Peiseniece, & Mikelsone, 2026), and the present review focuses on the former.

2.5 Artificial intelligence in HRM and leadership

AI-enabled HRM is defined here as the use of systems that learn from data to classify, predict, recommend or act within HR and leadership processes for example machine-learning screening, predictive HR analytics, adaptive learning platforms, conversational agents and algorithmic scheduling (Budhwar et al., 2023; Pereira et al., 2023; Tambe et al., 2019). This definition deliberately separates AI from generic digitalisation such as e-recruitment or paperless HR, because AI differs in autonomy, opacity and its capacity to restructure tasks (Kellogg et al., 2020; Langer & Landers, 2021). The organisational value of AI depends on an AI capability that combines data, technology, skills and governance (Chowdhury et al., 2023), and its consequences depend on whether it is designed to automate human judgement or to augment it (Raisch & Krakowski, 2021). Trust in AI and its perceived transparency shape whether employees accept or resist it (Glikson & Woolley, 2020).

2.6 Theoretical lenses

Five lenses recur in the literature. The ability–motivation–opportunity (AMO) framework explains how HR practice bundles affect performance by enhancing employees' abilities, motivation and opportunities to contribute (Appelbaum et al., 2000; Jiang et al., 2012). Social exchange theory explains why employees reciprocate organisational investment with discretionary effort (Blau, 1964; Cropanzano & Mitchell, 2005). The (natural-)resource-based view explains why hard-to-imitate human and technological resources yield environmental and competitive advantage (Barney, 1991; Hart, 1995). Social learning and signalling perspectives explain how leaders' behaviour and the consistency of organisational signals shape employees' interpretation of green initiatives (Connelly et al., 2011; Robertson & Barling, 2013). Socio-technical systems theory holds that technical and social subsystems must be jointly optimised (Trist & Bamforth, 1951).

We use job demands–resources (JD-R) theory as the integrating lens (Bakker & Demerouti, 2007, 2017; Demerouti et al., 2001). JD-R proposes that job resources (for example feedback, autonomy, support and development opportunities) initiate a motivational process that fosters engagement, whereas job demands (for example workload, monitoring and role ambiguity) initiate a health-impairment process that depletes energy. JD-R is well suited to the present problem for three reasons. It contains engagement as its central outcome. It can absorb the dominant GHRM lenses: AMO-enhancing practices are job and personal resources, and social exchange explains why resources elicit reciprocation. And its dual-process logic captures the ambivalence of AI, which can supply resources (feedback, learning support) and impose demands (surveillance, opacity, pace) simultaneously. Conservation-of-resources theory (Hobfoll, 1989) and self-determination theory (Deci & Ryan, 2000) complement JD-R by explaining why resource loss and the thwarting of autonomy are especially damaging.

3 Methodology

3.1 Research design

The study adopts a hybrid design that combines science mapping with a systematic, theory-building literature review. Bibliometric methods reveal the structure of a large field objectively but cannot judge the meaning or quality of the work they map; systematic reviews provide interpretive depth but are vulnerable to selective reading (Donthu et al., 2021; Zupic & Čater, 2015). Combining them follows recommendations for transparent, reproducible and theory-oriented management reviews (Post et al., 2020; Snyder, 2019; Tranfield et al., 2003). The protocol follows the SPAR-4-SLR stages of assembling, arranging and assessing (Paul et al., 2021) and reports identification, screening and inclusion according to PRISMA 2020 (Page et al., 2021). The bibliometric phase answers RQ1 and RQ2; the coded review and in-depth appraisal answer RQ3; and the synthesis informs the framework developed for RQ4, following a theory-synthesis approach to conceptual articles (Jaakkola, 2020).

3.2 Database selection

Records were retrieved from OpenAlex, an open bibliographic index that provides titles, abstracts, document types, affiliations, cited references and retraction flags through a documented API (Priem et al., 2022). OpenAlex was chosen for three reasons. First, its coverage of journals from emerging economies where most GHRM research is produced is broader than that of selective indices, while its reference coverage is comparable to that of Web of Science and Scopus for publications indexed in all three (Culbert et al., 2025). Second, the full query, retrieval date and raw records can be shared, so any reader can reproduce the corpus exactly. Third, its metadata can be converted directly into VOSviewer input. Scopus and Web of Science were not used because institutional access was not available to the review team at the time of the search; equivalent search strings for both databases are reported in Table 1 to support replication and robustness checks. The implications of this choice broader inclusion of journals of uneven quality and incomplete reference metadata are discussed in Section 8.

3.3 Search strategy

The search was executed on 27 October 2026 against titles and abstracts using the OpenAlex field title_and_abstract.search, which applies stemming, for publications dated 2010–2026. Search terms were derived from the vocabulary of seminal reviews (Ren et al., 2018; Renwick et al., 2013; Robertson & Barling, 2013) and refined iteratively by checking that known key studies were retrieved. The query combined three blocks of exact phrases with the Boolean OR operator (Table 1). AI terms were deliberately *not* included in the query: retrieving the whole GHRM–leadership–engagement field and then identifying the AI-linked subset allows the share of AI research and its position in the field to be measured, rather than assumed.

Table 1
Search protocol

Element	Specification
Database and date	OpenAlex (API), searched 27 October 2026
Search field	Title and abstract (stemmed phrase search)
Block A – green HRM	"green human resource management" OR "green human resource" OR "green HRM" OR "GHRM" OR "green HR practices" OR "environmental human resource management"
Block B – green leadership	"green transformational leadership" OR "green leadership" OR "environmentally specific transformational leadership" OR "green servant leadership" OR "environmentally specific servant leadership" OR "green inclusive leadership" OR "green ethical leadership" OR "environmental leadership" OR "environmentally specific leadership"
Block C – green engagement	"green work engagement" OR "green engagement" OR "environmental work engagement" OR "employee green engagement"
Combination	Block A OR Block B OR Block C
Time span	2010–2026 (2026 partial, to 27 October)
Document types retrieved	Journal articles and reviews
AI subset (identified after retrieval)	"artificial intelligence", "AI", "machine learning", "deep learning", "generative AI", "ChatGPT", "large language model", "algorithmic", "chatbot", "natural language processing" in title or abstract
Scopus replication string	TITLE-ABS-KEY(Block A OR Block B OR Block C) AND PUBYEAR > 2009 AND (DOCTYPE(ar) OR DOCTYPE(re))
Web of Science replication string	TS=(Block A OR Block B OR Block C) AND PY=(2010–2026), document types: Article, Review

3.4 Eligibility criteria

Table 2 lists the eligibility criteria. Records were eligible if they were peer-reviewed journal articles or reviews in English with an abstract, published 2010–2026, and if they used at least one focal construct in

an organisational sense. Records were excluded if they were not journal articles or reviews; if they were duplicates, retracted, editorials or corrections; if they were deposited in preprint servers or repositories; or if a focal term referred to something other than organisational practice for example national "environmental leadership" in climate diplomacy or consumer "green engagement".

Table 2
Eligibility criteria

Criterion	Inclusion	Exclusion
Document type	Journal articles and reviews	Book chapters, books, conference papers, theses, preprints, editorials, corrections
Status	Published; not retracted	Retracted (OpenAlex flag or title notice); repository or preprint version (e.g., Zenodo, SSRN, Research Square)
Language and abstract	English; abstract of at least 50 words	Non-English; no or insufficient abstract
Period	2010–2026	Before 2010
Topic	At least one focal construct (GHRM, green leadership, green engagement) used in an organisational or workplace sense	Construct used in a political, national, consumer or educational sense unrelated to organisations
Review set (coding)	At least two focal constructs, or AI with at least one focal construct, and an environmental outcome (environmental performance/sustainability or employee green behaviour)	Single-construct studies; studies without an environmental outcome
In-depth appraisal	AI-linked studies with green leadership or engagement; studies combining GHRM, green leadership and engagement	AI used only as an analytical method (e.g., text mining); AI or the focal constructs only mentioned peripherally

3.5 Screening and data cleaning

The search identified 8,153 records, of which 6,389 journal articles and reviews were retrieved with full metadata (Fig. 1). Data cleaning proceeded in five scripted steps. (i) Duplicates were removed using OpenAlex identifiers, DOIs and normalised titles combined with publication year (171 records), which also removed version duplicates. (ii) Retracted records (13) and one correction notice were removed. (iii) Records from preprint servers and repositories were removed using source names and DOI prefixes (229). (iv) Non-English records, including English-tagged records with Indonesian, Malay or other non-English abstracts, were removed (520), as were records lacking an abstract of at least 50 words (515). (v) The remaining 4,940 records were screened on title and abstract with rule-based relevance criteria that required a focal construct to appear in an organisational context; 259 records were excluded, most

of them concerned with national environmental leadership, education or consumer behaviour. The final bibliometric corpus comprised 4,681 documents. The full screening log, scripts and raw records are provided as supplementary material.

3.6 Construct tagging, review set and coding

Each included document was tagged for the presence of each focal construct (GHRM, green leadership, engagement) and of AI, using dictionaries applied to titles and abstracts (Supplementary Table S2). These tags were used to quantify the intersections between streams (RQ2). The review set for systematic coding comprised the 916 documents that combined at least two focal constructs, or AI with at least one focal construct, and that addressed an environmental outcome. These documents were coded for named theories, research design, sector, country and the roles assigned to engagement, leadership, GHRM and AI (mediator, moderator), again with documented dictionaries.

Because dictionary coding of abstracts can misclassify studies, its accuracy was checked. A random sample of 25 documents from the review set was read in full abstract by one reviewer and compared with the automated codes: 22 of 25 documents were judged relevant (precision 88%), and the design code agreed with the manual reading for 20 of the 23 documents whose design could be assessed (87%). Theory codes identify only theories *named* in titles or abstracts and therefore underestimate theory use; they are interpreted comparatively (AI-linked versus other studies) rather than as absolute prevalence. Finally, two subsets were appraised in depth by reading every abstract: the 63 AI-linked documents that also involved green leadership or engagement, of which 37 were retained after excluding studies in which AI was only an analytical method or a peripheral mention, and the 51 documents that combined GHRM, green leadership and engagement (87 unique studies, as one review belongs to both subsets). The exclusion reason for every AI-linked record is reported in Supplementary Table S4.

3.7 Bibliometric techniques

Performance analysis described annual output, sources, citations, authorship and countries. Science mapping was performed in VOSviewer 1.6.21 (van Eck & Waltman, 2010), run from the command line so that every parameter is documented and reproducible. VOSviewer normalises co-occurrence and co-citation counts with the association-strength method, positions items with the VOS mapping technique and assigns them to clusters with a weighted modularity-based algorithm (van Eck & Waltman, 2010; Waltman et al., 2010). Four analyses were conducted.

Term co-occurrence. Noun phrases were extracted from titles and abstracts with binary counting. A thesaurus merged synonyms and acronyms (for example "GHRM", "green HRM" and "green human resource management"; "GTL" and "green transformational leadership") and removed generic academic, methodological and geographical terms (Supplementary Table S3). Terms occurring in at least 50 documents were mapped (75 terms, 2,634 links; resolution 1.0; minimum cluster size 4). Overlay visualisation coloured terms by the average publication year of the documents in which they occur, and density visualisation showed concentrations of attention.

AI sub-field map. The same procedure was applied to the 187 AI-linked documents with a minimum of five occurrences (66 terms, 1,708 links).

Reference co-citation. Two references are co-cited when a third document cites both; co-citation clusters represent the intellectual base of a field (Small, 1973). Of the corpus documents, 2,499 (53.4%) had cited-reference metadata in OpenAlex, citing 50,799 distinct works; references cited by at least 80 corpus documents (177 references, 15,384 links) were mapped.

Country co-authorship. Countries were taken from author affiliations with full counting; the 40 countries with at least 20 documents were mapped.

Network and overlay maps were exported as vector graphics and rendered at 600 dpi. All maps, map and network files, thesaurus, scripts and the screening log are available in the supplementary materials.

4 Bibliometric results

4.1 Growth, sources and influential documents

Table 3 summarises the corpus. The 4,681 documents (4,500 articles and 181 reviews) were published in 1,926 sources by 9,955 authors, and they have received 78,249 citations (mean 16.7; h-index 133). Output was negligible before 2015 and has since grown at a compound annual rate of 49.4%; 68.8% of all documents were published in 2024–2026 (Fig. 2a). The three streams grow in parallel, but GHRM dominates: 3,807 documents involve GHRM, 1,177 green leadership and 590 engagement. AI-linked documents first appeared in 2018 and remained marginal until 2023, after which they rose from 17 documents in 2024 to 103 in 2026, or 8.7% of that year's output (Fig. 2b). AI is therefore the newest, fastest-growing and least mature theme in the field.

Table 3
Main characteristics of the bibliometric corpus

Indicator	Value
Period covered	2010–2026 (2026 to 27 October)
Documents (articles / reviews)	4,681 (4,500 / 181)
Sources	1,926
Authors	9,955
Single-authored documents	894 (19.1%)
Total citations / mean per document	78,249 / 16.7
h-index of the corpus	133
Compound annual growth rate, 2015–2025	49.4%
Share of documents published 2024–2026	68.8%
Countries (author affiliations)	112
Internationally co-authored documents	928 (19.8%)
Documents with cited-reference metadata	2,499 (53.4%)
Documents involving GHRM / green leadership / engagement / AI	3,807 / 1,177 / 590 / 187
Review set (coded) / in-depth appraisal	916 / 87

The most productive sources are *Sustainability* (169 documents), *Corporate Social Responsibility and Environmental Management* (86), *Business Strategy and the Environment* (81) and *Discover Sustainability* (57) (Table 4). Citation impact is concentrated in a small number of established journals: *Sustainability*, *Corporate Social Responsibility and Environmental Management*, *Business Strategy and the Environment* and the *International Journal of Manpower* together account for 22,255 citations. At the same time, the long tail of 1,926 sources includes many outlets with low citation impact, which is one reason why the review set was appraised critically rather than counted.

Table 4
Most productive sources

Source	Documents	Citations
Sustainability	169	8,402
Corporate Social Responsibility and Environmental Management	86	5,149
Business Strategy and the Environment	81	4,823
Discover Sustainability	57	281
International Journal of Research and Innovation in Social Science	35	16
International Journal of Manpower	34	3,881
Cogent Business & Management	32	2,078
Frontiers in Psychology	32	1,708
International Journal of Organizational Analysis	28	1,404
Sustainable Futures	25	393

Table 5 lists the ten most-cited documents. All are GHRM studies; the field's citation core consists of a foundational review (Renwick et al., 2013), a scale development study (Tang et al., 2018), a practice overview (Ahmad, 2015) and empirical studies linking GHRM to employee green behaviour, green culture and environmental performance (Chaudhary, 2020; Dumont et al., 2017; Guerci et al., 2016; Roscoe et al., 2019; Saeed et al., 2019; Yong et al., 2020). None of the most-cited documents involves engagement or AI, which confirms that both remain peripheral to the field's intellectual core.

Table 5
Ten most-cited documents in the corpus (OpenAlex citation counts, October 2026)

Rank	Document	Source	Citations
1	Renwick et al. (2013), Green human resource management: A review and research agenda	International Journal of Management Reviews	2,580
2	Dumont et al. (2017), Effects of green HRM practices on employee workplace green behavior	Human Resource Management	1,551
3	Tang et al. (2018), Green human resource management practices: Scale development and validity	Asia Pacific Journal of Human Resources	1,091
4	Saeed et al. (2019), Promoting employee's proenvironmental behavior through green human resource management practices	Corporate Social Responsibility and Environmental Management	1,043
5	Roscoe et al. (2019), Green human resource management and the enablers of green organisational culture	Business Strategy and the Environment	1,026
6	Ahmad (2015), Green human resource management: Policies and practices	Cogent Business & Management	897
7	Rehman et al. (2021), Analyzing the relationship between green innovation and environmental performance in large manufacturing firms	Technological Forecasting and Social Change	779
8	Yong et al. (2020), Pathways towards sustainability in manufacturing organizations	Business Strategy and the Environment	713
9	Chaudhary (2020), Green human resource management and employee green behavior: An empirical analysis	Corporate Social Responsibility and Environmental Management	673
10	Guerci et al. (2016), Translating stakeholder pressures into environmental performance	The International Journal of Human Resource Management	587

4.2 How far are the four streams integrated?

Figure 3 decomposes the corpus into exclusive intersections of the four streams. Most documents belong to a single stream: 2,913 address GHRM without green leadership, engagement or AI, and 723 address green leadership alone. The pairwise combinations GHRM–engagement (376) and GHRM–green leadership (303) are the largest intersections, but only 51 documents (1.1% of the corpus) combine GHRM, green leadership and engagement, and only three of these also involve AI. AI-linked research is concentrated in the GHRM–AI combination (124 documents); only 5.9% of engagement documents and 2.6% of green leadership documents mention AI at all. Conversely, of the 187 AI-linked documents, 18.7% mention engagement and 16.6% green leadership, often as a background variable rather than a modelled mechanism (Section 5.4).

4.3 Conceptual structure: four thematic clusters

The term co-occurrence map (Fig. 4; Table 6) contains four clusters. Cluster 1 (red, 32 terms) is the largest and represents a *strategic and capability* perspective: GHRM is linked to green innovation, sustainable and organisational performance, competitive advantage, the resource-based view, green intellectual and human capital, Industry 4.0, digital transformation, governance, ESG and artificial intelligence. Cluster 2 (green, 25 terms) represents the *leadership–behaviour micro-foundation*: green transformational, servant, inclusive and ethical leadership, employee green behaviour, OCBE, green creativity, green organisational culture, green psychological climate, green self-efficacy, green work engagement, and the AMO, social exchange and social identity lenses; hospitality and higher education are its typical settings. Cluster 3 (blue, 9 terms) captures *environmental knowledge and concern* environmental sustainability, environmental knowledge and concern, climate change and carbon footprint together with banking and healthcare settings and employee well-being. Cluster 4 (yellow, 9 terms) is the *GHRM practice bundle and its motivational outcomes*: green recruitment, training, performance management, rewards and involvement, together with employee engagement, organisational culture, green motivation and job satisfaction.

The map shows the structural position of AI. "Artificial intelligence" belongs to the strategic-capability cluster and is linked most strongly with GHRM (105 co-occurrences), digital transformation (32), employee engagement (31), environmental performance (29) and green recruitment and training (28 and 27). It co-occurs with green work engagement in only one document and with green transformational leadership in three. In other words, the field discusses AI as an organisational capability and an HR-process tool, but almost never in relation to the leadership–engagement–behaviour pathway that cluster 2 identifies as the mechanism of GHRM.

Table 6
Thematic clusters of the term co-occurrence map

Cluster	Terms	Mean year*	Most frequent terms	Interpretation
1 (red)	32	2024.1	green HRM, HRM, green innovation, sustainable performance, organisational sustainability, Industry 4.0, competitive advantage, resource-based view, digital transformation, governance, artificial intelligence, ESG	Strategic and capability perspective: GHRM as a firm resource for performance, innovation and digital transformation
2 (green)	25	2024.1	employee green behaviour, environmental performance, green transformational leadership, green leadership, hospitality, employee commitment, AMO theory, green organisational culture, OCBE, green creativity, social exchange theory, green work engagement	Leadership–behaviour micro-foundation: how leaders and climate turn GHRM into employee green behaviour
3 (blue)	9	2023.5	environmental sustainability, environmental knowledge, environmental management, climate change, environmental concern, banking, healthcare, carbon footprint, employee well-being	Environmental knowledge, concern and awareness
4 (yellow)	9	2024.2	green training, green recruitment, green performance management, green rewards, employee engagement, organisational culture, green involvement, green motivation, job satisfaction	GHRM practice bundle and motivational outcomes

Note. Occurrence-weighted mean of the average publication year of the cluster's terms |

The overlay map (Fig. 5) shows how the agenda has shifted. Terms associated with environmental management systems, green supply chain management, carbon footprint and Industry 4.0 have the earliest average publication years (2022.3–2023.4), followed by the GHRM practice bundle and the leadership–behaviour terms (around 2024). The most recent terms are ESG (2025.6), institutional theory (2025.4), sustainable leadership (2025.3), digital transformation (2025.3), artificial intelligence (2025.3), governance (2025.1) and organisational capability (2025.1). The newest frontier is therefore technological and governance-oriented, and it is developing within the capability cluster rather than within the employee-level cluster. The density map (Supplementary Fig. S1) confirms that attention is concentrated around GHRM, employee green behaviour, environmental performance and the practice bundle, with AI-related terms at the periphery.

4.4 Intellectual structure: three co-citation clusters

The co-citation network of the 177 most co-cited references (Fig. 6; Table 7) has three clusters. Cluster 3 (blue; 56 references; mean year 2013.6) is the *conceptual foundation* of GHRM, including the reviews and agenda-setting papers of Renwick et al. (2013), Jackson et al. (2011) and Ren et al. (2018), the scale of Tang et al. (2018), and early work linking HRM to environmental management (Daily & Huang, 2001; Jabbour & Santos, 2008; Paillé et al., 2014). Cluster 1 (red; 64 references; mean year 2020.1) is the *empirical consolidation* of GHRM–outcome relations, dominated by studies of employee green behaviour, OCBE and environmental performance in hotels, manufacturing and services (Anwar et al., 2020; Hameed et al., 2020; Kim et al., 2019; Roscoe et al., 2019; Saeed et al., 2019) and by the green work engagement study of Aboramadan (2022). Cluster 2 (green; 57 references; mean year 2011.8) joins the *psychology of leadership and green behaviour* Robertson and Barling (2013), Norton et al. (2015), Bissing-Olson et al. (2013), Kim et al. (2017), Chen and Chang (2013) and Mittal and Dhar (2016), with Dumont et al. (2017) and Singh et al. (2020) as bridges with the field's *methodological toolkit* of structural equation modelling and common-method-bias references (Podsakoff et al., 2003).

Two observations follow. First, no reference whose subject is AI, algorithmic management or digital HRM reaches the co-citation threshold: the AI literature has not yet entered the field's intellectual base. Second, the co-location of leadership psychology with SEM methodology in cluster 2 indicates that the leadership–behaviour stream has been built predominantly with cross-sectional survey designs, which the coded review confirms (Section 5.2). Engagement theory itself (Bakker & Demerouti, 2007; Kahn, 1990; Schaufeli et al., 2002) is also absent from the core, which means that green work engagement has been imported as a variable more often than theorised as a mechanism.

Table 7
Co-citation clusters (intellectual base)

Cluster	References	Mean year	Most co-cited references	Interpretation
3 (blue)	56	2013.6	Renwick et al. (2013); Tang et al. (2018); Ren et al. (2018); Ahmad (2015); Paillé et al. (2014); Jabbour and Santos (2008); Jackson et al. (2011); Daily and Huang (2001)	Conceptual foundation of GHRM and its link with environmental management
1 (red)	64	2020.1	Kim et al. (2019); Saeed et al. (2019); Roscoe et al. (2019); Chaudhary (2020); Hameed et al. (2020); Yong et al. (2020); Anwar et al. (2020); Aboramadan (2022)	Empirical consolidation of GHRM → employee green behaviour → environmental performance
2 (green)	57	2011.8	Dumont et al. (2017); Singh et al. (2020); Robertson and Barling (2013); Chen and Chang (2013); Norton et al. (2015); Mittal and Dhar (2016); Podsakoff et al. (2003)	Leadership and employee green behaviour psychology, with the SEM and common-method-bias toolkit

4.5 The AI sub-field

The term map of the 187 AI-linked documents (Fig. 7) has five clusters, all with mean publication years between 2025.2 and 2025.4. One cluster joins GHRM and AI with digital transformation, HR analytics, governance, ethics, algorithmic bias, automation and ESG the *technology-governance* core. A second links leadership, green leadership and green transformational leadership with sustainable performance, organisational capability, AI readiness, SMEs, manufacturing and the resource-based view a *capability* view in which leadership is treated as a firm-level resource. A third connects the HR practice bundle (green recruitment, training, involvement and rewards) with employee engagement and organisational culture. A fourth links technology, the Internet of Things and Industry 4.0 with environmental performance, trust and employee commitment, and a fifth contains the many systematic and bibliometric reviews. Engagement thus appears in the AI sub-field mainly as an outcome of AI-enabled HR practice bundles, and leadership mainly as an organisational capability, rather than as interacting parts of one psychological mechanism. The presence of a separate review cluster also shows that the AI sub-field already contains a large share of reviews relative to primary evidence.

4.6 Social structure

Authors from 112 countries contributed to the corpus, but production is concentrated in emerging economies of South and Southeast Asia and the Middle East: Indonesia (805 documents), Pakistan (630), India (472), China (432) and Malaysia (387) lead, followed by Saudi Arabia (210) and the United Kingdom (159). Citation impact is led by China (19,729 citations), Pakistan (15,065), Malaysia (10,368) and the United Kingdom (9,253). Only 19.8% of documents are internationally co-authored. The co-authorship network (Fig. 8) shows regional clusters a Gulf and Middle Eastern cluster, a South-East Asian cluster linked to the United States, a Pakistan–China axis, and a European–Australian cluster with relatively few ties between them. Europe and North America are under-represented relative to their weight in HRM and organisational psychology research, which limits the field's exposure to the regulatory contexts (for example the European Union's sustainability-reporting and AI regulation) in which AI-enabled HR practice will be most closely governed.

5 Critical synthesis of the review set

5.1 A theory profile split by level

The 916 studies in the review set name a theory in their title or abstract in only 30.6% of cases (280 studies). Among the theories named, the resource-based view (12.7%), AMO (11.8%) and social exchange theory (6.7%) dominate, while JD-R (2.1%), conservation of resources (1.2%) and self-determination theory (0.9%) the theories that explain engagement are rare. The split between AI-linked and other studies is more revealing (Fig. 9). Studies without AI rely on employee-level lenses: AMO (13.1%) and social exchange (8.0%) are their most frequent theories. AI-linked studies rely on firm-level capability lenses: the resource-based view (14.6%), dynamic capabilities (10.1% versus 1.2%) and socio-technical systems (6.2% versus 0.1%), while social exchange (1.1%) and social identity (0%) almost disappear. The theoretical vocabulary of the AI stream is therefore not equipped to explain what happens

to employees' engagement when AI enters green HR and leadership practice, which is the central gap this review addresses.

5.2 A narrow methodological base

Of the 706 empirical studies in the review set, 75.2% use questionnaire surveys analysed with structural equation modelling or regression, and 67.7% are single-wave survey studies without time-lagged, longitudinal, experimental or multilevel components; 67.1% rely solely on self-reports from a single source. Only 7.9% report time-lagged or multi-wave data, 2.1% multi-source or dyadic data, 1.6% multilevel designs and 0.7% experiments or vignettes. This profile matters for the field's central claims. Mediation chains such as GHRM → engagement → behaviour → performance imply temporal ordering that single-wave data cannot establish, and common-source designs inflate the associations among perceptions of GHRM, leadership and engagement (Podsakoff et al., 2003). Encouragingly, the most recent studies at the core intersection include time-lagged designs (Siddique et al., 2026) and multi-source employee–supervisor data (Lazanaki et al., 2026), showing that stronger designs are feasible.

5.3 Theme 1: GHRM works through engagement but not unconditionally

Engagement is modelled as a mediator in 16.3% of the review set, making it one of the most frequently tested mechanisms after GHRM itself (27.8% as a mediator of leadership or strategy effects). The evidence supports the core logic. Green work engagement mediates the effect of GHRM on employees' green behaviours in higher education (Aboramadan, 2022), GHRM and green leadership predict green work engagement through green organisational culture in Vietnamese agribusiness (Tran, 2023), employee engagement transmits, and personality attributes condition, the effect of GHRM on green behaviour (Ababneh, 2021), and green work engagement and green innovation serially mediate the effect of GHRM on sustainability performance in business-to-business firms (Akgün et al., 2026). These findings are consistent with the AMO and social exchange logic that GHRM supplies abilities, motives and opportunities which employees reciprocate with energy invested in environmental tasks.

Three qualifications are, however, necessary. First, the mechanism is not universal: in a sample of Malaysian higher-education employees, green work engagement was not significantly related to ecological behaviour once green culture and top-management support were considered (Noor Faezah et al., 2025). Second, engagement is frequently operationalised with general (not green-specific) items or conflated with commitment and satisfaction, so that different studies test different constructs under the same name. Third, the outcomes are usually self-reported behaviours rather than measured environmental performance, so the final link to organisational sustainability is inferred rather than demonstrated (Katz et al., 2022; Zacher et al., 2023).

5.4 Theme 2: Green leadership as antecedent, amplifier and partial substitute of GHRM

The review set shows three distinct roles for leadership. As an *antecedent*, green transformational leadership increases the adoption and implementation of GHRM, which then mediates its effects on green innovation and environmental performance (Alzuman et al., 2025; Haider et al., 2026; Singh et al., 2020). As an *amplifier*, leadership is tested as a moderator in 11.1% of the review set; it strengthens the effect of GHRM on employee outcomes and signals that HR policy is sincere (e.g., Al-Swidi et al., 2021). As a *parallel resource*, leadership predicts engagement directly: green leadership and GHRM predict green work engagement through employees' environmental awareness (Siddique et al., 2026), and multi-source evidence shows that GHRM fosters green innovative behaviour through sequential psychological processes that are stronger under supportive leadership (Lazanaki et al., 2026). Environmentally specific servant leadership can also mediate between green strategy and employees' OCBE (Luu, 2020).

The leadership stream rarely asks what happens when part of the leader's informational and developmental role is delegated to algorithms. This question is not hypothetical. Real-time feedback, goal tracking and personalised learning recommendations core elements of transformational and servant leadership are precisely the functions that AI systems now perform (Budhwar et al., 2023; Parker & Grote, 2022). The next theme shows that the first studies to address this question do not find a simple complementarity.

5.5 Theme 3: AI at the employee level augmenting, substituting or demanding?

Of the 37 AI-linked studies retained after in-depth appraisal, 12 are reviews or conceptual papers and 25 report primary data; Table 8 summarises the empirical studies that model AI together with green leadership, GHRM or engagement and report interpretable results. All of them use single-wave surveys analysed with PLS-SEM or regression, one combines PLS-SEM with fsQCA (Santoso et al., 2026), and none uses a control group, longitudinal data or multilevel modelling. Within these limits, three patterns can be distinguished.

Augmentation. Several studies find that AI strengthens the green HR and leadership pathway. Avatar-led green training increased hotel employees' green engagement in OCBE through workplace spirituality, especially among employees with strong biospheric values (Hao et al., 2025). AI adoption and GHRM jointly predicted green employee behaviour in Pakistani manufacturing SMEs, with organisational culture as a boundary condition (Najam Shaikh et al., 2025). In Vietnamese hotels, AI was positively associated with green servant and green transformational leadership, which in turn were associated with GHRM, green innovation culture and low-carbon or green innovative behaviour (Dinh, Bui, et al., 2026; Dinh, Nguyen, et al., 2026). Green AI capability strengthened the effect of green knowledge-oriented leadership on green innovation in Malaysian SMEs (Al Koliby et al., 2025).

Substitution. Other studies find that AI and leadership do not simply add up. In Bangladeshi manufacturing and healthcare firms, AI improved sustainable supply-chain performance directly but *weakened* the effect of green leadership on that performance, which the authors interpret as a substitution of digital systems for some leadership functions (Hoque & Das, 2026). In Pakistan, AI did

not significantly moderate the effect of green transformational or spiritual leadership on environmental sustainability, whereas leaders' emotional intelligence did (Tanveer, 2025). In Indonesian manufacturing firms, AI capabilities affected green technology innovation only *through* green leadership (Santoso et al., 2026), suggesting that leadership translates technological potential into environmental action rather than being replaced by it.

Demands. The clearest employee-level evidence is negative. Among employees of Egyptian five-star hotels, AI awareness increased job stress and thereby reduced green work engagement; technological self-efficacy weakened the effect of AI awareness on stress, and trust in leadership weakened the effect of stress on engagement (Khairy et al., 2024). This is precisely the health-impairment process of JD-R theory, and it shows that AI can reduce the very engagement on which the green pathway relies while leadership trust and employees' personal resources buffer that effect.

Table 8

Empirical studies modelling AI with green leadership, green HRM or engagement (in-depth appraisal)

Study	Context and sample	AI construct (role)	Leadership / GHRM / engagement constructs	Reported result (direction for AI)
Hao et al. (2025)	724 hotel employees; PLS-SEM	Avatar-led green training (delivery of a GHRM practice)	Green engagement in OCBE; workplace spirituality; biospheric values	Training enhanced green engagement via workplace spirituality (positive)
Khairy et al. (2024)	392 employees of five-star hotels, Egypt; PLS-SEM	AI awareness (antecedent)	Green work engagement; job stress; trust in leadership; technological self-efficacy	AI awareness raised job stress and lowered green work engagement (negative)
Najam Shaikh et al. (2025)	Manufacturing SMEs, Pakistan; survey SEM	AI adoption (antecedent)	GHRM; green employee behaviour; organisational culture (moderator)	AI adoption and GHRM jointly predicted green behaviour (positive, culture-contingent)
Tanveer (2025)	389 workers, Pakistan; survey SEM	AI (moderator)	Green transformational and spiritual leadership; emotional intelligence	AI did not moderate leadership → environmental sustainability (null)
Haq et al. (2025)	399 manufacturing SMEs, Pakistan; PLS-SEM	Green AI adoption (antecedent; TOE/TAM)	Green servant leadership (moderator); green investment	Green AI adoption improved environmental and operational performance (positive)
Al Koliby et al. (2025)	219 manufacturing SMEs, Malaysia; PLS-SEM	Green AI capability (moderator)	Green knowledge-oriented leadership; environmental strategy	AI capability strengthened leadership → green innovation (positive)
Hoque and Das (2026)	405 managers and employees, Bangladesh; survey SEM	AI (direct and moderator)	Green leadership; green innovation	AI improved performance directly but weakened the leadership effect (substitution)
Dinh, Bui, et al. (2026)	923 hotel managers and employees, Vietnam; PLS-SEM	AI (antecedent)	Green servant leadership; GHRM; green innovation behaviour	AI → leadership → GHRM → behaviour → environmental performance (positive, sequential)

Note. Results are reported as stated in the original abstracts; all studies are single-wave surveys. Full coding of all 37 retained studies is provided in Supplementary Table S4 | |

Study	Context and sample	AI construct (role)	Leadership / GHRM / engagement constructs	Reported result (direction for AI)
Dinh, Nguyen, et al. (2026)	569 hotel employees, Vietnam; PLS-SEM	AI (antecedent and moderator)	Green transformational leadership; GHRM; green innovation culture	AI associated with low-carbon behaviour via leadership and GHRM (positive)
Santoso et al. (2026)	101 manufacturing firms, Indonesia; PLS-SEM and fsQCA	AI capabilities (antecedent)	Green leadership (mediator)	AI affected green technology innovation only through green leadership (indirect)
Siddiqui and Akhtar (2026)	200 bank employees, Pakistan; PLS-SEM	AI support (moderator)	Green transformational leadership; green employee engagement	Leadership predicted green employee engagement; two moderating effects, including AI support, supported; mediators not supported (mixed)
Rezeki and Fachrurazi (2026)	249 SME owners and employees, Indonesia; PLS-SEM	AI-enabled green recruitment; AI utilisation (antecedent and mediator)	Transformational leadership; work engagement	Work engagement and AI utilisation tested as mediators of SME resilience
Note. Results are reported as stated in the original abstracts; all studies are single-wave surveys. Full coding of all 37 retained studies is provided in Supplementary Table S4 | |				

Across Table 8a consistent pattern emerges. Where AI is conceptualised as an organisational capability and the outcome is firm-level performance, the reported effects are positive. Where AI is measured as something employees experience and the outcome is a psychological state, the effects are mixed or negative. The literature has therefore drawn its optimistic conclusions mainly from the level at which employees' experience is invisible. Broader evidence from AI-enabled sustainable HRM points in the same direction: perceived AI-driven sustainable HRM can support engagement (Jia & Hou, 2024), but algorithmic control and opacity are known sources of techno-stress and resistance (Kellogg et al., 2020; Langer & Landers, 2021; Tarafdar et al., 2019).

5.6 Theme 4: Boundary conditions authenticity, climate and the footprint of AI

The review set repeatedly identifies conditions under which the GHRM–leadership–engagement pathway is stronger or weaker. Green organisational culture and green psychological climate are the most frequent mediators and moderators (6.8% of the review set as mediators), and climate determines whether GHRM practices are interpreted as genuine (Dumont et al., 2017; San Román-Niaves et al.,

2025). Perceived authenticity is critical: when employees perceive green initiatives as symbolic, GHRM produces cynicism rather than engagement (Ahmad & Sadiq, 2025), a pattern consistent with research on greenwashing (Delmas & Burbano, 2011). Moral emotions such as organisational pride also transmit the effects of corporate responsibility on green behaviour (Zhang, Ren, et al., 2024).

AI introduces two further boundary conditions that the field has hardly examined. The first is trust and AI literacy: technological self-efficacy and trust in leadership buffered the negative effects of AI in the only study that tested them (Khairy et al., 2024), and trust is a general precondition of AI acceptance at work (Glikson & Woolley, 2020). The second is the environmental footprint of AI itself. Training and running large models consume substantial energy (Strubell et al., 2019), yet only 97 documents in the corpus (2.1%) mention an environmental or carbon footprint at all, and almost none of the AI-linked studies counts the footprint of the systems it recommends against their claimed environmental gains. A green HR system that relies on energy-intensive AI without accounting for it risks the same credibility problem as greenwashing.

5.7 Synthesis: five gaps

The bibliometric and critical analyses converge on five gaps. *Gap 1 (integration)*: only 1.1% of the field examines GHRM, green leadership and engagement together, and three documents add AI. *Gap 2 (level)*: AI is studied as a firm-level capability with capability theories, whereas the mechanism of GHRM operates at the employee level and is explained by exchange and motivational theories. *Gap 3 (ambivalence)*: the first employee-level studies show that AI can add resources, substitute for leadership or impose demands, but no framework explains when each occurs. *Gap 4 (design)*: two-thirds of empirical studies are single-wave, single-source surveys, and none of the AI studies uses longitudinal, experimental or multilevel evidence. *Gap 5 (context and footprint)*: evidence is concentrated in a few emerging economies with little international collaboration, and the environmental cost of AI is ignored. Sections 6 and 7 respond to these gaps.

6 An integrative framework: AI and the green job demands–resources pathway

Building on JD-R theory (Bakker & Demerouti, 2017; Demerouti et al., 2001) and the evidence synthesised above, Fig. 10 proposes a framework in which green leadership and GHRM influence environmental sustainability by shaping employees' green job resources and demands, which drive green work engagement and, through it, green behaviour. AI is modelled as a moderating layer whose configuration determines whether it adds to green job resources or to job demands.

Leadership and GHRM as sources of green job resources. Green leaders provide meaning, clarity and individual support for environmental tasks and act as role models (Chen & Chang, 2013; Robertson & Barling, 2013). GHRM practices provide the abilities, incentives and opportunities that AMO theory describes; in JD-R terms, ability-enhancing practices build personal resources such as green self-efficacy, motivation-enhancing practices provide recognition and meaningfulness, and opportunity-

enhancing practices provide autonomy and voice (Albrecht et al., 2015; Appelbaum et al., 2000; Jiang et al., 2012). Leadership also shapes how GHRM is experienced: consistent signals from leaders make HR policies credible (Al-Swidi et al., 2021; Connelly et al., 2011).

Proposition 1

Green leadership is positively related to employees' green job resources (environmental meaning, role clarity, support and developmental feedback).

Proposition 2

GHRM practice bundles are positively related to green job resources, with ability-, motivation- and opportunity-enhancing practices relating most strongly to green self-efficacy, perceived meaningfulness and green autonomy, respectively.

Proposition 3

Green leadership is positively related to the adoption of GHRM and strengthens the relationship between GHRM and green job resources by increasing the perceived authenticity of GHRM.

Engagement as the motivational mechanism. Job resources initiate a motivational process that fosters engagement, and job demands initiate a health-impairment process that depletes it (Bakker & Demerouti, 2007). Engaged employees invest discretionary energy in environmental tasks, which is expressed as task-related green behaviour and OCBE (Aboramadan, 2022; Boiral & Paillé, 2012), and these behaviours aggregate to unit-level environmental performance where a green climate makes them normative (Dumont et al., 2017; Norton et al., 2015).

Proposition 4

Green job resources are positively, and green job demands negatively, related to green work engagement; green work engagement mediates the relationships of green leadership and GHRM with employee green behaviour.

Proposition 5

Green work engagement is positively related to employee green behaviour and OCBE, which in turn are positively related to unit-level environmental performance; the link from behaviour to performance is stronger in units with a strong green climate.

AI as a moderating layer. The evidence in Table 8 suggests that AI's effect depends on its configuration. An *augmenting* configuration uses AI transparently to support human judgement personalised green learning, developmental eco-feedback and decision support with a human in the loop and should enlarge the resource value of GHRM and leadership (Hao et al., 2025; Raisch & Krakowski, 2021). A *substituting or surveilling* configuration uses AI to automate leaders' developmental functions or to monitor

employees' environmental performance opaquely; it should weaken the leadership pathway (Hoque & Das, 2026) and add techno-demands that reduce engagement (Kellogg et al., 2020; Khairy et al., 2024).

Proposition

a. *AI in an augmenting configuration strengthens the positive relationships of green leadership and GHRM with green job resources.*

Proposition

b. *AI in a substituting or surveilling configuration increases green job demands (techno-stress, perceived control and opacity) and weakens the relationship between green leadership and green work engagement.*

Boundary conditions. Perceived authenticity of green initiatives (Ahmad & Sadiq, 2025; Delmas & Burbano, 2011), green climate (Dumont et al., 2017), employees' AI literacy and trust (Glikson & Woolley, 2020; Khairy et al., 2024), visibility of AI's environmental footprint (Strubell et al., 2019) and institutional context shape whether resources or demands prevail.

Proposition 7

The positive pathway from green leadership and GHRM through green job resources to green work engagement is stronger when initiatives are perceived as authentic, when employees trust and understand the AI systems involved, and when the environmental footprint of these systems is transparently accounted for.

The framework differs from prior models in three ways. It replaces the implicit assumption that AI is a uniformly positive capability with a dual-pathway mechanism that accommodates the positive, null and negative findings in Table 8. It specifies engagement as a mechanism with resource-based antecedents rather than as an interchangeable attitude. And it treats the environmental footprint and authenticity of AI as part of the sustainability problem rather than outside it.

7 Discussion

7.1 Theoretical contributions

This review contributes to research on GHRM, green leadership and sustainable HRM in three ways. First, it moves the claim that these literatures are "fragmented" from assertion to evidence. Construct-intersection analysis, term mapping and theory profiling show that AI research is located in a firm-level capability cluster, that it shares almost no vocabulary with the leadership–engagement–behaviour cluster, and that its theoretical lenses (resource-based view, dynamic capabilities, socio-technical systems) are not the ones that explain employees' engagement. Prior reviews of AI-enabled GHRM (Alherimi et al., 2025; Shetty et al., 2026; Singh & Sinha, 2026) catalogued applications and themes; this review shows where the AI stream is disconnected from the mechanism through which GHRM operates.

Second, the review re-specifies the GHRM–sustainability pathway in JD-R terms. The dominant AMO and social exchange explanations describe *why* GHRM and leadership motivate employees; JD-R adds *how* through resources and demands that are observable, measurable and changeable and, crucially, it accommodates the possibility that the same intervention adds resources for some employees and demands for others. This is especially valuable once AI enters HR practice, because AI changes the resource–demand balance of work directly (Parker & Grote, 2022; Tarafdar et al., 2019).

Third, the review integrates the contradictory early evidence on AI. By separating augmenting from substituting or surveilling configurations, and capability-level from employee-level measurement, it explains why studies of AI as a firm capability report positive effects whereas studies of AI as an employee experience report mixed or negative effects (Hoque & Das, 2026; Khairy et al., 2024; Tanveer, 2025). This offers a theoretical rather than merely methodological account of the heterogeneity in the literature.

7.2 Research agenda

Table 9 translates the five gaps into a theory–context–characteristics–methodology agenda.

Table 9
Research agenda (theory, context, characteristics and methodology)

Dimension	Gap identified	Research priorities
Theory	AI studied with capability theories; engagement theory absent from the intellectual base	Test the JD-R dual pathway (P1–P7); combine JD-R with self-determination and conservation-of-resources theory to explain when AI satisfies or thwarts autonomy and competence; integrate signalling theory to model authenticity and greenwashing
Context	Evidence concentrated in a few emerging economies; low international collaboration; Europe and North America under-represented	Cross-national comparisons that vary AI regulation and sustainability-reporting regimes; studies in carbon-intensive sectors and the public sector; designs that compare SMEs with large firms that already deploy AI in HR
Characteristics	AI measured as generic "adoption" or "awareness"; engagement often general or conflated with commitment	Measure AI configuration (transparency, human oversight, purpose: development vs. control) and specific AI-enabled practices; use validated green work engagement measures; measure AI's energy use and emissions alongside its claimed environmental gains
Methodology	67.7% single-wave studies; 67.1% single-source; no longitudinal, experimental or multilevel AI studies	Time-lagged and diary designs to establish the order of leadership, resources, engagement and behaviour; field and vignette experiments that manipulate AI configuration; multilevel designs linking team leadership and climate to individual engagement and unit environmental performance; objective environmental data; fsQCA for configurational effects

Three studies would be particularly valuable. The first is a multi-wave field study in which green leadership and GHRM are measured at time 1, green job resources and demands (including AI-related demands) at time 2, green work engagement at time 3 and supervisor-rated green behaviour and unit-level environmental indicators at time 4. The second is a vignette or field experiment that holds a green HR practice constant for example environmental training or eco-feedback and manipulates whether it is delivered by a leader, by a transparent AI assistant or by an opaque monitoring system, to test Propositions 6a and 6b directly. The third is a cross-national study that compares organisations operating under strict AI and sustainability-disclosure regimes with those operating under weak ones, to test the institutional boundary conditions of Proposition 7.

7.3 Practical implications

For HR managers, the review implies that GHRM should be designed and evaluated as a system of job resources rather than as a checklist of green practices. Training, feedback, recognition and involvement opportunities should be assessed by whether employees experience them as increasing their capacity and freedom to act on environmental goals. For leaders, the evidence that green leadership amplifies GHRM and buffers stress implies that leadership development remains essential even where AI takes over routine feedback and monitoring; leaders should use AI-generated information as input to developmental conversations rather than as a substitute for them.

For organisations deploying AI in HR, the review suggests four safeguards: (i) use AI for developmental purposes personalised learning and constructive eco-feedback before using it for surveillance or evaluation; (ii) make AI-supported decisions explainable and keep humans accountable for consequential decisions; (iii) build employees' AI literacy and self-efficacy, which buffer techno-stress (Khairy et al., 2024); and (iv) count the energy use and emissions of AI systems against the environmental gains claimed for them, so that "green AI" claims do not become a new form of greenwashing (Delmas & Burbano, 2011; Strubell et al., 2019). For policymakers and industry bodies, the concentration of evidence in SMEs of emerging economies indicates a need for shared AI infrastructure, training and guidance that smaller firms cannot develop alone.

8 Limitations and conclusion

8.1 Limitations

The review has limitations that also indicate opportunities for further work. First, it relies on a single database. OpenAlex offers broad and reproducible coverage, but it indexes journals of uneven quality and provides cited-reference metadata for only 53.4% of the corpus, so the co-citation analysis represents the citing behaviour of that subset. Replicating the search in Scopus and Web of Science with the strings in Table 1 would test the robustness of the clusters. Second, the review set was coded with documented dictionaries applied to titles and abstracts; validation on a random sample showed acceptable accuracy (88% relevance precision and 87% design agreement), but theory codes capture only theories named in abstracts and are interpreted comparatively. Third, the in-depth appraisal was

based on abstracts, not full texts, and Table 8 reports results as stated by the original authors without re-estimating effect sizes; a meta-analysis would become feasible as the AI evidence base grows. Fourth, screening and coding were conducted primarily by one author; although the scripts and decisions are fully documented, independent double coding would further strengthen reliability. Fifth, the corpus includes records published up to 27 October 2026, and the AI stream is changing rapidly, so its structure should be re-examined as the stream matures. Finally, English-language restriction excluded 520 records, many of them Indonesian-language studies in a highly productive national literature.

8.2 Conclusion

Green HRM, green leadership and work engagement form a well-evidenced human pathway to environmental sustainability, and artificial intelligence is entering every stage of that pathway. This review shows, however, that the four literatures have developed largely in parallel. AI research treats AI as a firm-level capability and draws on capability theories, while the mechanism through which GHRM and leadership change behaviour employees' green work engagement is explained by employee-level theories that the AI stream rarely uses. The few studies that cross this divide indicate that AI can augment the pathway, substitute for parts of leadership, or impose demands that erode engagement. By re-specifying the pathway in job demands–resources terms and distinguishing augmenting from substituting or surveilling uses of AI, the review offers a framework, seven propositions and a methodological agenda for determining when AI helps organisations become more sustainable through their people rather than at their expense.

Declarations

Funding. Not Applicable

Competing interests. The authors declare no competing interests.

Author contributions. Tumsela Asghar: Conceptualization, Methodology, Investigation, Writing, original draft.

Data availability. The OpenAlex query, raw records, screening log, coding dictionaries, VOSviewer map and network files, thesaurus, and analysis scripts are provided as supplementary material and can be used to reproduce all results.

References

1. Ababneh, O. M. A. (2021). How do green HRM practices affect employees' green behaviors? The role of employee engagement and personality attributes. *Journal of Environmental Planning and Management*, *64*(7), 1204–1226. https://doi.org/10.1080/09640568.2020.1814708
2. Aboramadan, M. (2022). The effect of green HRM on employee green behaviors in higher education: the mediating mechanism of green work engagement. *International Journal of Organizational*

Analysis, *30*(1), 7–23. https://doi.org/10.1108/ijoa-05-2020-2190

3. Ahmad, I., & Sadiq, M. (2025). Beyond the green glow: an integrated review of the dark side of green human resource management. *International Journal of Organizational Analysis*, 1–30. https://doi.org/10.1108/ijoa-08-2025-5843
4. Ahmad, S. (2015). Green human resource management: Policies and practices. *Cogent Business & Management*, *2*(1), Article 1030817. https://doi.org/10.1080/23311975.2015.1030817
5. Akgün, A. E., Keskin, H., & Esen, E. (2026). Green human resource management and B2B sustainability performance: the serial mediating role of green work engagement and green innovation. *Journal of Business & Industrial Marketing*, *41*(6), 856–870. https://doi.org/10.1108/jbim-01-2025-0045
6. Al Koliby, I. S., Al-Swidi, A. K., Al-Hakimi, M. A., & Farhan, S. A. G. (2025). How green knowledge-oriented leadership drives green innovation in SMEs: the mediating role of environmental strategy and the moderating role of green AI capability. *Cogent Business & Management*, *12*(1), Article 2520914. https://doi.org/10.1080/23311975.2025.2520914
7. Al-Swidi, A. K., Gelaidan, H. M., & Saleh, R. M. (2021). The joint impact of green human resource management, leadership and organizational culture on employees' green behaviour and organisational environmental performance. *Journal of Cleaner Production*, *316*, Article 128112. https://doi.org/10.1016/j.jclepro.2021.128112
8. Albrecht, S. L., Bakker, A. B., Gruman, J. A., Macey, W. H., & Saks, A. M. (2015). Employee engagement, human resource management practices and competitive advantage. *Journal of Organizational Effectiveness: People and Performance*, *2*(1), 7–35. https://doi.org/10.1108/joepp-08-2014-0042
9. Muhammad Ramzan ALI, Muhammad Sharjeel Aziz, Muhammad Younis (2026)
10. Alherimi, N., Abdulmaksoud, S., Ahmed, V., & Bahroun, Z. (2025). A systematic literature review of artificial intelligence advancements in green human resource management. *Sustainability*, *17*(22), Article 10283. https://doi.org/10.3390/su172210283
11. Ali, M. R., Asghar, T., Kadirova, Z., Khasanovna, V. M., & Akram, M. F. (2026). *Artificial intelligence in green human resource management: Examining the mediating role of employee engagement in attaining organizational sustainability* [Preprint]. Research Square. https://doi.org/10.21203/rs.3.rs-11412497/v1
12. Ali, M. R., Aziz, M. S., & Younis, M. (2026). Fostering environmental sustainability through green human resource management, green leadership, and work engagement: Examining the emerging role of artificial intelligence. In *Proceedings of the Republican Scientific-Practical Conference "Human and Artificial Intelligence Collaboration in Higher Education: The Future of Education" (24 September 2026)* (pp. 388–410). https://doi.org/10.5281/zenodo.22897287
13. Ali, M. R., Peiseniece, L., & Mikelsone, E. (2026). Fostering environmental sustainability through green HRM green leadership and work commitment. *Discover Sustainability*. https://doi.org/10.1007/s43621-026-04468-z

14. Alzuman, A., Alkhozaim, S. M., Alnasser, E. M., Al-Romeedy, B. S., Alhamdi, F. M., Alsetoohy, O., & Sheikhelsouk, S. (2025). Strategic pathways to economic sustainability: The mediating role of green HRM between green leadership and advocacy in tourism and hospitality. *Sustainability*, *17*(21), Article 9671. https://doi.org/10.3390/su17219671
15. Ali, M.R., Peiseniece, L. & Mikelsone, E. Fostering environmental sustainability through green HRM green leadership and work commitment. Discov Sustain (2026). https://doi.org/10.1007/s43621-026-04468-z
16. Ali, M.R., Peiseniece, L., Mikelsone, E., Shah, A.S.A. and Kadirova, Z., 2026. Co-Creating Sustainable Innovation From Within: Green HRM Practices Enabling EmployeeGreen Behavior in KIBS Ecosystems Across Pakistan, China, And Uzbekistan. Journal of Management Practices, Humanities and Social Sciences, 10(2), pp.263-277. https://doi.org/10.33152/jmphss-10.2.7
17. Bakhronkulova, L., Ali, M., Khabirova, Z., Azimjon, A., Zebo, A. and Muslima, A., 2025, June. Artificial Intelligence in Cybersecurity: Threats, Defenses, and Future Directions. In ENVIRONMENT. TECHNOLOGY. RESOURCES. Proceedings of the International Scientific and Practical Conference (Vol. 2, pp. 23-30). https://doi.org/10.17770/etr2025vol2.8592
18. Shah, A.S.A., Ali, M.R., Vokhidova, M., Xusanov, C. and Musaeva, R., 2025. Charting the Future: Analyzing Innovative Strategies in Strategic Management for Sustainable Performance Excellence and Business Leadership in the Telecom Industry. Business Ethics and Leadership, 9(4), pp.195-208. https://doi.org/10.61093/bel.9(4).195-208.2025
19. Ali, M., Peiseniece, L. and Mikelsone, E., 2025, June. Through the green work commitment, a literature review examines the relationship between green HRM and environmental sustainability. In Environment. Technology. Resources. Proceedings of the International Scientific and Practical Conference (Vol. 1, pp. 31-43). https://doi.org/10.17770/etr2025vol1.8635
20. Ali, M., Peiseniece, L. and Mikelsone, E., 2025, June. The mediating role of green work commitment in the relationship between green HR practices, AI elements, and environmental sustainability: a quantitative analysis. In ENVIRONMENT. TECHNOLOGY. RESOURCES. Proceedings of the International Scientific and Practical Conference (Vol. 2, pp. 15-22). https://doi.org/10.17770/etr2025vol2.8578
21. Khan, S., Ali, M., Akram, M., Azizova, N., Vokhidova, M. and Isamukhamedova, G., 2025, June. Exploring the impact of digital transformation on business model innovation in the retail sector. In Environment. Technology. Resources. Proceedings of the International Scientific and Practical Conference (Vol. 1, pp. 281-288). https://doi.org/10.17770/etr2025vol1.8640
22. “FOSTERING ENVIRONMENTAL SUSTAINABILITY THROUGH GREEN HUMAN RESOURCE MANAGEMENT, GREEN LEADERSHIP, AND WORK ENGAGEMENT: EXAMINING THE EMERGING ROLE OF ARTIFICIAL INTELLIGENCE”. Zenodo. Available at: https://doi.org/10.5281/zenodo.22897287
23. Ali, M.R. and Iqbal, S.M.J., 2022. Examining the mediating influence of green behavior on the impact of green HR practices on environmental sustainability. iRASD Journal of Management, 4(3), pp.479-

494.

24. Tehmina Rafi, Muhammad Ramzan Ali, Zulaykho Kadirova, Usama Yousaf (2025) “IMPACT OF BOARD GENDER DIVERSITY, FOREIGN OWNERSHIP, AND OWNERSHIP CONCENTRATION ON CORPORATE FINANCIAL DECISIONS AND FIRM VALUE: EVIDENCE FROM THE TEXTILE SECTOR OF PAKISTAN”. Zenodo. Available at: https://doi.org/10.5281/zenodo.17421976
25. Ali, M., Kadirova, Z. and Ismoyilov, B., 2024, June. Practicing green HRM to achieve environmental sustainability. In Environment. Technology. Resources. Proceedings of the International Scientific and Practical Conference (Vol. 1, pp. 24-33). https://doi.org/10.17770/etr2024vol1.7961
26. MUHAMMAD, R. A., BAKHTIYOR, I., MAHLIYO, M. & MUHAMMAD, F. A. 2023. Role of Servant Leadership in Work Performance: Identifing the Mediating Relation with Employee Ambidexterity and Moderating with Competitive Orientation. Oeconomia Copernicana, 14, 181-211.
27. AKRAM, M. F., ALI, M. R. & KADIROVA, Z. 2023a. ROLE OF CONSUMER DIGITAL LITERACY IN CONSUMER BEHAVIORAL INTENTIONS: MEDIATING EFFECT OF PERCEIVED EASE OF USE, USEFULNESS AND CUSTOMER ENGAGEMENT.
28. AKRAM, M. F., ALI, M. R. & KADIROVA, Z. 2023b. Role of consumer digital literacy in consumer behavioral intentions: Mediating effect of perceived ease of use, usefulness and customer engagement. Multidisciplinary Journal of Educational Research, 13, 104-130.
29. ALI, M. R., AKRAM, M. F., URKINBAYEV, T. A., TASHTAYEVA, S. K. & ARIPDJANOV, G. T. 2023. The Pathways to Achieve Green Economy and The Process of Sustainable Development Goals. SGS-Engineering & Sciences, 2.
30. Muhammad Ramzan Ali, Dr. Liga Peiseniece, Dr. Elina Mikelsone (2025) “ARTIFICIAL INTELLIGENCE IN GREEN HUMAN RESOURCE MANAGEMENT: UNDERSTANDING THE MEDIATING ROLE OF EMPLOYEE ENGAGEMENT IN ACHIEVING ENVIRONMENTAL SUSTAINABILITY”. Zenodo. Available at: https://doi.org/10.5281/zenodo.15193336.
31. Muhammad Ramzan Ali, Dr. Liga Peiseniece, Dr. Elina Mikelsone (2025) “ARTIFICIAL INTELLIGENCE IN GREEN HUMAN RESOURCE MANAGEMENT: UNDERSTANDING THE MEDIATING ROLE OF EMPLOYEE ENGAGEMENT IN ACHIEVING ENVIRONMENTAL SUSTAINABILITY”. Zenodo. Available at: https://doi.org/10.5281/zenodo.15193336.
32. Alimova Zebo1, Muhammad Ramzan Ali(PhD)2, Bakhronkulova Laylo3, Farzona Mirsodikova4, 5Irkinov Rasuljon (2025) “THE ROLE OF AI IN DEVELOPING GLOBAL CYBERSECURITY POLICIES”. Zenodo. Available at: https://doi.org/10.5281/zenodo.14899972
33. Muhammad Ramzan Ali, Dr Muhammad Bilal Qureshi, Dr Adnan Manzoor (2025) “CYBER SECURITY AND ARTIFICIAL INTELLIGENCE: REVOLUTIONARY TRENDS CREATING THE FUTURE”. Zenodo. Available at: https://doi.org/10.5281/zenodo.14911281
34. Kadirovich, X.C., Shah, A.S.A., Ali, M.R. and Khasanovna, V.M., 2026. The Moderating Role of Staff Training and Mediating Role of Venue Reputation in Accessible MICE Tourism: Effects on Business Event Satisfaction. https://doi.org/10.21203/rs.3.rs-11106800/v1

35. Ali, M. R. (n.d.) Artificial Intelligence in Green Human Resource Management: Examining the Mediating Role of Employee Engagement in Attaining Organizational Sustainability. Research Square. Available at: https://doi.org/10.21203/rs.3.rs-11412497/v1
36. Anwar, N., Nik Mahmood, N. H., Yusliza, M. Y., Ramayah, T., Noor Faezah, J., & Khalid, W. (2020). Green Human Resource Management for organisational citizenship behaviour towards the environment and environmental performance on a university campus. *Journal of Cleaner Production*, *256*, Article 120401. https://doi.org/10.1016/j.jclepro.2020.120401
37. Appelbaum, E., Bailey, T., Berg, P., & Kalleberg, A. L. (2000). *Manufacturing advantage: Why high-performance work systems pay off.* Cornell University Press.
38. Bahuguna, P. C., Srivastava, R., & Tiwari, S. (2023). Two-decade journey of green human resource management research: a bibliometric analysis. *Benchmarking: An International Journal*, *30*(2), 585–602. https://doi.org/10.1108/bij-10-2021-0619
39. Bakker, A. B., & Demerouti, E. (2007). The Job Demands-Resources model: state of the art. *Journal of Managerial Psychology*, *22*(3), 309–328. https://doi.org/10.1108/02683940710733115
40. Bakker, A. B., & Demerouti, E. (2017). Job demands–resources theory: Taking stock and looking forward. *Journal of Occupational Health Psychology*, *22*(3), 273–285. https://doi.org/10.1037/ocp0000056
41. Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108
42. Begum, S., Ashfaq, M., Xia, E., & Awan, U. (2022). Does green transformational leadership lead to green innovation? The role of green thinking and creative process engagement. *Business Strategy and the Environment*, *31*(1), 580–597. https://doi.org/10.1002/bse.2911
43. Benevene, P., & Buonomo, I. (2020). Green human resource management: An evidence-based systematic literature review. *Sustainability*, *12*(15), Article 5974. https://doi.org/10.3390/su12155974
44. Bindeeba, D. S., Tukamushaba, E. K., Bakashaba, R., & Atuhaire, S. (2025). Green human resources management and green innovation: a meta-analytic review of strategic human resources levers for environmental sustainability. *Discover Sustainability*, *6*(1), Article 650. https://doi.org/10.1007/s43621-025-01444-x
45. Bissing-Olson, M. J., Iyer, A., Fielding, K. S., & Zacher, H. (2013). Relationships between daily affect and pro-environmental behavior at work: The moderating role of pro-environmental attitude. *Journal of Organizational Behavior*, *34*(2), 156–175. https://doi.org/10.1002/job.1788
46. Blau, P. M. (1964). *Exchange and power in social life.* Wiley.
47. Boiral, O., & Paillé, P. (2012). Organizational citizenship behaviour for the environment: Measurement and validation. *Journal of Business Ethics*, *109*(4), 431–445. https://doi.org/10.1007/s10551-011-1138-9
48. Budhwar, P., Chowdhury, S., Wood, G., Aguinis, H., Bamber, G. J., Beltran, J. R., Boselie, P., Lee Cooke, F., Decker, S., DeNisi, A., Dey, P. K., Guest, D., Knoblich, A. J., Malik, A., Paauwe, J., Papagiannidis, S.,

Patel, C., Pereira, V., Ren, S., . . . Varma, A. (2023). Human resource management in the age of generative artificial intelligence: Perspectives and research directions on ChatGPT. *Human Resource Management Journal*, *33*(3), 606–659. https://doi.org/10.1111/1748-8583.12524

49. Carballo-Penela, A., Ruzo-Sanmartín, E., Álvarez-González, P., & Paillé, P. (2023). How do GHRM practices influence firms' economic performance? A meta-analytic investigation of the role of GSCM and environmental performance. *Journal of Business Research*, *165*, Article 113984. https://doi.org/10.1016/j.jbusres.2023.113984
50. Chaudhary, R. (2020). Green human resource management and employee green behavior: An empirical analysis. *Corporate Social Responsibility and Environmental Management*, *27*(2), 630–641. https://doi.org/10.1002/csr.1827
51. Chen, Y. S., & Chang, C. H. (2013). The determinants of green product development performance: Green dynamic capabilities, green transformational leadership, and green creativity. *Journal of Business Ethics*, *116*(1), 107–119. https://doi.org/10.1007/s10551-012-1452-x
52. Chowdhury, S., Dey, P., Joel-Edgar, S., Bhattacharya, S., Rodriguez-Espindola, O., Abadie, A., & Truong, L. (2023). Unlocking the value of artificial intelligence in human resource management through AI capability framework. *Human Resource Management Review*, *33*(1), Article 100899. https://doi.org/10.1016/j.hrmr.2022.100899
53. Christian, M. S., Garza, A. S., & Slaughter, J. E. (2011). Work engagement: a quantitative review and test of its relations with task and contextual performance. *Personnel Psychology*, *64*(1), 89–136. https://doi.org/10.1111/j.1744-6570.2010.01203.x
54. Connelly, B. L., Certo, S. T., Ireland, R. D., & Reutzel, C. R. (2011). Signaling theory: A review and assessment. *Journal of Management*, *37*(1), 39–67. https://doi.org/10.1177/0149206310388419
55. Cropanzano, R., & Mitchell, M. S. (2005). Social exchange theory: An interdisciplinary review. *Journal of Management*, *31*(6), 874–900. https://doi.org/10.1177/0149206305279602
56. Culbert, J. H., Hobert, A., Jahn, N., Haupka, N., Schmidt, M., Donner, P., & Mayr, P. (2025). Reference coverage analysis of OpenAlex compared to Web of Science and Scopus. *Scientometrics*, *130*(4), 2475–2492. https://doi.org/10.1007/s11192-025-05293-3
57. Daily, B. F., & Huang, S. (2001). Achieving sustainability through attention to human resource factors in environmental management. *International Journal of Operations & Production Management*, *21*(12), 1539–1552. https://doi.org/10.1108/01443570110410892
58. Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. https://doi.org/10.1207/s15327965pli1104_01
59. Delmas, M. A., & Burbano, V. C. (2011). The drivers of greenwashing. *California Management Review*, *54*(1), 64–87. https://doi.org/10.1525/cmr.2011.54.1.64
60. Demerouti, E., Bakker, A. B., Nachreiner, F., & Schaufeli, W. B. (2001). The job demands-resources model of burnout. *Journal of Applied Psychology*, *86*(3), 499–512. https://doi.org/10.1037/0021-9010.86.3.499

61. Dinh, H., Bui, T. T. K., Ngoc Anh, N., Nhung, N. H., & Hien, L. T. (2026). AI and green performance: The role of green servant leadership, and employees green innovation behavior. *HighTech and Innovation Journal*, *7*(3), 1007–1023. https://doi.org/10.28991/hij-2026-07-03-012
62. Dinh, H. T., Nguyen, N. H., Nguyen, N. A., & Bui Thi, K. T. (2026). Green transformational leadership encourages low-carbon practices: the regulatory function of AI and the intermediary role of green innovation culture. *Journal of Hospitality and Tourism Insights*, 1–19. https://doi.org/10.1108/jhti-12-2025-1515
63. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070
64. Dumont, J., Shen, J., & Deng, X. (2017). Effects of green HRM practices on employee workplace green behavior: The role of psychological green climate and employee green values. *Human Resource Management*, *56*(4), 613–627. https://doi.org/10.1002/hrm.21792
65. Glikson, E., & Woolley, A. W. (2020). Human trust in artificial intelligence: Review of empirical research. *Academy of Management Annals*, *14*(2), 627–660. https://doi.org/10.5465/annals.2018.0057
66. Guerci, M., Longoni, A., & Luzzini, D. (2016). Translating stakeholder pressures into environmental performance – the mediating role of green HRM practices. *The International Journal of Human Resource Management*, *27*(2), 262–289. https://doi.org/10.1080/09585192.2015.1065431
67. Haider, S. A., Akbar, A., Aman-Ullah, A., Poulova, P., & Tehseen, S. (2026). Green transformational leadership as a catalyst for sustainable environmental performance through green HRM and innovation. *Discover Sustainability*, *7*(1), Article 202. https://doi.org/10.1007/s43621-025-02497-8
68. Hameed, Z., Khan, I. U., Islam, T., Sheikh, Z., & Naeem, R. M. (2020). Do green HRM practices influence employees' environmental performance?. *International Journal of Manpower*, *41*(7), 1061–1079. https://doi.org/10.1108/ijm-08-2019-0407
69. Hao, F., Ng, W., Aman, A. M., & Zhang, C. (2025). Technology for sustainability: the impact of Avatar-led Green Training on OCBE and green creativity. *International Journal of Contemporary Hospitality Management*, *37*(1), 140–160. https://doi.org/10.1108/ijchm-12-2023-1927
70. Haq, F. u., Suki, N. M., Setini, M., Masood, A., & Khan, T. A. (2025). Adopting green AI for SME sustainability: mediating role of green investment and moderation by green servant leadership. *Sustainable Futures*, *10*, Article 101002. https://doi.org/10.1016/j.sftr.2025.101002
71. Hart, S. L. (1995). A natural-resource-based view of the firm. *The Academy of Management Review*, *20*(4), 986. https://doi.org/10.2307/258963
72. Hobfoll, S. E. (1989). Conservation of resources: A new attempt at conceptualizing stress. *American Psychologist*, *44*(3), 513–524. https://doi.org/10.1037/0003-066x.44.3.513
73. Hoque, M. O., & Das, D. C. (2026). Green leadership and sustainable supply chain performance: The mediating and moderating effects. *Social Sciences & Humanities Open*, *13*, Article 102973. https://doi.org/10.1016/j.ssaho.2026.102973

74. Jaakkola, E. (2020). Designing conceptual articles: four approaches. *AMS Review*, *10*(1-2), 18–26. https://doi.org/10.1007/s13162-020-00161-0

75. Jabbour, C. J. C., & Santos, F. C. A. (2008). The central role of human resource management in the search for sustainable organizations. *The International Journal of Human Resource Management*, *19*(12), 2133–2154. https://doi.org/10.1080/09585190802479389

76. Jackson, S. E., Renwick, D. W. S., Jabbour, C. J. C., & Muller-Camen, M. (2011). State-of-the-Art and future directions for green human resource management: Introduction to the special issue. *German Journal of Human Resource Management: Zeitschrift für Personalforschung*, *25*(2), 99–116. https://doi.org/10.1177/239700221102500203

77. Jia, X., & Hou, Y. (2024). Architecting the future: exploring the synergy of AI-driven sustainable HRM, conscientiousness, and employee engagement. *Discover Sustainability*, *5*(1), Article 30. https://doi.org/10.1007/s43621-024-00214-5

78. 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

79. Kahn, W. A. (1990). Psychological conditions of personal engagement and disengagement at work. *Academy of Management Journal*, *33*(4), 692–724. https://doi.org/10.2307/256287

80. Katz, I. M., Rauvola, R. S., Rudolph, C. W., & Zacher, H. (2022). Employee green behavior: A meta-analysis. *Corporate Social Responsibility and Environmental Management*, *29*(5), 1146–1157. https://doi.org/10.1002/csr.2260

81. Kellogg, K. C., Valentine, M. A., & Christin, A. (2020). Algorithms at work: The new contested terrain of control. *Academy of Management Annals*, *14*(1), 366–410. https://doi.org/10.5465/annals.2018.0174

82. Khairy, H., Ahmed, M., Asiri, A., Gazzawe, F., Abdel Fatah, M., Ahmad, N., Qahmash, A., & Agina, M. (2024). Catalyzing green work engagement in hotel businesses: Leveraging artificial intelligence. *Sustainability*, *16*(16), Article 7102. https://doi.org/10.3390/su16167102

83. Kim, A., Kim, Y., Han, K., Jackson, S. E., & Ployhart, R. E. (2017). Multilevel influences on voluntary workplace green behavior: Individual differences, leader behavior, and coworker advocacy. *Journal of Management*, *43*(5), 1335–1358. https://doi.org/10.1177/0149206314547386

84. Kim, Y. J., Kim, W. G., Choi, H. M., & Phetvaroon, K. (2019). The effect of green human resource management on hotel employees' eco-friendly behavior and environmental performance. *International Journal of Hospitality Management*, *76*, 83–93. https://doi.org/10.1016/j.ijhm.2018.04.007

85. Langer, M., & Landers, R. N. (2021). The future of artificial intelligence at work: A review on effects of decision automation and augmentation on workers targeted by algorithms and third-party observers. *Computers in Human Behavior*, *123*, Article 106878. https://doi.org/10.1016/j.chb.2021.106878

86. Lazanaki, V., Tsoni, E., & Katsaros, K. (2026). What makes employees innovate green? A multi-source examination of HRM, leadership, and psychological mechanisms. *World*, *7*(4), 61. https://doi.org/10.3390/world7040061

87. Li, W., Bhutto, T. A., Xuhui, W., Maitlo, Q., Zafar, A. U., & Ahmed Bhutto, N. (2020). Unlocking employees' green creativity: The effects of green transformational leadership, green intrinsic, and extrinsic motivation. *Journal of Cleaner Production*, *255*, Article 120229. https://doi.org/10.1016/j.jclepro.2020.120229

88. Luu, T. T. (2019). Green human resource practices and organizational citizenship behavior for the environment: the roles of collective green crafting and environmentally specific servant leadership. *Journal of Sustainable Tourism*, *27*(8), 1167–1196. https://doi.org/10.1080/09669582.2019.1601731

89. Luu, T. T. (2020). Integrating green strategy and green human resource practices to trigger individual and organizational green performance: the role of environmentally-specific servant leadership. *Journal of Sustainable Tourism*, *28*(8), 1193–1222. https://doi.org/10.1080/09669582.2020.1729165

90. Mittal, S., & Dhar, R. L. (2016). Effect of green transformational leadership on green creativity: A study of tourist hotels. *Tourism Management*, *57*, 118–127. https://doi.org/10.1016/j.tourman.2016.05.007

91. Najam Shaikh, S., Sohu, J. M., Shaikh, S., Zahra Kherazi, F., & Soomro, S. (2025). Artificial intelligence adoption, green HRM, and employee behavior: Driving environmental sustainability in SMEs with organizational culture as a moderator. *Sage Open*, *15*(4), Article 21582440251392673. https://doi.org/10.1177/21582440251392673

92. Noor Faezah, J., Yusliza, M., Ramayah, T., Johar, E. R., & Rosli, N. (2025). Top management support as a catalyst: unpacking the influence of green culture, green HRM, and green work engagement on employee ecological behaviour. *Journal of Management Development*, *44*(4), 534–562. https://doi.org/10.1108/jmd-07-2024-0240

93. Norton, T. A., Parker, S. L., Zacher, H., & Ashkanasy, N. M. (2015). Employee green behavior. *Organization & Environment*, *28*(1), 103–125. https://doi.org/10.1177/1086026615575773

94. Ones, D. S., & Dilchert, S. (2012). Environmental sustainability at work: A call to action. *Industrial and Organizational Psychology*, *5*(4), 444–466. https://doi.org/10.1111/j.1754-9434.2012.01478.x

95. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, n71. https://doi.org/10.1136/bmj.n71

96. Paillé, P., Chen, Y., Boiral, O., & Jin, J. (2014). The impact of human resource management on environmental performance: An employee-level study. *Journal of Business Ethics*, *121*(3), 451–466. https://doi.org/10.1007/s10551-013-1732-0

97. Parker, S. K., & Grote, G. (2022). Automation, algorithms, and beyond: Why work design matters more than ever in a digital world. *Applied Psychology*, *71*(4), 1171–1204.

https://doi.org/10.1111/apps.12241

98. Paul, J., Lim, W. M., O'Cass, A., Hao, A. W., & Bresciani, S. (2021). Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR). *International Journal of Consumer Studies*, *45*(4). https://doi.org/10.1111/ijcs.12695
99. Pereira, V., Hadjielias, E., Christofi, M., & Vrontis, D. (2023). A systematic literature review on the impact of artificial intelligence on workplace outcomes: A multi-process perspective. *Human Resource Management Review*, *33*(1), Article 100857. https://doi.org/10.1016/j.hrmr.2021.100857
100. Pham, N. T., Vo-Thanh, T., Shahbaz, M., Duc Huynh, T. L., & Usman, M. (2020). Managing environmental challenges: Training as a solution to improve employee green performance. *Journal of Environmental Management*, *269*, Article 110781. https://doi.org/10.1016/j.jenvman.2020.110781
101. Pinzone, M., Guerci, M., Lettieri, E., & Redman, T. (2016). Progressing in the change journey towards sustainability in healthcare: the role of 'Green' HRM. *Journal of Cleaner Production*, *122*, 201–211. https://doi.org/10.1016/j.jclepro.2016.02.031
102. Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879
103. Post, C., Sarala, R., Gatrell, C., & Prescott, J. E. (2020). Advancing theory with review articles. *Journal of Management Studies*, *57*(2), 351–376. https://doi.org/10.1111/joms.12549
104. Priem, J., Piwowar, H., & Orr, R. (2022). *OpenAlex: A fully-open index of scholarly works, authors, venues, institutions, and concepts*. arXiv. https://doi.org/10.48550/arxiv.2205.01833
105. Raisch, S., & Krakowski, S. (2021). Artificial intelligence and management: The Automation–Augmentation paradox. *Academy of Management Review*, *46*(1), 192–210. https://doi.org/10.5465/amr.2018.0072
106. Rehman, S. U., Kraus, S., Shah, S. A., Khanin, D., & Mahto, R. V. (2021). Analyzing the relationship between green innovation and environmental performance in large manufacturing firms. *Technological Forecasting and Social Change*, *163*, Article 120481. https://doi.org/10.1016/j.techfore.2020.120481
107. Ren, S., Tang, G., & E. Jackson, S. (2018). Green human resource management research in emergence: A review and future directions. *Asia Pacific Journal of Management*, *35*(3), 769–803. https://doi.org/10.1007/s10490-017-9532-1
108. Renwick, D. W., Redman, T., & Maguire, S. (2013). Green human resource management: A review and research agenda*. *International Journal of Management Reviews*, *15*(1), 1–14. https://doi.org/10.1111/j.1468-2370.2011.00328.x
109. Rezeki, F., & Fachrurazi, F. (2026). Artificial intelligence-enabled green recruitment and transformational leadership in strengthening small and medium-sized enterprise resilience: The mediating roles of work engagement and artificial intelligence utilisation. *SA Journal of Human Resource Management*, *24*, Article a3860. https://doi.org/10.4102/sajhrm.v24i0.3860

110. Robertson, J. L., & Barling, J. (2013). Greening organizations through leaders' influence on employees' pro-environmental behaviors. *Journal of Organizational Behavior*, *34*(2), 176–194. https://doi.org/10.1002/job.1820

111. Roscoe, S., Subramanian, N., Jabbour, C. J., & Chong, T. (2019). Green human resource management and the enablers of green organisational culture: Enhancing a firm's environmental performance for sustainable development. *Business Strategy and the Environment*, *28*(5), 737–749. https://doi.org/10.1002/bse.2277

112. Saeed, B. B., Afsar, B., Hafeez, S., Khan, I., Tahir, M., & Afridi, M. A. (2019). Promoting employee's proenvironmental behavior through green human resource management practices. *Corporate Social Responsibility and Environmental Management*, *26*(2), 424–438. https://doi.org/10.1002/csr.1694

113. Saks, A. M. (2006). Antecedents and consequences of employee engagement. *Journal of Managerial Psychology*, *21*(7), 600–619. https://doi.org/10.1108/02683940610690169

114. San Román-Niaves, M., Morandini, S., Antonini, M., & Pietrantoni, L. (2025). Green human resource management and green psychological climate: A scoping review through the AMO framework. *Sustainability*, *17*(6), Article 2535. https://doi.org/10.3390/su17062535

115. Santoso, A. S., Desiana, P. M., Prijadi, R., Wulandari, P., & Martin-Rojas, R. (2026). Opening the black box of AI-enabled green innovation: a PLS-SEM and fsQCA study of manufacturing firms. *European Journal of Management Studies*, 1–31. https://doi.org/10.1108/ejms-05-2026-0070

116. Schaufeli, W. B., Salanova, M., González-romá, V., & Bakker, A. B. (2002). The measurement of engagement and burnout: A two sample confirmatory factor analytic approach. *Journal of Happiness Studies*, *3*(1), 71–92. https://doi.org/10.1023/a:1015630930326

117. Shetty, L., Dwivedi, A., Srivastava, S., Dubey, S., & Rizvi, N. U. (2026). A bibliometric analysis of intellectual structure and thematic evolution in artificial intelligence enabled green human resource management for environmental sustainability. *Discover Sustainability*. https://doi.org/10.1007/s43621-026-04611-w

118. Siddique, N., Imran, M., Raza, M. A., Shahid, A. U., & Siddiqui, A. M. (2026). Linking green leadership and green human resource management to green work engagement: the mediating mechanism of environmental awareness. *Social Responsibility Journal*, *22*(7), 1497–1513. https://doi.org/10.1108/srj-07-2025-0753

119. Siddiqui, M. A. N., & Akhtar, S. (2026). Driving sustainable engagement through green leadership: A moderated mediated model of green behaviors and artificial intelligence support in pakistan's banking Industry. *Market Forces*, *21*(1), 121–154. https://doi.org/10.51153/mf.v21.i1.738

120. Singh, K. N., & Sinha, A. P. (2026). AI-enabled green human resource management for sustainable workforce resilience: a systematic literature review. *International Studies of Management & Organization*, 1–24. https://doi.org/10.1080/00208825.2026.2726857

121. Singh, S. K., Giudice, M. D., Chierici, R., & Graziano, D. (2020). Green innovation and environmental performance: The role of green transformational leadership and green human resource

management. *Technological Forecasting and Social Change*, *150*, Article 119762. https://doi.org/10.1016/j.techfore.2019.119762

122. Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. *Journal of the American Society for Information Science*, *24*(4), 265–269. https://doi.org/10.1002/asi.4630240406
123. Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039
124. Strubell, E., Ganesh, A., & McCallum, A. (2019). Energy and policy considerations for deep learning in NLP. *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, 3645–3650. https://doi.org/10.18653/v1/p19-1355
125. Tambe, P., Cappelli, P., & Yakubovich, V. (2019). Artificial intelligence in human resources management: Challenges and a path forward. *California Management Review*, *61*(4), 15–42. https://doi.org/10.1177/0008125619867910
126. Tang, G., Chen, Y., Jiang, Y., Paillé, P., & Jia, J. (2018). Green human resource management practices: scale development and validity. *Asia Pacific Journal of Human Resources*, *56*(1), 31–55. https://doi.org/10.1111/1744-7941.12147
127. Tanveer, M. (2025). Leading green with heart and intelligence: Uniting AI, emotional intelligence, and transformational leadership for a sustainable future. *Sustainable Futures*, *10*, Article 101137. https://doi.org/10.1016/j.sftr.2025.101137
128. Tarafdar, M., Cooper, C. L., & Stich, J. (2019). The technostress trifecta - techno eustress, techno distress and design: Theoretical directions and an agenda for research. *Information Systems Journal*, *29*(1), 6–42. https://doi.org/10.1111/isj.12169
129. Tran, N. K. H. (2023). An empirical investigation on the impact of green human resources management and green leadership on green work engagement. *Heliyon*, *9*(11), Article e21018. https://doi.org/10.1016/j.heliyon.2023.e21018
130. Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing Evidence-Informed management knowledge by means of systematic review. *British Journal of Management*, *14*(3), 207–222. https://doi.org/10.1111/1467-8551.00375
131. Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the longwall method of coal-getting. *Human Relations*, *4*(1), 3–38. https://doi.org/10.1177/001872675100400101
132. van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3
133. Waltman, L., van Eck, N. J., & Noyons, E. C. (2010). A unified approach to mapping and clustering of bibliometric networks. *Journal of Informetrics*, *4*(4), 629–635. https://doi.org/10.1016/j.joi.2010.07.002
134. Yong, J. Y., Yusliza, M., Ramayah, T., Chiappetta Jabbour, C. J., Sehnem, S., & Mani, V. (2020). Pathways towards sustainability in manufacturing organizations: Empirical evidence on the role of

green human resource management. *Business Strategy and the Environment*, *29*(1), 212–228. https://doi.org/10.1002/bse.2359

135. Zacher, H., Rudolph, C. W., & Katz, I. M. (2023). Employee green behavior as the core of environmentally sustainable organizations. *Annual Review of Organizational Psychology and Organizational Behavior*, *10*(1), 465–494. https://doi.org/10.1146/annurev-orgpsych-120920-050421
136. Zhang, N., Ren, X., Sun, X., & Jin, C. (2024). The effect of corporate social responsibility characteristics on employee green behavior: A moral emotions perspective. *Behavioral Sciences*, *14*(11), Article 1045. https://doi.org/10.3390/bs14111045
137. Zhang, X., Panatik, S. A., & Zhang, N. (2024). Employee green behavior: Bibliometric-content analysis. *Heliyon*, *10*(10), Article e31045. https://doi.org/10.1016/j.heliyon.2024.e31045
138. Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*(3), 429–472. https://doi.org/10.1177/1094428114562629

Figures

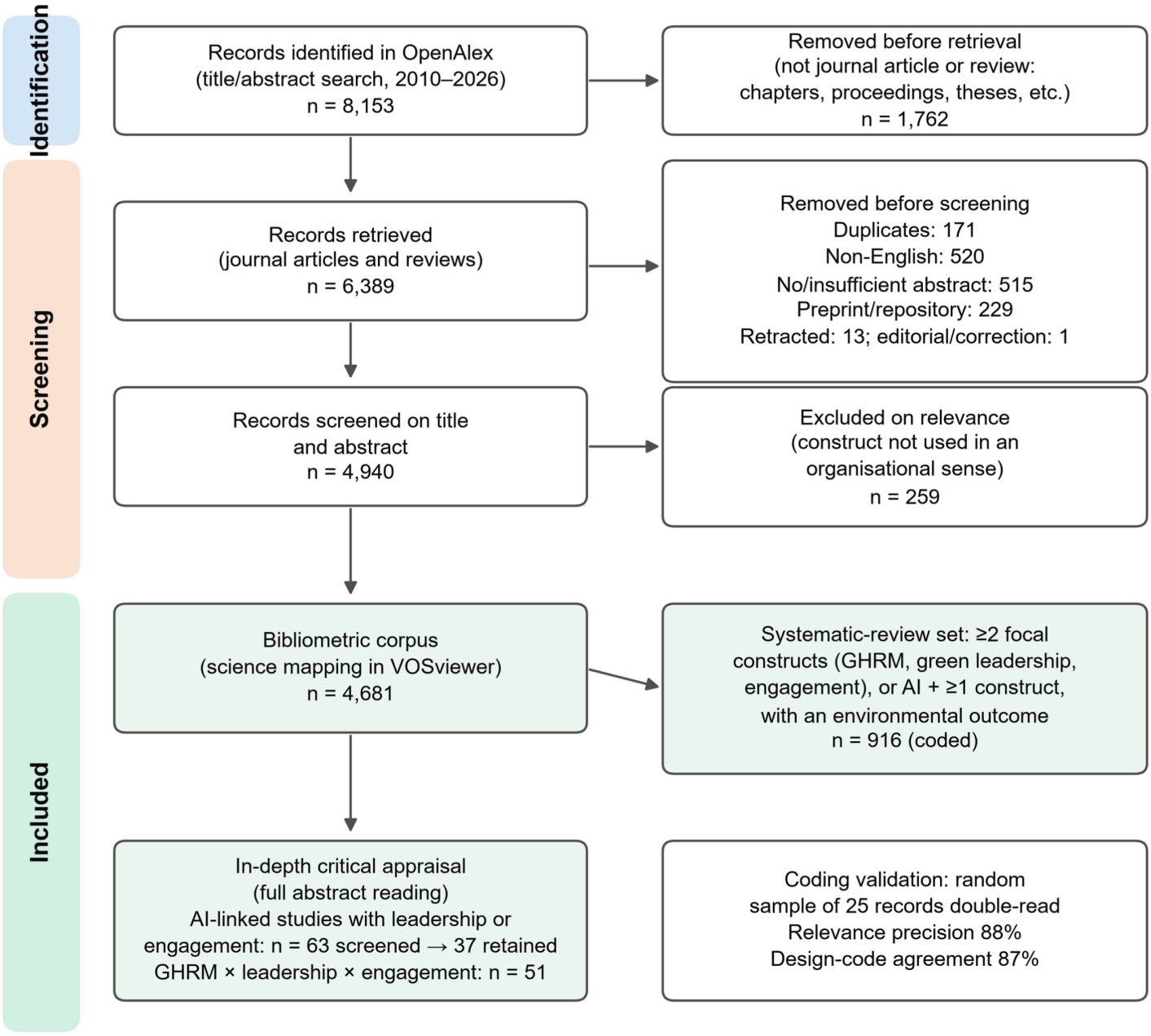


Figure 1

PRISMA 2020 flow of record identification, screening and inclusion. Source: authors, based on OpenAlex data retrieved on 27 October 2026

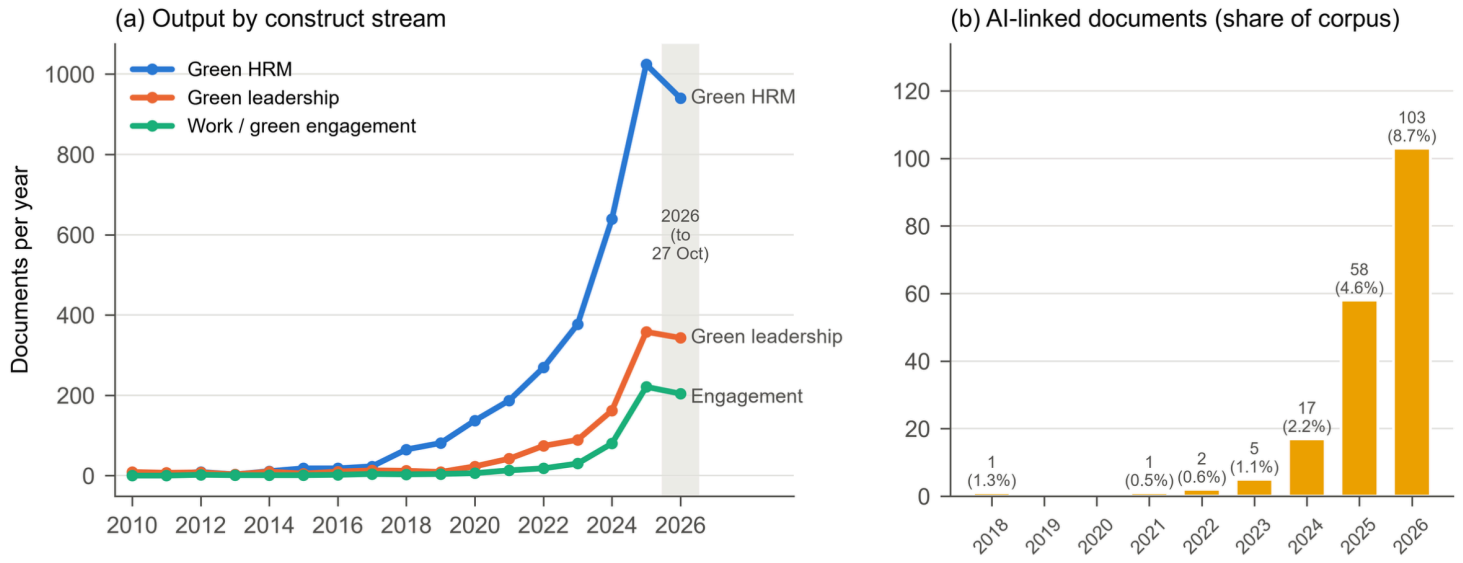


Figure 2

Annual scientific production. (a) Documents per year by construct stream (a document can belong to more than one stream). (b) AI-linked documents and their share of the annual corpus. The 2026 values cover January to 27 October. Source: authors, OpenAlex data

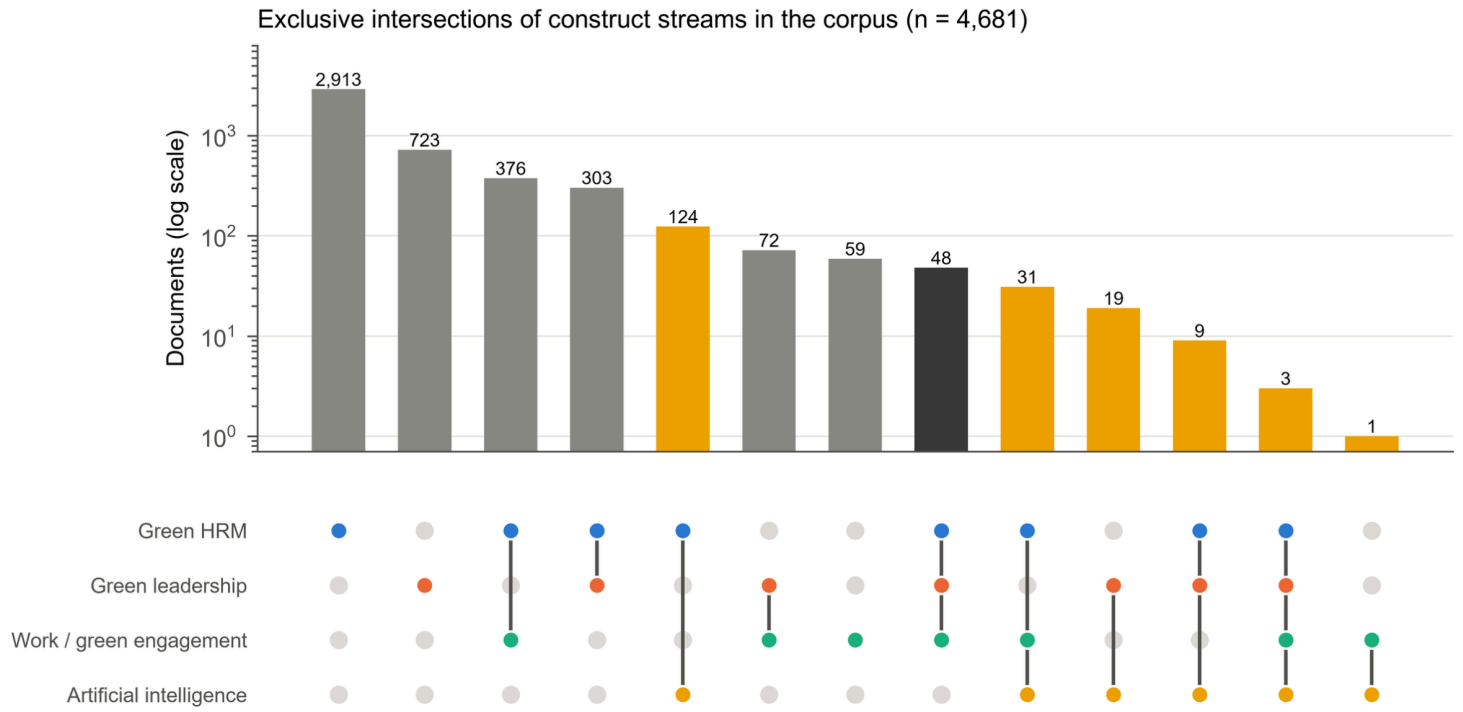


Figure 3

Exclusive intersections of the four construct streams (UpSet representation, logarithmic scale). Each bar counts documents that contain exactly the combination of constructs marked below it; yellow bars

involve AI and the dark bar marks the GHRM–green leadership–engagement intersection. Source: authors, OpenAlex data

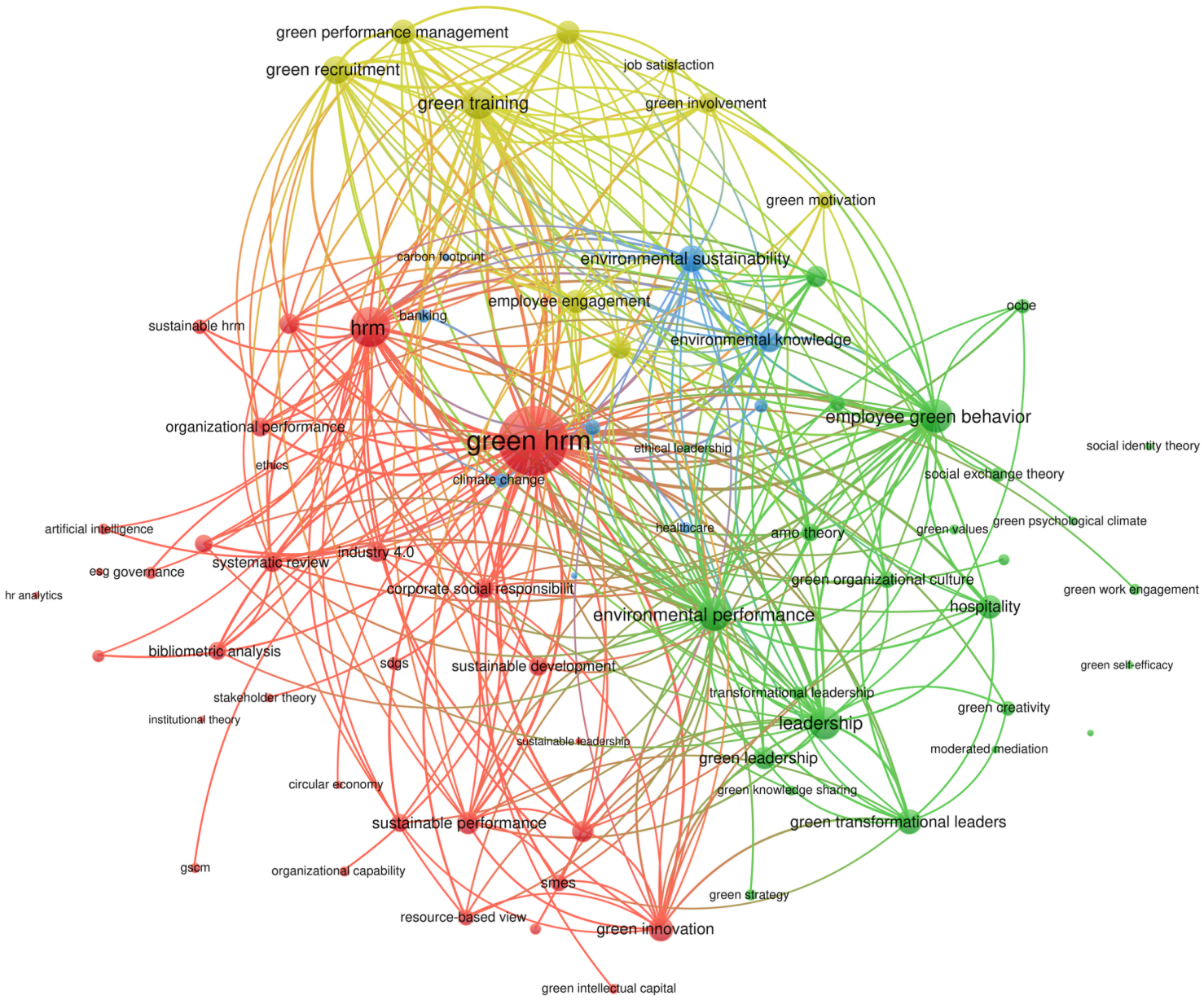


Figure 4

Term co-occurrence network (VOSviewer 1.6.21; 75 terms occurring in ≥ 50 documents; binary counting; association-strength normalisation; node size = occurrences; colour = cluster). Source: authors, OpenAlex data

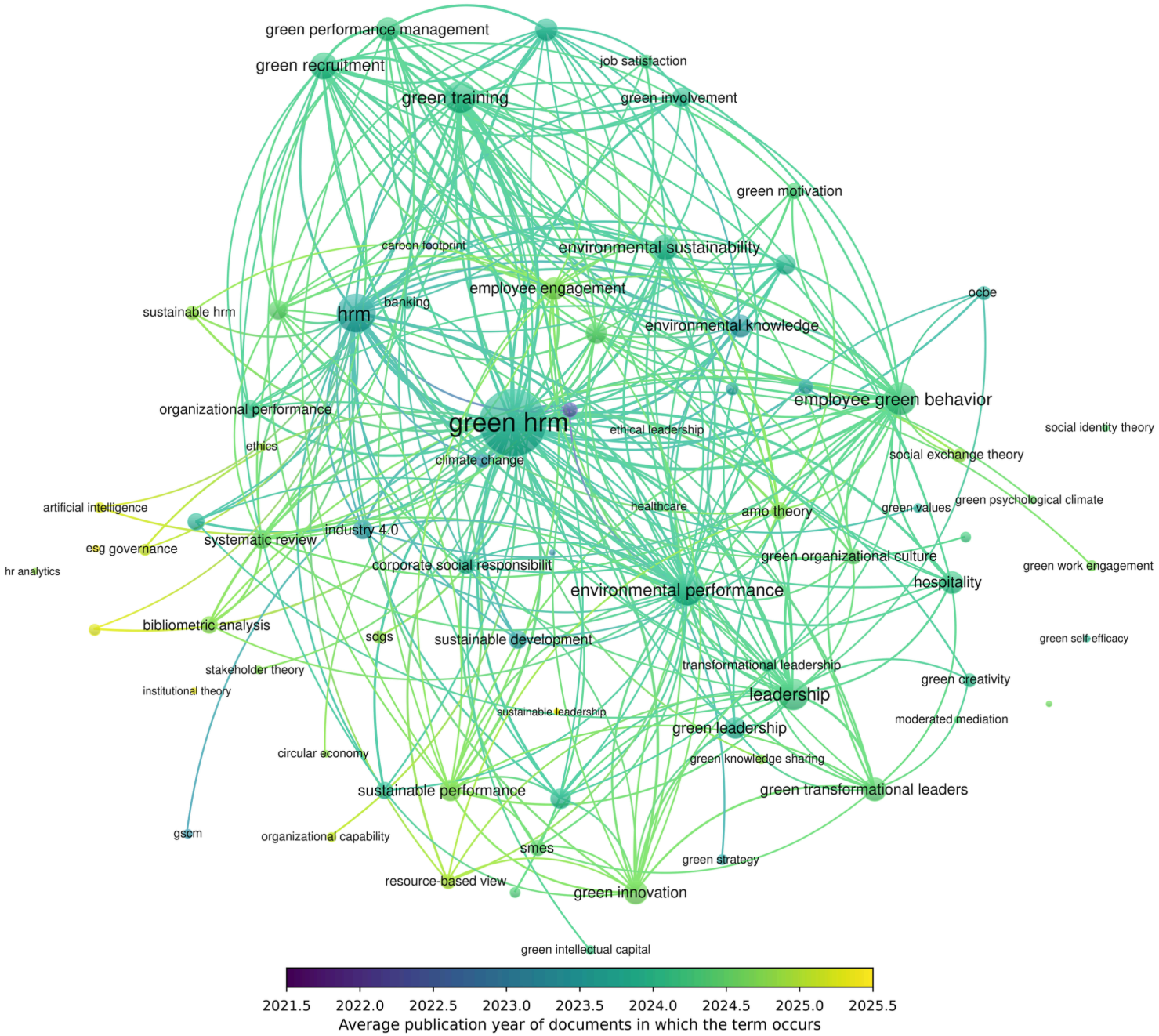


Figure 5

Overlay visualisation of the term map; colour indicates the average publication year of the documents in which a term occurs (VOSviewer 1.6.21). Source: authors, OpenAlex data

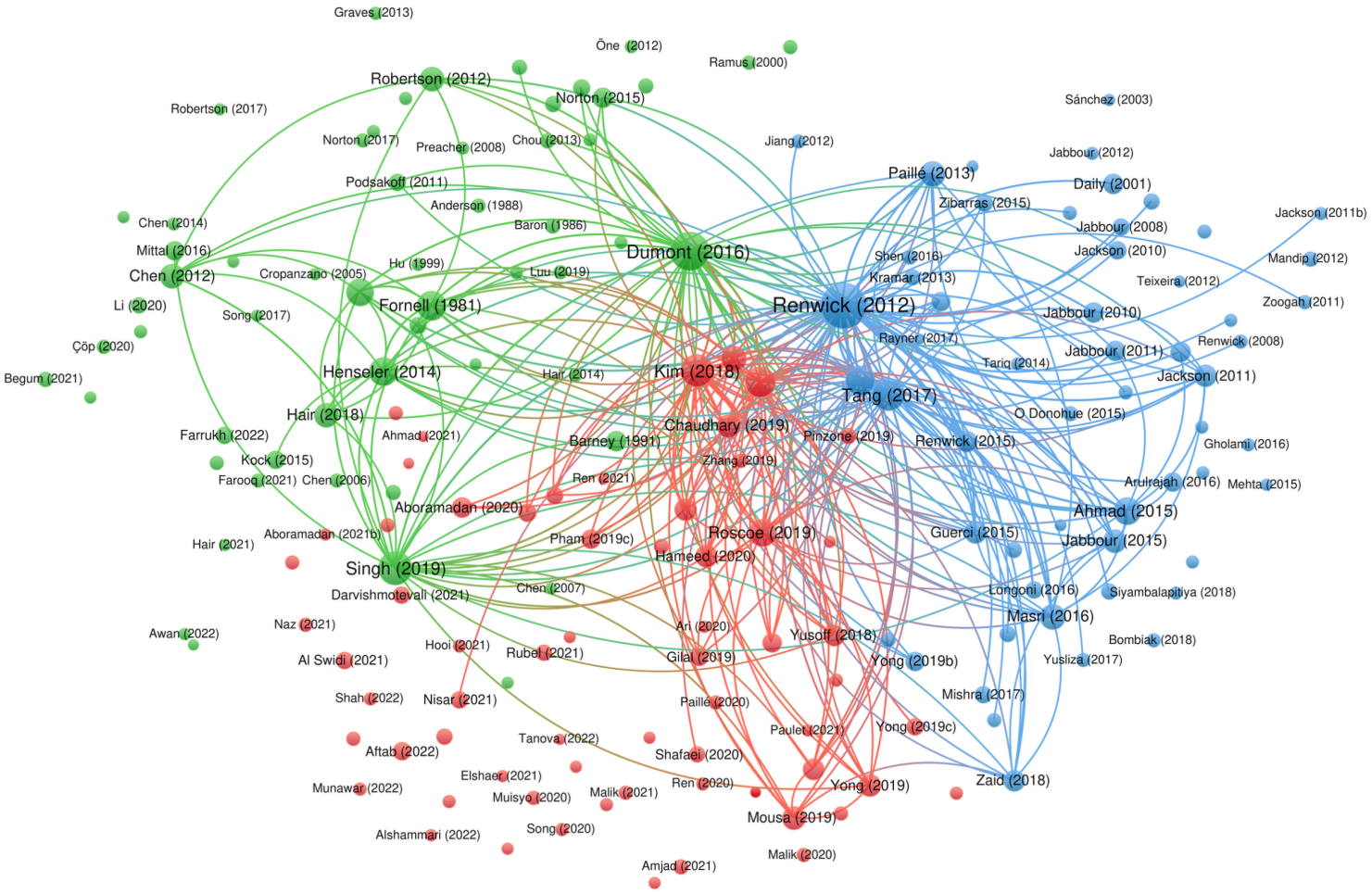


Figure 6

Co-citation network of references cited by ≥ 80 corpus documents (177 references; labels show first author and year as recorded in OpenAlex, which may be the online-first year). Source: authors, OpenAlex data

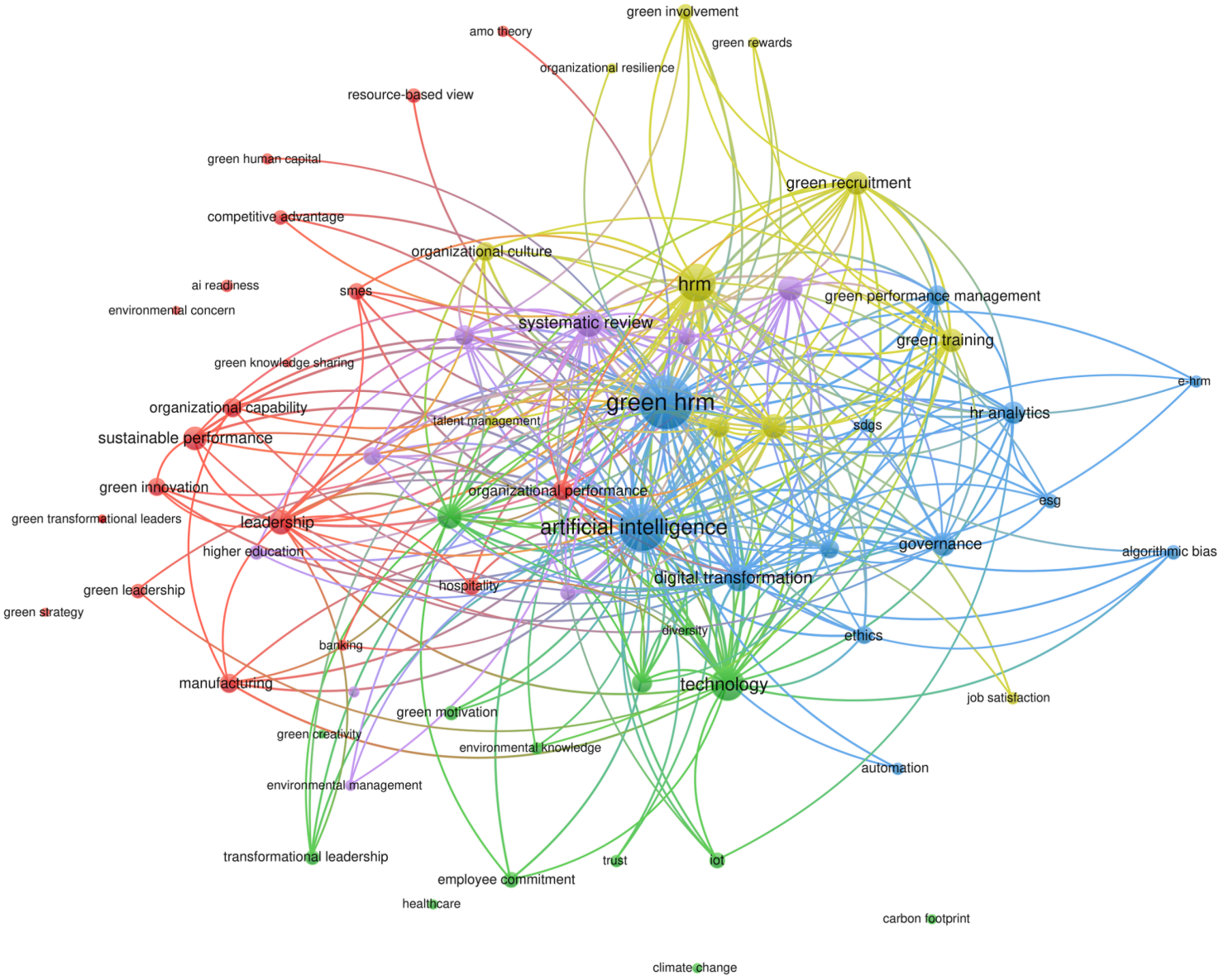


Figure 7

Term co-occurrence network of the 187 AI-linked documents (terms occurring in ≥ 5 documents). Source: authors, OpenAlex data

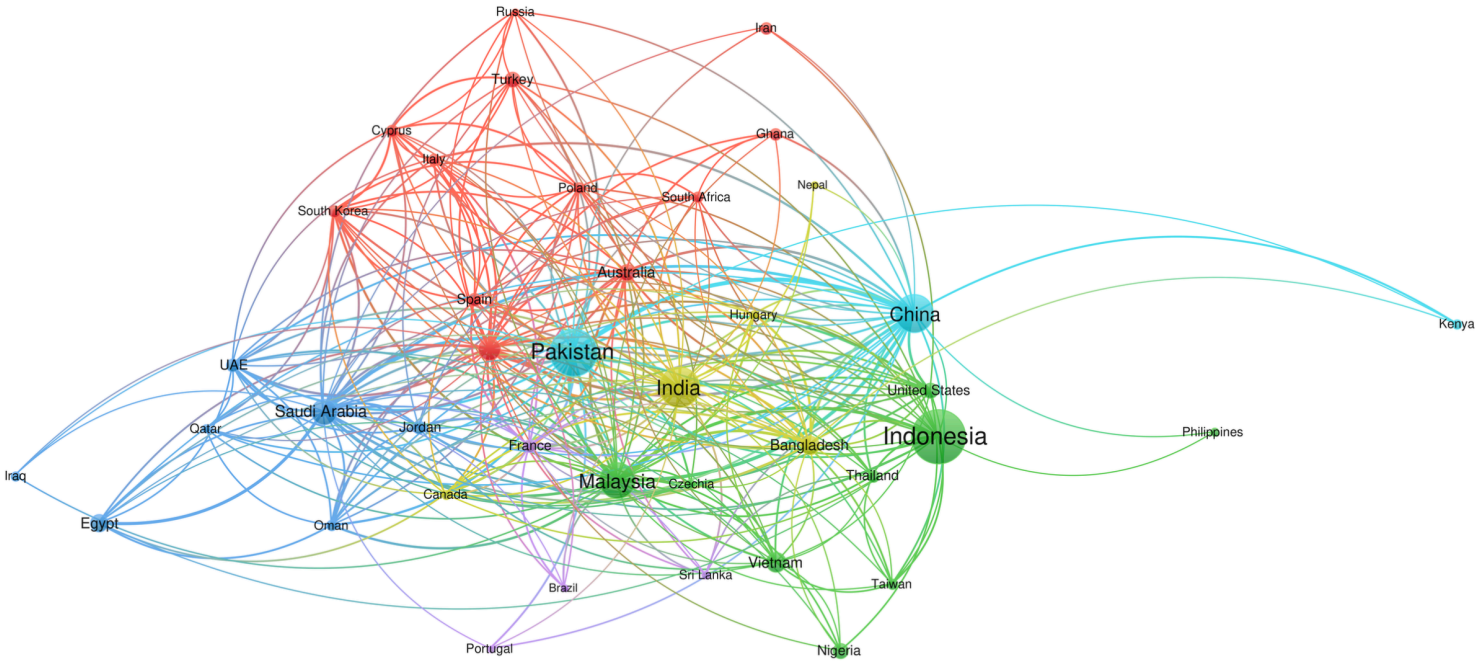


Figure 8

Country co-authorship network (40 countries with ≥ 20 documents; full counting; node size = documents). Source: authors, OpenAlex data

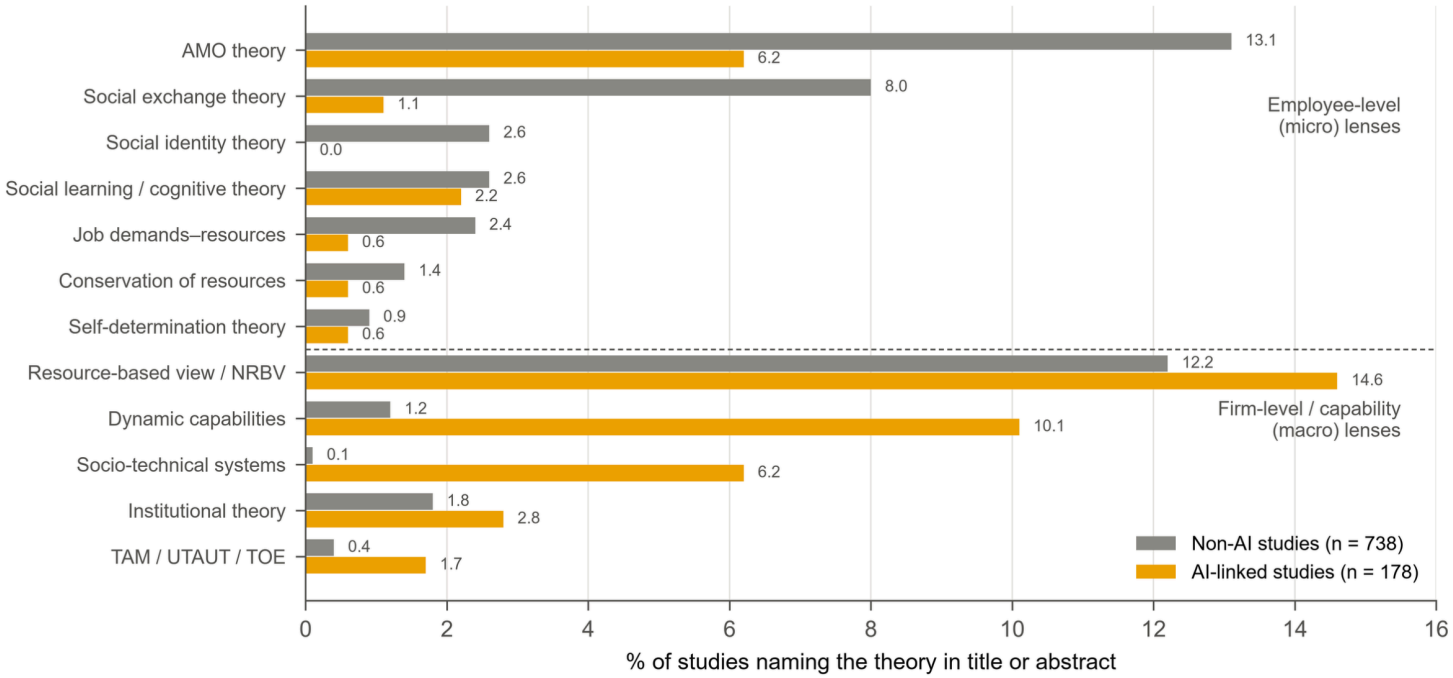


Figure 9

Theories named in titles or abstracts of AI-linked (n = 178) and other (n = 738) studies in the review set (% of studies). Source: authors' coding of OpenAlex records

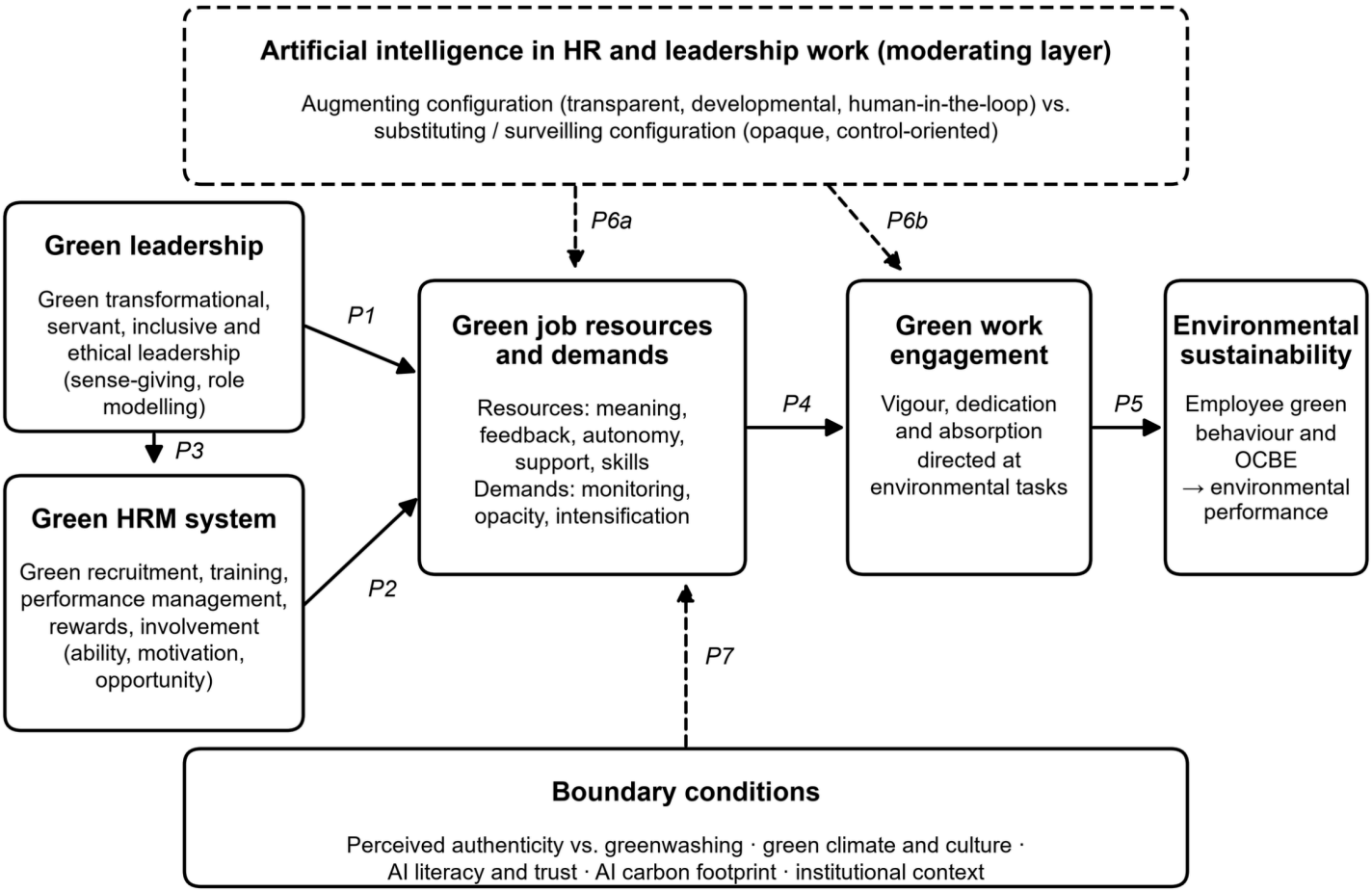


Figure 10

Integrative framework: green leadership, GHRM, AI and green work engagement as a job demands–resources pathway to environmental sustainability (P = proposition). Source: authors